Dealing with "fragile identities": resistance and refiguring in women mathematics students

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Many learners may be successful in mathematics but nevertheless see themselves as existing only on the margins of the practice, or as lacking stability in it – in this sense, they have what can be called a fragile identity. Although this kind of relationship with mathematics is not limited to girls and women, they do appear to express such fragile identities more often or more readily. Drawing on qualitative and quantitative data from undergraduates in three English universities, this paper presents an analysis of the way in which university mathematics is differentially experienced by men and women, and of the part this may play in women's ongoing narratives of self as mathematicians. It is suggested that some women resist traditional positionings in the mathematics world, drawing on local resources which enable a sense of agency as successful students and a refiguring of their relationships with mathematics.

Keywords: mathematics, undergraduates, learner identities, self-positioning, resistance

Fragile identities: school origins

Our starting point is a common observation that while many learners may be successful in mathematics they nevertheless see themselves as existing only on the margins of the practice, or as lacking stability in it – in this sense, they have what can be called a fragile identity. Although this is by no means the sole province of girls and women, they do appear to express such fragile identities more often or at least more readily, not only during the compulsory school years (Bartholomew, 1999; Boaler, 1997; Boaler *et al.*, 2000; Solomon, 2007a), but also within 6th form and Higher Education settings, where, in the UK, studying mathematics is a matter of choice (Mendick, 2005; Solomon, 2007b, 2008). Research into school mathematics suggests that these patterns are underpinned by discursive positionings which inscribe learners' relationships with mathematics in particular ways: gender discourses and institutional practices interact to constrain the range of identities that are available to mathematics learners such that girls appear to lack a niche in this particular world. This is especially apparent in the ubiquitous UK practice of teaching in 'ability' groups, which are characterized by particular cultures and (self)-positionings which are heavily gendered and also classed. So, for example, Bartholomew (1999) found that within a top set class, a group of middle class boys were positioned as the teacher's equals, marked out as quick to produce correct answers with apparently little effort. As 'budding mathematicians', a label conferred by their confident behaviour and set membership (but not necessarily their actual performance), they did not have to work hard to justify their place in the set, whereas girls were likely to be positioned and to position themselves as having 'less right' to be there. Thus Bartholomew (2000, 6)

argues that 'the culture of top set maths groups, and of mathematics more generally, makes it very much easier for some students to believe themselves to be good at the subject than for others'. Anxiety among top set girls is also well-documented elsewhere, and focuses in particular on the issue of understanding - for example Boaler (1997, 179) reports that 'high ability girls are, for some reason, more likely to desire understanding and become disaffected when they cannot attain it', while Boaler *et al.,* (2000) note their complaints about the impact on understanding of the fast pace of lessons. More generally, top set girls may express a sense of 'not belonging' to the community, being more likely to express marginalised identities with respect to mathematics which are more akin to those of lower set pupils in general (Solomon, 2007a). Mendick *et al.* (2008) report that male GCSE students are three times more likely to say they are 'good at maths', while in post-compulsory Year 12, it is even more the case that 'doing mathematics is doing masculinity': 'it is more difficult for girls and women to feel talented at and comfortable with mathematics and so to choose it and to do well at it' (Mendick, 2005, 217).

Maintaining a position of being 'good at mathematics' is also an issue. As Bartholomew's research suggests, girls need to justify their place in top sets, both to others and to themselves, but the markers of such a position may be elusive and shifting. Walkerdine (1998) notes how boys' 'poor performance is both excused and turned into a good quality' (162) while girls work hard and strive for what are 'feminine' qualities which are both required but at the same time de-valued by teachers, resulting in a generalised sense of insecurity:

> Girls, at the nexus of contradictory relationships between gender and intellectuality, struggle to achieve the femininity which is the target of teachers' pejorative evaluation. They often try to be nice, kind, helpful and attractive: precisely the characteristics that teachers publicly hold up as good — asking all children to work quietly or neatly, for example, while privately accusing the girls of doing precisely these things. Thus they are put in social and psychic double-binds. ... In the fourth year of secondary school girls were still performing better than boys overall but were often felt to be unconfident and put in the double-bind of not being pushed or helped …. the classroom processes and psychic struggles we have documented make it difficult for them to push for success. In English, by comparison, they were far more able to join in (162-3)

Thus gender identification and pedagogic discourse interact: as Creese *et al.* (2004, 192) argue, 'classrooms allow children to 'shift positions' (or not) by virtue of a school's specific values, pedagogies and discourses'. Girls and boys participate differently because they are taking up, negotiating and maintaining (or attempting to maintain) those positions which are open to them within the context of pedagogic discursive practice.

Positioning occurs over time, of course. Sfard and Prusak (2005) suggest that an important component part of identity is one's *designated identity*, formed from

> Narratives presenting a state of affairs which, for one reason or another, is expected to be the case, if not now then in the future.... The scenarios that constitute designated identities are not necessarily desired but always are perceived as binding. One may expect to "become a certain type of person," that is, to have some stories applicable to oneself, for various reasons: because the person thinks that what these stories are telling is good for her, because these are the kinds of stories that seem appropriate for a person of her sociocultural origins, or just because they present the kind of future that she is designated to have according to others, in particular according to people in the position of authority and power. (18)

What is important about such designated identities is that individuals subscribe to them unconsciously, taking up the offered position without question, 'without realizing that these are "just stories" and that there are alternatives' (18). We might ask, however, what options there may be for resistance to, or refusal of, offered positions; Sfard and Prusak say that there is (limited) room for choice, while Gee (2001, 116ff) suggests that it is possible to 'bid' for a particular identity position or to resist invitations to take up an ascribed identity. Within 'figured worlds' (Holland *et al.*, 1998) such as that of university mathematics, reflection on the nature of the figured world itself can provide an impetus for greater agency:

> The everyday aspects of lived identities … may be relatively unremarked, unfigured, out of awareness, and so unavailable as a tool for affecting one's own behavior. … [But] Ruptures of the taken-for-granted can remove these aspects of positional identities from automatic performance and recognition to commentary and re-cognition... Some signs of relational identity become objectified, and thus available to reflection and comment…. (140-141)

Thus identities can be re-told in 'narrative acts [which] may reinforce or challenge these figured worlds' (Skinner *et al.*, 2001 para 10). In the next section we consider the issues for women mathematics undergraduates who have, we might suppose, resisted invitations to take up ascribed identities, and so challenged the taken-for-granted in mathematics.

Dealing with fragility? The university experience

In the previous section we identified particular issues relating to girls and mathematics in the compulsory school years. These issues interact of course, but they fall into categories which we will use to organise what follows. First, relationships with teachers underpin much of girls' experience: the nature of pedagogic relationships appears to differ between boys and girls, in that boys are treated (and act) more as equals with the teacher, using them as a resource, whereas girls are more often the subject of didactic as opposed to dialogical exchanges. These patterns flood over into more social aspects of the relationship – girls appear to be more concerned to gain approval from teachers, and possibly have to work harder to gain it. Second, boys and girls take up different roles in the learning context: boys appear to be more confident, more likely to ask and answer questions and to interrupt; importantly, they are more likely to be rewarded for this. Third, girls may lack a sense of legitimacy as mathematics students in several senses: in comparison with others, in terms of the nature of their understanding, with respect to teachers' perceptions of them, and as simply being female – being female and good at mathematics may be seen as incompatible states. How visible are these issues among women who have opted for undergraduate mathematics? Are there any indications that they deal with identity positions differently in the university context?

Relationships with tutors

Moving to a university environment commonly entails a shift from small classes and close teacher-pupil contact to large scale lecture-based teaching supplemented by tutorials or workshops which may themselves be large in comparison with school or college; hence all students must work out new norms in tutor-student relationships. The British-based Students' Experiences of Undergraduate Mathematics

(SEUM) project (Brown & Macrae, 2005) found that perceptions of tutors as 'good' or 'bad' were dependent on their approachability, enthusiasm, willingness to interact and ability to make difficult material interesting and accessible. However, although they were used to seeking help from tutors pre-university, students did not necessarily continue to do so at university; they expected tutors to approach them, or felt that tutors were more concerned with research than teaching (Macrae *et al.*, 2001). Nevertheless, a small number of (male) students in this project reported getting involved in mathematical discussion (ie dialogic as opposed to help-focussed) with tutors (Brown & Rodd, 2004, Rodd & Bartholomew, 2006). Writing about science, mathematics and engineering (SME) students in the USA, Seymour and Hewitt (1997, 239) note that while both male and female students are critical of the quality of their teaching, they 'diverge not in the perception that pedagogical problems exist, but in their definitions of "good teaching", in what they expect of the faculty-student relationship'. They found that women sought positive relationships with their teachers, stressing more than men the ideal teacher as approachable and interested in them as a person (267). Praise was essential to motivation and to sustaining an identity of success so much that, in order to stay the course, they had to learn to separate out work and self, and to forego praise.

Gendered roles in the learning context

While women seek more personal relationships with tutors, a major element of traditional SME education is, Seymour and Hewitt suggest, the discourse of 'challenge'. They argue that young women do not know how to respond in accordance with the norms of this community, nor do they respond to the centrality of competition in it: 'what motivates most young women is neither the desire to win, nor the fear of failure in a competition with men, but the desire to receive praise' (265). In eschewing competition, women are more likely to work collaboratively, but given that perceived markers of 'inherent ability' – apparently making little effort, not asking questions in class, avoiding peer study – are crucial in maintaining a position in the male hierarchy, women's tendency to ask questions and to admit to problems consistently breaks the 'ground rules', and so 'reduce[s] their claims to 'smartness' among the men' (251).

This analysis begins to draw attention to the gendered nature of positioning in SME classes. Drawing on the SEUM project data, Bartholomew & Rodd (2003) report that women were less likely to be noticed in class, both by tutors – even when they made a contribution – and by their peers. They suggest that this 'invisibility' results from the lack of a discursive space for women who do mathematics; since the available identities and cultural norms are masculine, young women can only position themselves as good at mathematics by making themselves highly visible and stepping out of the available female identities. Thus contributing in class creates visibility but at the same time exposes women to responses which mark them as unfeminine and in one sense as outsiders. So, for example, observing the behaviour of one female student they note that: 'on one occasion when she offered a simplification there was an audible "oooh" from the class, suggesting she was being unattractively clever' (17). This was unusual: women students were more likely to choose invisibility as a means of self-protection from the difficulties of 'being a mathematical girl'.

Legitimacy and understanding

While they argue that some women are developing different ways of being good at mathematics through *intentional* invisibility and quiet control – 'a learning persona does not have to be an imitation of the masculine model' (49) - Rodd and Bartholomew (2006) note that even highly successful women undergraduates found it difficult to identify as good at mathematics. They tended to play down their achievements, 'tapping into discourses about mathematics learning which place "real understanding" in opposition to "memorization", and generally associate "flair" with boys' (44). Similarly, Mendick *et al.* (2008) report that undergraduates tend to divide mathematics sub-areas into 'masculine' and 'feminine', masculine areas being perceived as more 'intellectual'. What is meant by 'understanding' is crucial, however: undergraduate women are likely to berate themselves for not understanding at levels which are in fact more demanding than those that their male counterparts set for themselves (Solomon 2007b), failing to realise that their sense of 'not belonging' is constructed within a learning community which frequently emphasizes speed and performance. Furthermore, as Seymour and Hewitt report, earning legitimacy as a successful woman mathematics student in such a community is not without cost:

> Women were also concerned that male acceptance of their academic worth would have negative consequences for their sense of who they are as women. The problems of belonging and identity are linked, because the qualities that women feel they must demonstrate in order to win recognition for their "right" to belong (especially "smartness", assertiveness and competitiveness), raise the anxiety that such recognition can only be won at the expense of "femininity". (p.243)

As Rodd and Bartholomew also indicate, these women experienced, or were the object of, multiple tensions within the discourses of being good at SME subjects and being female. Being good at mathematics, or more accurately being *seen* to be good at mathematics, continues to conflict with femininity, as it does at school.

This research indicates that the same issues that can be observed in the school years are in operation at university level. However, women do make adjustments which enable them to continue, sometimes actively resisting the 'designated identities' of undergraduate mathematics learning. In what follows, we will show that while students in three English universities may agree on the nature of undergraduate mathematics teaching and its shortcomings, there appear to be gender differences in the ways that it is experienced and how students position self and others. Nevertheless, there are indications of challenge and resistance to the ways things are; how students might resource such resistance in order to maintain an identity of being successful in mathematics is a central concern of this paper.

The study

The data on which this paper is based are drawn from two sources:

(1) Interviews and focus groups involving 33 university students, 12 in their first year and 21 in their 2nd/3rd years, attending three different universities in England: 'Bradley' University and 'Middleton' University are members of the '1994 Group' of research-intensive universities (see http://www.1994group.ac.uk/) while 'Farnden' University is a member of the 'Million+ Group', which emphasises access to university teaching (see http://www.millionplus.ac.uk/). Students at Bradley and Middleton enter their degrees from more traditional educational routes and with higher grades than at Farnden. Fourteen of the students were women, and nineteen were men; three (two women, one man) were mature students. All were studying mathematics at undergraduate level,

either as a single major, or as part of a combined degree. The first-year students (Bradley) were individually interviewed about their 'mathematics histories' and their perceptions of mathematics and of themselves as mathematicians. The 2nd and 3rd year students (Middleton and Farnden) participated in 6 focus groups in which they were asked to discuss their experiences of learning mathematics at university, focussing on change in their teaching and learning environments from pre-university to the present. Audio recordings were transcribed and analysed thematically with particular focus on relationships with tutors, approaches to learning and the learning context, and gender.

(2) Questionnaires completed by 130 2nd year students at the three universities (42.3% at Bradley, 41.5% at Middleton and 16.2% at Farnden), covering various aspects of their experience, including perceptions of mathematics as a subject, contrasts with their pre-university mathematics experience, individual approaches to learning, perceptions of other mathematics students, relationships with tutors, and views of university support systems. There were 77 men and 53 women, 118 (91.5%) of whom were aged 19 or 20, with a further 9 aged 21-23, and a further 2 mature students aged 39 and 47 (both men). One respondent did not give their age. Questionnaires included 100 closed questions consisting largely of Likert-type items and were administered and collected during scheduled lecture sessions in the autumn term, 2008. Data were inputted and analysed using SPSS; the analysis in this paper is based on a selection of 41 5-point Likert items tapping the specific issues with which we are concerned in this paper.

Undergraduate identities: being good at maths?

In this section we present an analysis of what students say about their university studies, focusing on their self-positioning in the learning community. In response to the previous literature discussed above, we looked for patterns in the data that revolve around relationships with tutors, gendered roles in the learning context, and legitimacy and understanding; in what follows we integrate the interview and focus group data with our analysis of the questionnaire with this end in view. Turning first to the questionnaire data, we conducted an exploratory factor analysis on the 41 questionnaire items, resulting in the identification of five factors underlying the pattern of responses [1]. These five factors can be interpreted as measures of:

(1) confidence, interest and positive attitude;

(2) positive relationships with tutors;

[1] The initial analysis revealed the presence of 12 factors with eigenvalues greater than 1, explaining 21.0%, 8.4%, 6.4%, 5.6%, 4.7%, 4.2%, 3.6%, 3.2%, 3.0%, 2.9% 2.7% and 2.5% of the variance respectively. An inspection of the associated scree plot revealed an inflexion after the fifth component (ie a flattening out of the amount of variance explained) and five components were therefore retained for further investigation. A varimax rotation resulted in a simple structure with all five components showing a number of strong loadings. The five component solution explained 46.1% of the total variance (21%, 8.4%, 6.4%, 5.6% and 4.7% for factors 1 to 5 respectively). For details of the processes involved in exploratory factor analysis, and followed in this analysis, see Field (2009).

(3) positive attitude towards groupwork;

(4) willingness to ask questions;

(5) positive experience of mathematics before university.

As these tentative labels suggest, these emergent factors map on to the issues we have already identified - Factor 2 with relationships with tutors, Factors 3 and 4 with gendered roles in the learning context, and Factors 1 and 5 with legitimacy and understanding. We discuss them and their contributing items in the relevant sections below.

Relationships with tutors

The importance of relationships with tutors is particularly evident when students talk about changes in their learning environment: they comment frequently on the large classes which characterise university teaching in comparison to school and college, the increased pace (and pressure) as they move up through the years, and the increasing emphasis on independent learning. Within this context, tutors are described as having unquestioned power and authority, and the focus group narratives in particular draw heavily on familiar portrayals of mathematicians as eccentrics and poor communicators by definition, with the implication that student/tutor relationships cannot be other than poor. For example Jess (Middleton Year 2) tells the following story as part of a general account in the group of poor teaching and confusion:

> In one of his tutorials - he doesn't particularly help you. I said "I don't understand it, can you just look at what I've written for this question" and he just looked at it and said "Your answers are strange" and walked away. *[Laughter in the group as a whole]*

Other Middleton 2nd years report further on the power imbalance and tutors' failure to explain adequately:

> Nick: If you've got someone who's going to patronise you if you're totally wrong then you'll be reluctant to shout out (I won't mention any names) ..
>
> Megan: They pick on you..
>
> Nick: It's just the response you would get if you were to be wrong it would be "how do you not know?" - that kind of response.
>
> Megan: "Why don't you know it, it's blatantly obvious, it's simple" – no it's not!

Like Jess, who talks about aiming high but always being 'second best' ('I'll probably get a 2.2 but I always aim for one mark above ... I didn't get A at A-level I only got B, and I didn't get the A* at GCSE I only got A, so I'm not going to get a first I'll only get a second'), Emma (Middleton Year 2) finds it difficult to describe herself as a good student, both to herself and to others. Her (tentative) identification of herself as able is hedged by being set within the context of her tutor's assessment of her:

> My tutor seems to have high expectations of me after my results last year but I just hope I get through it and get a decent grade by the end. … I used to think [I can't get a first] but last year I got a first so it's kind of a big shock, and that's why I think my tutor has more faith in me than I do. … I

> never had it so to say I'm going to get this and I'm going to get that when I don't actually know, I don't want to say it and then fall flat on my face.

Matt, in the same Middleton Year 2 focus group as Emma, tells his success story in a strikingly different fashion: **'**I don't want to sound big headed but I'm hoping for a first. I think I'm on the way to getting that. …. my tutor has been trying to get me to do a PhD……'.

While there is agreement among students about the nature of relationships with tutors, the suggestion that there are gender differences in how these are experienced is borne out by the factor analysis: men scored significantly higher (and thus more positively) than women on factor 2 (positive relationships with tutors)

As can be seen from the results in Table 1, women respond more negatively to every item, although in two cases the differences are not significant. Debbie (Bradley, Year 1) presents an example of the complexity and impact of relationships with tutors in this account of difficulties with a university tutor:

> So there was something, and I can't even remember what the question was but it had something, we had to do the chain rule in it and my mind just went, I don't even know how to do this chain rule. I don't really understand it. So I went to Dr Fox and we've had some dealings before but we're all right now. And he was like, you know, "oh, you know, you're gonna have to get sorted out with these type of things, you know", and I flushed up and everything. But I sit it out, you know, because he's upset me before but I just think no, I'm determined to learn so I'll just, even if it's uncomfortable I'm not bothered. And so he gave me some examples and showed me, so I was saying well I learnt it through this DIDO and whatever and he said "well, she's obviously not a very good teacher your teacher if she's stressed on that and not on the other". And I felt disloyal for not sticking up for her afterwards. I thought "no, she is a good teacher, it's not her fault, I should know it".

	Outcome	**N (M)**	**N (F)**	**U value**	**z-score**	**2-tailed p value**
Factor 2: "Positive relationship with tutors"	Men more positive	74	46	1242	-2.483	0.013
Individual Factor 2 items						
I think most mathematics lecturers are approachable	Men more likely to agree Women more likely to disagree	77	52	1603.5	-2.189	0.029
Most mathematics lecturers do try to help me learn	Men more likely to agree Women more likely to disagree	77	53	1512.5	-3.092	0.002
When I ask lecturers for help, I often do not understand their explanations	Women more likely to agree Men more likely to disagree	77	52	1496.5	-2.547	0.011
The feedback I receive is sufficient to enable me to make progress with my academic work	Women more likely to disagree Men more likely to agree	Differences not statistically significant				
I think lecturers encourage participation in learning	Women more likely to disagree Men more likely to agree	Differences not statistically significant				

mathematics at university		

Table 1: Gender differences in factor 2 (positive relationships with tutors) and associated items

Gendered roles in the learning context

While relationships with tutors are clearly one aspect of gendered roles in the learning context, previous research indicates two further aspects of difference in terms of a preference on the part of women for group work and a reluctance for visible participation in class which is in tension with the need to ask questions in order to understand. Factors 3 and 4 identified attitudes to group work and to asking questions in class, with some interesting findings.

	Outcome	**N (M)**	**N (F)**	**U value**	**z-score**	**2-tailed p value**
Factor 3: "Positive attitude to groupwork"	Women more positive	Differences not statistically significant				
Individual Factor 3 items						
I learn a lot from working with student friends	Women more likely to agree Men more likely to disagree	Differences not statistically significant				
I prefer to do my 'private study' work with a group of other students	Women more likely to agree Men more likely to disagree	Differences not statistically significant				
If I need help I talk first of all with my friends	Women more likely to agree Men more likely to disagree	Differences not statistically significant				
I wish we had more group work	Women more likely to agree Men more likely to disagree	Differences not statistically significant				
I prefer to learn mathematics on my own	Men more likely to agree Women more likely to disagree	Differences not statistically significant				
I am better at mathematics than most other students on my course.	Men more likely to agree Women more likely to disagree	76	53	1510	-2.627	0.009

Table 2: Gender differences in factor 3 (positive attitude to groupwork) and associated items

Women scored more highly than men on factor 3, although this did not reach significance. As Table 2 shows, this factor included 6 items, of which five directly related to attitudes to working with others. While women were more likely to agree with the first four items, and to disagree with the fifth, these differences were not significant. However, one further item ('*I am better at mathematics than most other students on my course'*) loaded negatively on this factor; women were significantly more likely than men to disagree with this statement. There are various interpretations of this pattern: one may be simply that group work is a needed aid to learning, another that working with others enables recognition of their strengths in comparison to one's own; a further possibility is that the draw of group work might be to create a buffer against loss of confidence. The interview and focus group data suggest that all are plausible. Here, Roz (Farnden, Year 3) sums up the benefits:

> We all enjoy collaborative working because although you might be doing your own project, doing a stats project with discrete data sets, but, you know, did you get this problem on your set. And it's a kind of reassurance thing that you are actually doing the right thing, you have understood it properly or …..some people are really good at understanding that bit but woolly on that and somebody else….. and then you can…. We've all…I think we've all done better, well I've certainly done a lot better than I would have done if we hadn't had each other.

Factor 4 comprises four items, all of which relate to seeking help and asking questions in class: 'I go and ask lecturers for help when I need it', 'In a mathematics class or tutorial I would never volunteer an answer or speak out', 'In most mathematics classes or tutorials I am happy to ask questions' and 'I think I would approach most of my lecturers if I had a problem I really could not tackle'. While women scored more highly than men on this factor, the difference was not significant, as was the case with the contributing items. Previous research suggests that speaking out or not is a dilemma for women; clearly they seek to understand, but this can expose them. However, there is a difference between seeking out a tutor outside class as Debbie describes above, and speaking out in class; here Diane (Bradley, Year 1) explains why she will not do so:

> There was this one girl who, the poor girl, she sort of well [said] "shouldn't that be negative x or something" and he said "no". "Oh", and then she was…. she tried but she was wrong. Which is why I'd never point it out.

Sarah (Bradley, Year 1) comments that students who will speak publicly in lectures are much more likely to be men; if they notice a mistake, the women would not normally speak out, whereas the men will:

> I think they are more likely to be the ones that are going to point out there is a problem, you know, "there is a mistake on the [board]" or something like that, I have never seen a girl do that, well I have done a couple of times but I never really, I wouldn't do it in a lecture… they'd probably just leave it, or, you know, say to the person next to them, "that's wrong" or something like that but I wouldn't think they were going to shout it out unless they are quite a woman.

Carol (Bradley, Year 1) brings factors 3 and 4 together in her explanation of why she informally seeks out other students when she is stuck:

> I think it's just reassurance that you're not completely stupid because you can't do it, and just bouncing ideas off another person is better than sitting in your room attempting a question 50 times because you don't know how to do it. …. It's easier to talk amongst yourselves [outside of lessons] whereas in a tutorial you kind of feel under pressure just to not say anything in case it's the wrong answer.

Legitimacy and understanding

While factor 5 (positive experience before university) shows no significant gender differences (although men do score more highly), the picture changes somewhat for students once they arrive at university, as indicated by the pattern of results on factor 1 (confidence, interest and positive attitude). Factor 5 clusters together three items which complete the sentence 'Before I came to university…': *'Mathematics was one of my best subjects'*; *'Mathematics was one of my favourite subjects'*; and *'I was better at mathematics than most other students in my class'.* The broad agreement with these statements by the students in our sample accords with previous findings that students often study mathematics at university simply because they are good at it and find it easy (eg Brown & Macrae, 2003). Factor 1, however, identifies a familiar theme of coping with difficulty and challenge once at university: its thirteen items primarily tap 'positiveness' (*'I feel more positive about mathematics'*), confidence (*'My university experience has resulted in me being more confident with mathematics' / 'I feel I have the knowledge and confidence to help others in the class' / 'I realise that I am not very good at mathematics'*), motivation (*'I don't really want to do mathematics any more'*) and interest (*'I realise that I am not very interested in mathematics'*), together with observations on university/school teaching comparisons (*'Mathematics was more fun at school'* / '*Mathematics is taught better at university than*

school' / 'The style of university teaching (lectures and tutorials) suits my learning style'). While women score less positively on this factor than men, and on 11 out of its 13 individual items, the difference for factor 1 itself is not statistically significant. However, as Table 3 shows, the two highest loading items on factor 1 show significant differences, with men more likely to agree and women more likely to disagree with both *'I feel more positive about mathematics'* and '*My university experience has resulted in me being more confident with mathematics'*. In the light of their favouring of group work, women's greater likelihood of disagreeing on another factor 1 item *'I feel I have the knowledge and confidence to help others in the class'* is an interesting reflection of comparisons with the student body as a whole as is their greater likelihood of agreement with the independent (ie unrelated to factor 1) statement that *'Most mathematics students are cleverer than I am'*. As we have suggested above, it appears that mutually supportive small group work outside of formal settings provides a buffer against loss of confidence.

	Outcome	**N (M)**	**N (F)**	**U value**	**z-score**	2-tailed p value
Individual Factor 1 items						
I feel more positive about mathematics	Men more likely to agree Women more likely to disagree	76	53	1546	-2.358	0.018
My university experience has resulted in me being more confident with mathematics	Men more likely to agree Women more likely to disagree	76	53	1508.5	-2.617	0.009
I feel I have the knowledge and confidence to help others in the class	Men more likely to agree Women more likely to disagree	76	51	1303	-3.418	0.001
Independent item						
Most mathematics students are cleverer than I am	Women more likely to agree Men more likely to disagree	77	53	1499	-2.745	0.006

Table 3: Gender differences in selected factor 1 items, plus the independent (ie unrelated to factor 1) item 'Most mathematics students are cleverer than I am'

Complementing the issues regarding tutor relationships indicated by factor 2, the interview data suggest that perceived lack of understanding is part of the issue in women's reported loss of confidence. Debbie describes a strong desire to understand which is not responded to in the way she wants by tutors:

> I think I was hooked up on, I didn't understand… It was a case where we were doing the multiplying out of the matrices and stuff. I knew how to do, I learnt how to do it, I didn't understand why, why are matrices there in the first place, why do we have these groups of numbers, what does it mean, what's the point? You know, I didn't actually understand what they were for. I like to understand exactly what it is I'm doing and I was talking to a PhD student and he sort of explained to me, he said, "really what you need to do is just learn it and it will come, the understanding will come, you find that", you know, he said, "you'll find it better if you can just try to adopt that attitude rather than get too stressed on understanding it". But I like to know what it is [laughs] and I used to, like, knock on the lecturer's door, "please", you know, "why with the matrices, what's the point of it?".

Indeed, Diane thinks that lack of understanding will be her undoing:

> I mean, in some of the homeworks I'm getting good marks but I don't understand it to the same extent that I understood the A-Level maths which is why I think I'm going to do worse. .... on some

> of the exercises I'd written next to a question "I really don't understand what I've done here". ... Because I got those questions right but I still didn't understand what I was doing really.

In contrast, Richard (Bradley, Year 1), acknowledges the issue but stands away from it, prioritising right answers:

> I think I'm the kind of person who should care about understanding but I don't … but I am competitive … I'm the kind of person who you'd think would want to know, but getting the right answer is more important …….it depends what you mean by understanding, maybe I want total understanding and unless I have total understanding I think I don't understand at all … but I understand well enough to carry on.

Survival and resistance

The data reviewed in the previous section suggest that, in keeping with previous research, men and women differ in the ways in which they experience university mathematics, leading to greater expression on the part of women students of what we have called fragile identities. Our question is, however, whether and how women resist such fragility, and what resources they might draw on to do so – it seems reasonable to suppose that their continued study of mathematics beyond the compulsory years is indicative of the development of strategies of survival. In this final section we explore the data for emerging evidence of resistance to ascribed positions and a refiguring of women's relationships with mathematics. We focus in particular on women's recognition of and resistance to gender and ability discourses, and on the related impact of the availability of space for group work and for one-one access to tutors at Middleton and Farnden universities as a means of – literally – creating spaces for women to be mathematical.

Reflecting on gender and ability discourses

Although our data suggest that women's experience of university mathematics is frequently negative, there is evidence that some students reflect on the gender dynamics of university mathematics in ways which signify resistance to the status quo by subjecting it to scrutiny and criticism. In their study of mathematics in popular culture, Mendick *et al (*2008, 33) report that 'participants showed a critical awareness that the images they held of mathematicians were clichés and often both used them and distanced themselves from them'. Similarly, some women students tell their experience in critical ways which support a re-authoring and refiguring of their relationships within the classroom and the institution via a 'debunking' of traditional hierarchies. They are dismissive of male pretensions, for example. Diane observes that men are over-confident, and she is critical of their competitive behaviour:

> [They are] usually men .....they're getting too big headed and they know 'I can do this' …. They're all smug and they sit there and they're filling in the answers and then they sit back and sort of look over at what the other guy who's sitting next to them… like, 'Huh, you've done it wrong there'.

Sarah also comments on gender issues, demonstrating her struggle with stereotypical comparisons concerning the nature of male and female success in mathematics as being based on male 'natural flair'

contrasted with female 'effort'. In her lengthy reflection, we see how she tries to resist the implications of such assumptions for her own mathematical ability, beginning with this comparison with her brother:

> I mean my brother, my brother was quite good at maths as well, but different to the way I am, I don't, erm, I mean, I would usually say that guys can usually be the ones who have this amazing ability, you know, just to be able to see it but [there] was a girl and she was just the same as, you know, you would think a guy might be ….

Her hesitance and back-tracking is indicative of how difficult it is to sustain her position of rejecting stereotypical assumptions as she oscillates between ascription of natural ability to men and her assertion that women can meet this criterion too. However, it is notable that her counter-example positions the solitary woman who is good at mathematics as 'the same as you would think a guy might be' – and thus by definition not truly feminine in her mathematical ability. Going on to talk about herself, she pulls back from the 'natural ability' discourse, and begins to formulate a position which recognises that success in mathematics as a result of working hard is genuine success:

> … and my brother as well he, I think he just didn't try actually, to be honest, but he, I think I was maybe better than him, not, you know "I was better than him" I don't think I was as natural at it as him but in a way I did better and I could do it better.

Unable perhaps to fully articulate this position, she returns to the gender comparison, providing further counter-examples in both directions of men who lack natural ability and women who possess it, reflecting on how she has changed her views:

> But, erm, I think that, I think there a lot of guys that can't do maths as well and there, I used to, I think I used to think that it was more a guys' subject but, I don't know, recently I think that girls, there are a lot of girls that are good at it as well and they have this natural thing where they are brilliant, erm,

That this is a difficult position to maintain is demonstrated by her subsequent difficulty and appeal to the interviewer:

> ... and if a guy is good at it then usually he is really good at it, like, he can just do it but saying that, I mean, it is all this different things because I know a guy who is doing maths and he is quite, he is really struggling but he is still ... doing maths. *[But there are women you know that are good at it?]* Yes, I mean, maybe usually if a guy can be like more, erm, natural at it but there is all the other cases isn't there?

Thus we see an ongoing resistance in Sarah's interview as she struggles to articulate a position of being female and good at mathematics which does not undermine either her mathematicalness or her femininity. This is clearly difficult within the traditional kind of environment described by Diane and other students in the study; in the next section we explore the potential of the support centre environment for creating 'ruptures of the taken-for-granted' (Holland *et al.*, 1998, 141) which sustain resistance to dominant discourses of what it is to be a successful mathematics student.

Colonising learning spaces

Farnden and Middleton are importantly different from Bradley University in that both have dedicated mathematics support centres. One impact of the availability of such spaces appears to be a shift in relationships with tutors which reduces the kinds of power imbalances reported above. Reflecting on the relational positioning of tutors and students, Roz described a subtle shift in power relations when approaching tutors for help on the neutral ground of the mathematics support centre as opposed to their own offices:

> If you go to their office …. you know there's a queue of people behind you , they were doing something before you arrived if there wasn't anyone in the queue ahead of you so you feel like you're bothering them, it's their space as well and you're going into *their* office, whereas maths support is neutral ground for everybody … it doesn't belong to anybody.

Rachel and Liz (Farnden, Year 3) explain further how they feel differently about interaction with tutors in the support centre, describing how one-to-one discussion enables them to follow through queries with tutors in a way which they would not do in formal classes, when they have had time to think about the question. Both agree that interactions are different, not because of the tutor but because they themselves approach the situation differently, with more motivation and preparation:

> Liz: .. they'll sit down and work an example, and if you don't get it, they will try and be as helpful as they can. ...
>
> Rachel:... yes, and it's also at a time that you've chosen to go and do it so you're more motivated ...
>
> Liz:... and you've studied the right question ...

The support centre setting also enables small group teaching which feels less exposing:

> Rachel: ... in your little group you can have a lecturer sit down and explain it to you which might be better for some people, because some people might not want to ask a question in front of the whole lecture whereas they will in the maths support centre just to one of the tutors.

Rachel goes on to explain why she prefers this:

> I don't like to ask public questions myself, I would rather go to maths support afterwards and be able to ask it myself..... I think it's because I don't want to look stupid in front of the rest of the group. It could be a really simple question and it's one simple answer that will give you what need, but in front of everybody….

Given these observations, it is perhaps telling that the gender difference in factor 2 scores (positive relationships with tutors) was not significant among Middleton students (women at Farnden are few, and the Farnden sample size is small, hence this sub-sample is not included in the statistical comparisons between universities); however, the difference remains significant for Bradley students – men reported more positively on relationships with tutors at this university. These contrasts are illustrated in Table 4, which shows a further difference between these two universities with respect to factor 3 (positive attitude towards groupwork): while Bradley university shows no significant gender differences, Middleton women score significantly higher than men. The focus group data from both Middleton and Farnden suggest a general appreciation for the support centres and the opportunities for group work that they afford; the questionnaire data suggest furthermore that this is particularly significant from women's point of view.

	Outcome	N (M)	N (F)	U value	z-score	2-tailed p value
Factor 2 "positive relationships with tutors"						
Middleton	Men's scores are higher than women's	Differences not statistically significant				
Bradley	Men's scores are higher than women's	27	25	213	-2.280	0.023
Factor 3 "positive attitude towards groupwork"						
Middleton	Women's scores are higher than men's	31	18	178	-2.095	0.036
Bradley	Men's scores are higher than women's	Differences not statistically significant				

Table 4: Gender differences in factors 2 (positive relationships with tutors) and 3 (positive attitude towards groupwork) for Bradley and Middleton students.

Given the data we have reviewed above on relationships with tutors, and on gendered roles in the classroom context, the impact of the availability of space is potentially far-reaching in terms of students' access to learning and their relationships with mathematics. As we have reported elsewhere (Solomon et al 2010), support centres appear to have a significant impact on discourses of ability and learning: they lead in particular to an appreciation of, and emphasis on, collaborative work and, in consequence, to a shift in attitudes towards university mathematics as a community of enquiry as opposed to individual performance-oriented pursuit. Thus the dynamics of the support centres provide a context in which all students can take up empowered positions with respect to mathematics: as Roz says, the Farnden centre became 'the place to be' where 'everyone has something to offer'. The discursive shift towards an emphasis on collaboration rather than competition and on recognition of the value contributed by all students provides further resources for resistance to dominant discourses. While we would argue that this benefits all students, our data suggest that this may be particularly the case for women in providing new ways of being both mathematical and female.

Conclusion

Previous research suggests that one of the problems for women mathematics students is that there is no discursive space in which they can belong, since the available identities and cultural norms are masculine. While Seymour and Hewitt argue that to some extent women can only succeed by taking up what are essentially masculine roles, our data suggest that some successfully resist ascribed identity positions despite the difficulties presented by the often unquestioned norms of university mathematics environments. Our analysis indicates that relationships with tutors are central to their experience, and that these impact not only on confidence but also on access to mathematics itself. However, the women in this study also describe challenging the status quo, resourcing this by critical analysis of their situation, and by capitalising on the provision of 'legitimate' working space. These 'ruptures of the taken-for-granted' (Holland *et al.* 1998, 141) appear to make a significant difference in opening up different ways of being undergraduate mathematics students.

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