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Not just for men: A case study of the teaching and learning of information technology in higher education

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Abstract. Previous research has indicated that women are avoiding the 'hard' end of computer studies on courses in higher education. In this paper we challenge some of the descriptions of computing and suggest that computing is best understood as a concrete science characterised by the acquisition of artistry. We report findings from a case study of men and women on IT courses in one higher education institution in the UK. Students followed common first-year modules involving the use of workbooks aimed at encouraging independent learning. Our methodology involved observations of the coaching styles of male and female tutors in computer laboratories. Thirty-four one-and-a-half-hour sessions were observed. Attendance was higher for the sessions led by female tutors, but male students had higher attendance rates overall. We found that the male tutors had more short interactions with female students and intervened more directly manipulating the keyboard or mouse, but that both male and female tutors spent longer with men in the class. However, women students we observed appeared confident, were more vocal and were sought out by their peers as advice givers. Women tutors adopted a more active coaching style, which encouraged collaboration between students and greater peer interaction. We conclude that we should use case studies to re-describe women's presence within computing and render it more visible. From our observations of women in computer laboratories it is clear that computing is not just for men.

Keywords: classroom observation, coaching style, collaborative learning, computing, gender, higher education

Introduction: Women and information technology

There is international concern about the falling proportions of women coming onto higher education courses in both computing science and information technology. Rosemary Wright (1997) has shown that the percentages of women taking IT/computing courses fell in twelve countries between 1985–90, including the US, and rose in only seven. In the UK the percentage of women on computing/IT courses has fallen (Wright 1997). The number of women from the UK entering UK all computer science courses in 1999 formed 18% of the total number of students on these courses (UCAS 1999). The comparable figure for 1990 was 28% (Wright 1997). The proportion is

lower on software engineering courses with women making up only 11% of the total in 1999 (Durndell 1991; UCAS 1999). We have argued elsewhere (Clegg and Trayhurn 1999) that the decline cannot be explained in terms of women's capacities (see Henwood 1996), rather that the dominant cultural construction of computing remains resolutely male (Edwards 1990; Mahony and Van Toen 1990; Volman et al. 1995).

Gerda Siann (1997) has argued that women are exhibiting a '*we can, we don't want to*' approach to computer studies. Women are, however, attracted to IT in combination with other skills and subjects (Durndell and Lightbody 1993; Durndell et al. 1990). The ideological association of computing with masculinity is strongest on computing courses that are described as science or engineering. In higher education, formal methods, mathematics (Mahony and Van Toen 1990) and the more esoteric claims for artificial intelligence (Adam 1998) appear to establish computer science as an abstract and difficult subject (Kukla 1994), lacking traditional appeal to women (Fox Keller 1992; Kirkup 1992). Women are more attracted to subjects which demand the exercise of highly developed inter-personal as well as intellectual skills (Siann 1997). While Alison Adams (1998) cautions against over-simplified views of artificial intelligence research, perceptions of what courses have to offer have real effects even when such constructions are inaccurate. Research in schools (Beynon 1993; Kirkup 1992; Whitelegg 1992) shows that computer studies has been frequently linked with science teaching, disproportionately taught by men, and that computer clubs and the home computer games market remains dominated by boys (Haddon 1988; Orr Vered 1998). Choices of study in higher education are therefore shaped within a discourse that presents computing as male.

In our research we have attempted to challenge some of these assumptions. We have argued that computing is a concrete science (Clegg 1999) and that this description fits the more practical orientation of applied courses and industry (Mahony and Van Toen 1990). Concrete sciences build up concepts of their own which are not simply dependent on the laws of abstract science, rather they represent an accumulated knowing-how based on performance (Collier 1997). The knowledge produced in the concrete sciences therefore cannot be simply disconfirmed by abstract science, since concrete sciences like computing depend in large part on retroduction from practical experience.

There is a synergy between our depiction of computing as a concrete science and descriptions of computing as a technology; both models recognise the importance of creativity and phenomenologically based tacit knowledge (Adam 1998; Wajcman 1991). If we work from descriptions of what contemporary IT specialists do in both universities and industry we get a

broader picture of the skills and expertise involved (Lander and Adam 1997; Grundy 1996). The origins of restrictive views of computer science are historical – based on US defence funding (Edwards 1990) – and ideological, the result of attempts to establish computer science as a prestigious field for research in elite university institutions. Moreover, as Alison Adam (1998) points out, the association of more phenomenologically based ways of knowing as 'feminine' has a long history, and one from which new (mostly male) intellectuals distanced themselves in establishing an academic home. Abstract formal knowledge has in the past been defined as more prestigious. However, we would argue that a more inclusive definition of computing is both more accurate in characterising practice, and opens up questions about the skills involved in doing computing.

Research by Sherry Turkle and Seymour Papert (1990) provides rich descriptions of this tacit, concrete knowledge. Their work suggests that there is no one way of doing computing. Rather computing practice is characterised by what they describe as 'epistemological pluralism' – a variety of ways of solving computer problems. However, in their research they found that non-conventional problem solving was discouraged in favour of more formal methods. They describe alternative styles as a form of bricolage. Bricolage involves solving problems by putting together elements by feel rather than adopting linear rule-bound logic. Turkle and Papert cite instances where female 'bricoleurs' had to adapt their practices by presenting their solutions as if they were arrived at by following step-by-step procedures in order to fit in with the dominant pedagogy.

Linda Stepulevage and Sarah Plumeridge (1998) have drawn on feminist standpoint theory to argue that both women tutors and women students take on different positions from men in approaching computing practice (Harding 1986, 1991; Hartsock 1987). The women in their study conceptualised computing as a skill to be practised rather than simply the application of logical, rule bound procedures. In our earlier research we found that many women who came onto IT courses brought with them a wealth of experience from other contexts, most notably from using computers as databases and tools in administrative and clerical jobs (Clegg et al. 1999; Clegg and Trayhurn 1999). These resources are rooted in practice. However, because such skills are associated with end-use they are rarely given credit as 'real' computing. If we recognise these practices as part of computing the terms of the debate shift from why women are not doing computing to how, and where, they are.

There is a similarity between our re-conceptualisation of computing as a concrete science and re-definitions of professional knowledge originated by Donald Schon (1983, 1987). Schon rejected the then-dominant positivist

characterisation of scientific knowledge as the basis for professional knowledge and decision making. He argued that abstract knowledge does not precede and pre-determine professional knowledge, rather that professional knowledge demands its own epistemology of practice based on a knowing-in-action. This knowing-in-action can become the subject of active reflection and experimentation, which can in turn form the basis of professional education. While there is much to criticise about the application of Schon, including his own lack of awareness of gender issues (Clegg 1999), nonetheless his core concept of knowing-in-action and reflection in and on action capture the same phenomenologically grounded concrete scientific knowledge that we are suggesting characterises computing. This coming together is crucial for us in attempting to contextualise the pedagogic aspects of IT education, since it gives a view of computing as an artistry which can be coached, rather than a set of formal rules to be learned and then applied. The key location for us in looking at gender and computing is therefore the laboratory where such coaching takes place.

Our interest in how women participate has led us to investigate those areas of IT teaching in HE which attract more women (Siann 1997). The site for our case study is therefore on applied information systems courses rather than computer science courses. We have chosen to look at what is going on in computer laboratories to explore whether, and if so how, classroom interaction in IT teaching in a higher education setting is influenced by gender. If women are enrolling on IT courses it is important to establish what the nature of their experiences is likely to be. The research in schools presents a depressing picture of stereotyped responses to female school students, which serve to marginalise girls in the classroom and limit their interaction with computers both in formal lessons and in rest periods (Beynon 1993; Whitelegg 1992; Elkjaer 1992; Orr Vered 1998). We are interested in exploring whether this pattern changes once women come into higher education.

Case study methodology

We adopted a case study methodology concentrating on describing interactions in computing laboratories. Alison Adam (1998) has suggested that we need numbers of case studies in order to try build up a picture of what conditions for women in computing are like. Our case study can contribute a small part of this by highlighting some of the practices occurring in the laboratory. We would therefore claim theoretical relevance (Pawson and Tilley 1997). We wanted to look in some detail to try to establish whether patterns of interaction could be detected. The disadvantage of such an approach is that our empirical findings are specific to the case and cannot be statistically generalised.

For our purposes, however, the advantages of in-depth description outweigh the disadvantages. Specific cases studies are crucial for the construction of theoretically adequate descriptions of the relationship between gender and IT pedagogy in higher education. As with the now well-established tradition of school-based ethnography and observation (Hammersley 1994), the primary purpose of this study is to contribute to an understanding of process rather than normative generalisation.

Context

Our study took place in the School of Information Management in a large post-1992 university in the UK. We looked at three courses: Business Information Management, Business Information Systems and Business Information Technology. The course had a common first-year practice module. Although the courses all have a large element of computing, their emphasis on the development of technical competencies in a practice context sets them apart from traditional computer science courses. The decision to emphasise real-world business environment rather than the computer as a machine was made in order to encourage more students into computing. By focusing on information the courses attempt to overcome misperceptions about computer use. Business Information Management is the most business-orientated of the routes while Business Information Technology is the most technical. Despite efforts to improve the gender composition of courses, the ratio of women to men is reversed on the two courses, with women in the majority on the business course and men on the technology course.

All students follow compulsory common elements in their first year, which they are required to complete. Staff on the courses had been involved in a series of teaching and learning developments which involved authoring common workbooks '*Professional and Personal Skills – Understanding IT*' which introduced all the students to key computing skills and packages. The workbooks cover: information skills, including literature searching and CD-ROM usage; written communication skills, including Microsoft WORD; numeracy skills, including Microsoft EXCEL; and presentational skills including Microsoft POWERPOINT. The workbooks provide a common curriculum and assessment for practical, computer – laboratory based sessions tutored by both male and female lecturers. This initiative presented a rich research opportunity to observe classes taken by both male and female tutors where the detail of the teaching input and learning strategy had been agreed in advance.

The model underlying the workbooks and computing laboratory activity was based on reflective practice. Students were asked to keep a learning journal documenting both personal and professional development and their

experiences as learners. The pedagogic model incorporated a view of IT practice which was close to our previously hypothesised characterisation of computing as a concrete science – a form of artistry – rather than a series of formal principles which are only applied at a later stage. While we are not suggesting that this approach is necessarily more conducive to the learning of either males or females, it does provide an ideal context in which coaching styles can be observed. Moreover, since part of the continuing professional development associated with the staff responsible for these courses had had some formal input and discussion of equal opportunities, we could therefore assume that our observations were taking place in an intended atmosphere of good practice.

Ethics

In setting up the research it was important to establish that ours was a research project and separate from the quality assurance procedures associated with the course. This was crucial to negotiating access to laboratories and gaining informed consent. Classroom observation is extremely sensitive in British higher education as a result of proposed quality assurance initiatives and it was vital to establish both independence and confidentiality (Lee 1993). The project's research assistant conducted all the observations. The other two researchers who work at the institution as full-time members of staff did not know the names of the people who agreed to participate. The data was stripped of any personal identifiers before it was analysed by the team as a whole. These precautions meant that we have not been able to access data from other sources such as student evaluations, but we believe they were necessary on ethical grounds. We agreed to disseminate the research as a set of findings to the course team, and hope that the research might be taken on board as part of an action research project by the course team at a later stage.

Sample

All the members of the course team were invited to participate. Out of fifteen staff approached eight agreed to participate, three women and five men – slightly over-representing the number of women tutors teaching on the course. A total of thirty-four observations were made of laboratory sessions each lasting one-and-a-half hours. The numbers of observations were distributed unevenly between the individuals, largely as a result of the practicalities of arranging observations when more than one class was in progress and in an attempt to try to ensure that as many individual sessions were observed with women tutors as with men. A total of sixteen observations were made with female tutors, eighteen with male tutors.

Table 1. Schedule of observations by sex of tutor and gender composition of group

Sex of Tutor	Number of sessions observed	Number of males in class	Number of females in class	Class size
Female (A)	6	13	7	20
Female (B)	7	15	7	22
Female (C)	3	18	0	18
Male (D)*	3	15	5	20
	4	12	8	20
Male (E)	3	9	9	18
Male (F)	2	16	2	18
Male (G)	2	7	11	19
Male (H)	4	16	4	20

* Male D was observed with two different classes

Data collection

The main method of data collection was observation. This was relatively unobtrusive in computer laboratories where students are familiar with spare workstations being occasionally accessed by other people. The researcher was introduced at the beginning of the first session, and there is only one reference in the field notes to an instance where a student's behaviour appeared to be affected by the presence of the observer. Some of the categories for observation were agreed in advance: seating plans, type and duration of interactions, gender patterns of both tutor and peer interactions.

The observer worked with a simple chart of pre-determined observational categories for interactions between tutor and student, and student peer interactions by gender, manoeuvring of mouse or keyboard by tutor or other student, as well as space for jottings and comments. Field notes were recorded continuously in the class, marking the type and length of interactions, the gender of the initiator, degree of movement during the session. These categories were devised by the main researchers before the study and were based both on the literature and one of the researcher's extensive experience of teaching in laboratory contexts (McIntyre and Macleod 1994). Short interactions were recorded simply as events, but where longer interactions took place these were timed.

In most classes it was possible for the observer to move around and observe particular interactions at the machine, in particular looking at whether peers or tutor directly intervened by moving the mouse or keyboard. Other

observational events were not pre-designed (Delamont and Hamilton 1994). These included particular vignettes in the field notes, reporting direct speech where it was observed, or particular gestures and patterns of interaction, for example where the tutor knelt down or stood up by the side of a student, whether other students joined in and so on. The observer recorded detailed field notes of each session which were written up after each observation.

Later in the observation, when students had become familiar with the presence of the observer, some basic questions were asked about previous computing experience. The timing of the interviews at the end of the observation period was designed not to compromise the conduct of the observations and allow some cross-checking of interpretative adequacy in relation to student's appearance of familiarity with the technology (Delamont and Hamilton 1994). A total of thirty-five short interviews were conducted with ten women and twenty-five men. The researcher probed whether the course was what the student expected, previous experience of computers and qualifications, own computer ownership and whether they used computers for leisure. These interviews took place in three sessions, all with students of the female tutors. The desirability of combining interviewing with observation could appropriately be challenged on the grounds that it compromises the position of the observer in the field. However, we have no evidence from our data that this was or was not the case. There is also precedent from other observation studies where researchers have moved towards a mixed methodology in an attempt to counteract the problems of interpretation based solely on observational data (Hammersley 1994). No formal interviews took place with the tutors but where they volunteered information, this was recorded.

Owing to the assurances of confidentiality it was not possible to validate the observations in the field by cross-checking using multiple observers, but weekly meetings were held to discuss the recording of the data and to look at the field notes. The team meetings discussed emerging patterns and acted to make sure that where theoretically interesting patterns were identified (such as the manipulation of the mouse by male tutors), they were systematically checked against observations which could serve to contradict these inductive hunches. The resulting data were therefore a mixture of quantitative recording of events and richer qualitative descriptions of classroom interactions (Hammersley 1994).

Analysis

A spreadsheet analysis of the frequency and types of interaction was prepared from the field notes. The categories logged were the frequency of interactions of tutor to student by gender; duration of interactions where this was possible to record (some interactions were too short to time and were merely noted as

events); peer interaction by gender; mobility in the laboratory, moving to and from machines; vocalisations (gender of speaker rather than what was said as this was often not possible to record); and a count of direct interventions using key or mouse manoeuvres by gender. This simple mapping gave us the basis to summarise the data descriptively. In some instances caution must be exercised in interpreting data of this type. Thus, where multiple interactions occurred we have used the commentary for qualitative insight rather than relying on simple counts. Qualitative observations, based on the notes in the session, were written up as soon after each session as practicable so that as much detail as possible was captured.

The observer also noted ascribed ethnicity of participants. There is some controversy here owing to the use of a simple black/white/Asian ascription, rather than a self-defined notion of ethnicity. However, after lengthy debate, we agreed that such crude distinctions might be relevant, as they allowed us to observe whether there was a degree of separateness based on perceived distinctions of colour. This data was not used numerically but was noted in qualitative descriptions of particular events.

The observer also produced pen portraits of the teaching and learning style within each class. These portraits are summative of the set of observations for each individual tutor, and allowed us to distinguish between particular tutors rather than recording just male and female. Qualitative data from the observational notes are preserved in these pen portraits and we have drawn on these in attempting to characterise the diversity of teaching and learning styles which occurred in different tutor groups.

Findings

Gendered patterns in attendance

There was considerable variation of gender composition across groups (see Table 1 above). The overall ratio of female to male students in the observations was approximately 1:2. In terms of the study we were more interested in the patterns of interaction within the groups; however one statistic in relation to attendance did emerge: overall attendance was a little higher with the female tutors, and female attendance a little less with both male and female tutors. The aggregate figures can be seen as follows in Table 2. The percentages are calculated based on the class size (range 18–22) broken down by sex, and the actual observed attendance in each class by sex of student, and sex of tutor (three female, five male).

The aggregate masks variations between tutors, individual students, and group composition. The two women tutors with mixed groups both had a

Table 2. Attendance rate by sex of tutor and sex of student

Tutor	Male attendance	Female attendance
Male tutor	66%	59%
Female tutor	74%	68%

N = 403 (the total number of actual attendances observed)

mean attendance of sixteen (ranges five and eight), and out of the seven women students in each group a mean attendance of five (ranges three and two). The variations in attendance, however, were much more pronounced among the five men. At one extreme, one male tutor averaged attendance of only eleven (range twelve), and among a maximum of eight women a mean of four with a range between one and seven. After the first week when attendance was fifteen, one class fell as low as three. This contrasts with one of the other male tutors who achieved a hundred percent attendance among the four women in his class and seventy five percent among the men.

These figures reflect clear differences between tutors in relation to tutors' expectations of attendance and the way of organising. Female tutor B encouraged students to attend and participate in her class, she checked the students individually by name and told the students in her group who were the top attendees (the top four were women). This group maintained a strong sense of group activity and worked through the workbooks together. Female tutor A used the register to actively check names while making it clear what her expectations are for behaviour in the class:

> The lecturer first asks the class to look through the manual, as this is their first session in EXCEL, after first coming to collect a manual each. The lecturer instructs the whole class how to log on and takes a register as she walks around the group asking their names. The lecturer also asks the group not to use the student e-mail system, as this is a class on EXCEL (observation notes – typed summary from session 32).

In contrast, male tutor D would check whether anyone needed help and would leave early if none of the students did:

> The lecturer asks the whole group if they are O.K. And as so few of the group have attended he has decided to leave the session. (He informs me that there is no point staying around as they all seem to be O.K and all they are doing is completing the distance learning task). One male asks the lecturer a question as he puts on his coat and he is given some help, then the lecturer leaves the session after 25 minutes. There should be 20

Table 3. Interactions by sex of tutor

	Interactions with male students	Interactions with female students
Male tutors	31	42
Female tutors	26	23

> in this group and only 9 have turned up. The nine continue to work quietly on their own. I stay in the lab and continue to observe. The Asian female has left herself logged onto POWERPOINT and is now logging onto the terminal next to her to access the student e-mail system. All the rest of the students are completing their set questions (observation notes – typed summary from session 20).

His role was expressed more clearly as a resource to be accessed if required, rather than an active organiser of student learning. Another male tutor allowed students to work with different packages and on different sections of their workbook during the session and to leave when they wanted. He moved actively around to ensure that the students knew he was there for help, but he did not organise students' learning collectively. This variation in practice, in part, explains the differential attendance rates between male and female tutors in our case study. Even with common workbooks and a collective commitment to developing independent learning, pedagogic style varied widely.

Gender and tutor/student interaction

We were interested in tutor/student interactions by the sex of the tutor and systematically recorded the number of instances of individual interaction by gender. The table below shows all the instances of tutors interacting with individual students as opposed to the whole group or sub-groups.

As with the attendance data, there was variation between tutors. All three women tutors organised more whole-group activity and therefore interacted more with the whole group or sub-group. However, given the proportionately smaller numbers of female students in the groups, the high level of interactions of male tutors with female students is interesting and deserves further attention. In our previous research we had noted that women reported that male tutors intervene assuming that they do not understand (Clegg et al. 1999), and it appears that in this study male tutors were more vigilant in relation to the minority of women in the class. Many of the observed

Table 4. Number of direct manipulations of keyboard or mouse by tutor

	Number of manipulations of male student's mouse or keyboard	Number of manipulations female student's mouse or keyboard
Male tutor manipulating mouse or keyboard	7	11
Female tutor manipulating mouse or keyboard	5	2

interactions were very short, a matter of stopping and checking. From the qualitative data we identified three of the males as walking up and down and checking or signalling by their movement that they were available, the fourth left the class if no one appeared to need help, while the fifth was more didactic.

We also systematically recorded observations of direct manipulation of mouse or keyboard by tutor.

It would be inappropriate to calculate a statistic based on the data as they represent multiple observations for each case. However, the opportunities for male tutors to manipulate the keyboard of male students was proportionately slightly greater than the observed outcome, whereas for the female tutors the observed outcome is roughly proportionate. While we must be aware of the relatively small number of instances involved, our observations suggest that the male tutors are more likely to take control, particularly when demonstrating to women. Given that we have already noted a greater incidence of male tutor interaction with women students, there is some indication that male tutors are more likely to intervene directly to simply show, or carry out the procedure for a female student.

In contrast to the number of interactions, the data indicated that both male and female tutors spent longer with male students. Observational notes suggest that on those occasions when tutors spent time with individual males, they engaged in lengthy dialogue. This may be seen in the following example:

> The lab is very quiet and the three females are working on their own as are two of the males. Two pairs of males are working together and are using the one workbook between the 2 of them. The other lone male is now with the lecturer and is being shown how to do the calculations on EXCEL using formulas. The group is very quiet with a lot of quiet discussions in the groupings. The lecturer is spending a lot of time with this lone male and is working through the calculations in the examples.

> Asian female asks a question of the male next to her and this is the first time that I have seen an Asian female in any of the sessions ask a question of a male other than the lecturer (this was subsequently cross-checked).
>
> The lecturer has been with the lone male for 20 minutes now.
>
> The 2 male pairings have resorted to hand held calculators as has the male on his own. Both of the Asian females are working on the formulae now, as is the other female and one of the lone males.
>
> One of the males in one of the pairs has not been interacting with the PC and has been writing using a hand held calculator and is now logging onto EXCEL. Female walks over to one of the lone males to ask him a question and I note that the lecturer has been with the other lone male now for 35 minutes (observation notes: Tutor E – typed summary from session 29).

The tutor in this instance was recorded as having informal contact with males, rather than females. Where this occurred it appeared to be about football or other social concerns. This pattern of individual tutors getting '*stuck*' talking to individual males appeared in eleven sessions in total, in seven session involving four of the male tutors, and in four sessions with the two female tutors with mixed groups. Conversely, there are only two examples in the data of similarly lengthy exchanges with individual women. These instances highlight the ways in which walking around the laboratory to pick up cues and questions can in fact become part of a gendered practice – despite a seemingly relaxed and approachable style. While women in our observations may be getting more attention in terms of the incidence of the interactions, qualitatively, individual males may dominate the classroom by virtue of attracting disproportionate amounts of tutor time. Our observations thus provide another example of the complexity of the relationship between gender and teacher/lecturer time (e.g. Randall 1987; French and French 1993; Hammersley 1993).

When we looked at the instances of students asking tutors for help, we found that, proportionate to their numbers in class-women asked for help just as frequently as their male peers. There were thirty-four instances of men, and twenty-one of females, asking for help. However, when this is broken down by gender of the tutor, women initiated more questions with male tutors (fourteen instances) than with female tutors (seven instances). This cannot be attributed solely to the gender composition of the groups since we over-sampled women with women tutors. However, it does fit with descriptions from the pen portraits of teaching and learning styles. The women tutors adopted more all-group styles, whereas some of the male tutors – as suggested above – adopted an approach which relied more heavily on the students asking for help, effectively taking the stance of being a resource rather than a

director of learning. In order to receive tutor input in these classes, women as well as men had to request help. It appears therefore that how students behave in class is shaped by the teaching and learning style as well as by the gender of the tutor.

Peer interaction

As well as tutor interaction we were also keen to explore the patterns of peer interaction. Out of the sessions there were thirteen recorded instances of women working alone, and twenty-four of men. As this is roughly proportional to the total numbers in the classes, it does not confirm the stereotype of male loners suggested elsewhere in the literature (Durndell et al. 1990). There were twenty-six recorded instances of female peers working together, thirty-nine instances of all male peer groups (the all male group was excluded but had three recorded peer groups), and twenty-three recorded instances of mixed peer groups. Proportionately, there was more female peer group activity than male. In some classes the dominant practice was to work quietly with very little peer interaction. Students worked at their tasks from the workbook with little interaction with either peer group or tutor. In other groups, however, we noted that there was a lot of interaction.

In particular, female tutor B was active in shaping class activities and produced more peer interaction and helping behaviour. The following observation illustrates how tutor intervention sometimes generated subsequent peer discussion:

> The lecturer is now with a group of three females and one male that has moved to be within the subgroup. The lecturer is helping them with queries regarding the exercise. She is manipulating the females keyboard and asking her questions of the data on the screen.
>
> The two girls with the unsure male are joined by another male and all four are trying to calculate the formula. One of the girls is moving the mouse although it is not her personal computer. A large group of students has gathered around the terminal that the lecturer has now sat at. The Asian male is offering information and states that “it doesn’t work”. This whole subgroup is very vocal as they ask questions and discuss the problem between themselves (observation notes – typed summary from session 31).

This group had more mixed-peer interactions than any other group. However, even in this group there were males who worked quietly alone. Levels of peer interaction thus appeared to be influenced by tutor-directed learning style. Fewer peer interactions were seen to occur in hands-off sessions, while those in which tutors adopted a hands-on style showed greater cross-gender

Table 5. Help giving among students by gender

	Help given same gender	Help given opposite gender
Requests for help from males	29	27
Requests for help from females	22	13

collaboration. Individual learning styles involving some loners were evident in all sessions. Gender appeared also to have some effect on tutor style, with female tutors being more active organisers of learning and male tutors being more responsive. However, given the small numbers involved, great care must be exercised in making generalisations, and it must be recognised that such trends might be a reflection of personal style unrelated to gender.

Students moved around the classroom in order to interact with their peers and/or the tutor. There was only one observed instance of a tutor asked a student to move. Mobility was defined where the student moved his or her chair (mostly wheeled) around the lab to sit at another machine or moved around the room in any other way. Women were proportionately more mobile with twenty-one recorded instances of female mobility, and twenty-four instances of male mobility. Similarly there were more instances of recorded female vocalisation. We recorded fifteen instances of females vocalising loudly compared with twenty-one males. When viewed in conjunction with their higher incidence of peer group formation, it would appear that females are more active in class, and engage in more collaborative behaviour. This also appeared more subtly in some of our observations of women '*keeping pace*' with one another, checking the screens of neighbouring women, as they worked on tasks.

In terms of help-seeking behaviour from peers we recorded requests for help by the gender of the student responding to the request. Table 5 summarises this information.

The table shows that women were disproportionately giving help to both their male and female peers. In the observational notes there are references to suggestions from students that a particular person is consulted because of their perceived expertise. This pattern seems to counteract the notion from some of the previous literature of males as host and expert and women as classroom guests (Elkjaer 1992). However it confirms our previous work which suggests that women with administrative and office experience are confident in contexts which focus on real-world applications rather than on computer science (Clegg and Trayhurn 1999; Clegg 1999).

Similar evidence may be found in the short interviews. One woman with her own personal computer and a vocational qualification in business studies said she found the workbook easy but added '*I understand that this background is for everyone as, they* [the other students] *do not all have experience*'. A number of women when questioned seemed quite happy to voice their confidence in their abilities to do the work. Only one woman was identified from the interviews as finding it hard; she commented on feeling '*inadequate compared to the lads that know what they are doing*' None of the confident women compared themselves to the males.

Coaching styles

In this section we have examined the qualitative data in order to try bring together some of the findings about the coaching styles practised by the tutors. There was variation in the personal styles of the three women tutors. One tutor was described as '*approachable, does not appear over friendly (not too much smiling)*' (observation notes), whereas another was characterised as '*extremely friendly and approachable, almost matey with the students and there was a great deal of social as well as academic discussion*' (observation notes). However, there were similarities in the coaching styles of the women tutors who seemed concerned to make sure that the whole class shared a common learning experience.

All the female tutors started the sessions by structuring the whole group and letting the students know which parts of the workbook they were dealing with. In two groups in particular (tutors B and C) there was a very high rate of peer interaction and helping behaviour between peers. The only observed mention of the learning journal element of the course was in the session of tutor B. She addressed the group encouraging students to think about their whole learning experience, and to use the learning journal for personal as well as professional development. This tutor produced an attendance list for all the sessions and told the students which of them had attended most, as well as how everyone was getting on in handing in their work. In her group all the participants had handed in their four pieces of assessment (with the exception of one male who was finishing it off in that class). This sharing of information encouraged interaction:

> The lecturer is now returning some of the work to the students and as she does so one of the females asks her a question. The lecturer manipulates the mouse as she explains. One of the other females has moved to a position behind the girl and they are both looking at the on-line help that the lecturer has accessed. The lecturer ends up spending a lot of time with this group of 4 girls working through EXCEL with them explaining that

> the package is a useful one to learn as it is well used in business. The girls are listening to the lecturer and asking questions of her.
>
> Three of the males have their own sub-group and are looking at the screen of one of them. He is e-mailing. This group of males is very vocal and one of the females joins them.
>
> The lecturer and the three remaining girls are trying to work something out and are joined by a male who explains how to make the calculation. He apparently has prior knowledge of this software as he was on another course here last year, and the lecturer encourages him to help the females. The group manages to complete their task amid much discussion and questioning and involvement with one or two of the others in the group (observation notes – typed summary from session 25).

The example showed the lecturer moving the mouse but in a way that facilitated interaction and prompted questions from her students. The lecturer also positively encouraged a knowledgeable student to help others, while other groups formed to work together. She also referred to the real business context while demonstrating a package. Rather than discouraging student autonomy, this more interventionist approach supported it. The most successful examples of collaboration in our observations appeared in the sessions with the three women tutors.

In contrast, some of the male tutors took a much more hands-off approach. Lecturer D, for example, informed the students they could do the work at more convenient times to themselves. He would arrive at the beginning of the session and leave if the students did not appear to need his help. This group showed little cohesion as a group, other students not part of the class would come in and use terminals and the tutor appeared unsure which students were members of his tutor group. This lecturer described his style to the observer: '*I am not doing a policing role*' and '*do-it-yourself independent learning*'. As these students were not asked to work at a single task in class there was no one focus for conversations around the groups. In contrast, lecturer H adopted a more didactic approach. He was described as having '*projected his voice, spoke clearly and directly, and commanded an air of authority*' (observation notes). However, unlike the more directive female lecturer, his style did not encourage peer interaction. In his classes males and females always sat next to their own sex, or alone, and there were no mixed groups. An extract from the observations illustrates a different style of classroom teaching, which is interventionist – the tutor clearly directs the pace of the work – but does not encourage peer interaction and helping behaviours.

> For this session the group are looking at information and library skills for the first time. The lecturer gives an introductory talk about the session

> and proceeds to hand out the workbooks and manuals. All of the students have logged onto WINDOWS already without being asked by the lecturer and now they are looking at the workbooks.
>
> Two males that are sat together are not though, one is using the keyboard of the other's terminal, and I observe that one of the students is actually logged onto the student email system and is reading his messages.
>
> The group is very quiet as most of the students are reading through the workbook to familiarize themselves with the exercise task. Twenty minutes into the session now and most of them are accessing the program. The lecturer has been available for any questions as he has walked around the room but no one has asked any of him (observation notes: Male Tutor H).

Like some of the other male tutors this tutor was accessible but did not take the lead in initiating queries or prompting students to work together by active questioning:

> All of the four girls are situated in a row next to each other. I am aware that they are looking at each other's screens and they appear to be at the same point in the exercise.

The women in this instance appeared to be mirroring one another in a form of subtle peer activity, but this did not result in discussion or more active forms of peer collaboration.

> The male accessing the e-mail system is now reading the manual although he has not quit out of the e-mail system.
>
> The lecturer is with one of the males and is maneuvering his mouse as he explains something to him.
>
> A female asks a question of the lecturer and I observe that he does not move her mouse (could be that he is on the wrong side of her and he would have to lean across her to access it). As he leaves her she stands and assists a girl near her and moves the keys on the keyboard for her, and she does the same for the girl next to her.

This second example from the session again shows collaborative behavior among the women that does not develop any further, with no intervention from the tutor in terms of any questioning or prompting to check understanding.

> All of the girls are now into the CD ROM guides the lecturer has asked all of the group to go into.

> The student on e-mail is still logged onto the system and as the lecturer walks over to him, he is asked to quit the program. He reads the manual again (observation notes – typed summary from session 17).

From our observations we were able to identify two major coaching styles: Tutor as Director who organises learning; and Tutor as Resource (Brown and Atkins 1988). These typologies may be, in turn, associated with either high or low levels of peer interaction. The style that produced the most classroom activity amongst both males and females was tutor organised with high levels of peer interaction. Other studies of teaching and learning also suggest that active learning needs to be positively promoted by the tutor (Millis and Cottell 1998). These studies, however, have not looked specifically at IT laboratories in higher education. While research has indicated the importance of these tutor interventions, studies into classroom interaction in compulsory education seem to suggest that, even where teachers do try to intervene, boys continue to dominate computer space.

Discussion

All-class coaching styles appeared to benefit both men and women in terms of peer sharing (Wisker 1996). In our data this was the preferred style of the women tutors. In contrast, some of the male tutors adopted a hands-off style, although they manipulated the keyboard more directly and had more direct interactions with women students. Male students, however, were more likely to be able to engage tutors in lengthy interactions, and we found at least one example from our observations of a female student finding it difficult to gain attention. While theses patterns are not uncommon in classroom pedagogy more generally, it is particularly worrying that they continue in an area which, unlike most higher education, has difficulty in attracting women students.

Experiences in computer laboratories appear to take on a gendered dimension with different patterns of behaviour among males and females. These cannot be read as a lack of women's engagement. Many of the women appeared to take on a confident role and were consulted more often by their peers than were the male students. The interviews picked up on this pattern, noting that the women were confident in their own ability and finding the work easy, although they valued both the workbooks and the classroom activity. During this observational study, students were also reviewing their own development and evaluating growth of capability and skills in a separate project. These findings show increases in the students' evaluation of themselves as independent and self-directed learners; their ability to specify learning agreements; use resources to complete specific learning tasks;

and identify and quantify the skills gained to others (LMU 1998). These comments provide a context for the approaches to learning preferred by staff and their objectives. We were unable to follow up the non-attendees but the short fall of women in class is worrying, both in terms of their individual learning experiences, but also as it left the laboratories more populated by male students than was necessary given the proportions on the course.

Peer interaction appears as a key component in women's experiences. Women moved more in class and were recorded as vocalising more. This is fascinating when we consider that previous research in schools has suggested that boys in schools are more vocal in class and dominate (Beynon 1993; Elkjaer 1992). When women get into IT on applied courses where their previous IT experiences count, our observations suggest that in these circumstances they act confidently. From our observations, we would hypothesise that more collaborative learning might benefit women in computing. There is some evidence from a Swedish initiative which succeeded in increasing women's participation in engineering and computing that this is the case (Svensson 1998). Svensson argues that traditional methods in science and engineering are conducive to 'surface oriented learning' rather than deep learning (Ramsden 1992), and that women respond well to learning strategies which encourage deep learning and more closely approximate applied work contexts. Gina Wisker (1996) argues a similar case in favour of collaborative learning based on feminist principles. We have seen however from our observations that collaboration cannot be assumed in contexts where workbooks are designed to encourage active learning.

Staff in our study who structured the learning experience facilitated more co-operative behaviour than those staff who adopted a hands-off approach. There is some evidence from other studies that, as in our observations, female tutors may provide a more participatory climate for all students (Crawford and MacLeod 1990). This is in accord with the emphasis among advocates of co-operative learning on the need for structure (Millis and Cottell 1998). Women students in classes with positive coaching approaches appear to adopt highly verbal collaborative styles which are inclusive of women and men.

We are aware of the limitations of our study both in terms of its scope, and in terms of the limitations of its observational methods. We hope that more studies of computing in higher education are undertaken with a more developed ethnographic methodology, and using a greater range of classes. This would enable some of our tentative observations (for example variations in direct interventions using the keyboard or mouse) to be tested on a larger data set. Such studies could give us more insight into the processes involved. Although our conclusions are circumscribed, when set against other research, we believe that there is an emerging model of how women's presence within

computing can be made visible and recognised (Adam 1998). This shows congruence with the '*Can Do*' part of Gerda Siann's analysis (Siann 1997). It also begins to open up the possibility of re-describing parts of computing science. If we can develop a phenomenology rather than an ideology of computing practice we can be more confident in telling women, as well as men, that computing is an enjoyable artistry (as indeed are science and engineering). We can then avoid mis-describing computing as only fitted for men.

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