Computer Science at Kent

Arresting the Decline: conversations with female CS undergraduates

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Abstract

Computing, as a discipline within Higher Education, is a relatively new subject and it has undergone a rapid expansion and growth in popularity in recent years. Despite this rise in popularity the number (not just the proportion) of females studying Computing-related subjects at degree level is decreasing. This decline in the number of female applicants for Computer Science (CS) degree programmes is worrying to say the least. This paper reports the findings of a small research project designed to highlight problems and to suggest a course of action that could improve the situation. This initial investigation has attempted to identify any gender-related problems that female CS students at two traditional UK universities have encountered.

Introduction

Computing began to emerge as a discipline within Higher Education (HE) during the period of rapid expansion in the mid-1960s, and as such is a relatively new subject. It has undergone its own rapid expansion and growth in popularity in recent years. Despite this rise in popularity the proportion of female students studying Computing related subjects at first-degree level is decreasing. This decline in the number of female applicants for Computer Science (CS) degree programmes is undoubtedly worrying. In the early 1980s some 35% of applicants for CS degrees at UK Universities were women, but now the figure is closer to 10%. Figure 1, taking 1985 as an index, illustrates the scenario. This trend, which has been easy to highlight statistically, shows no signs of abating.

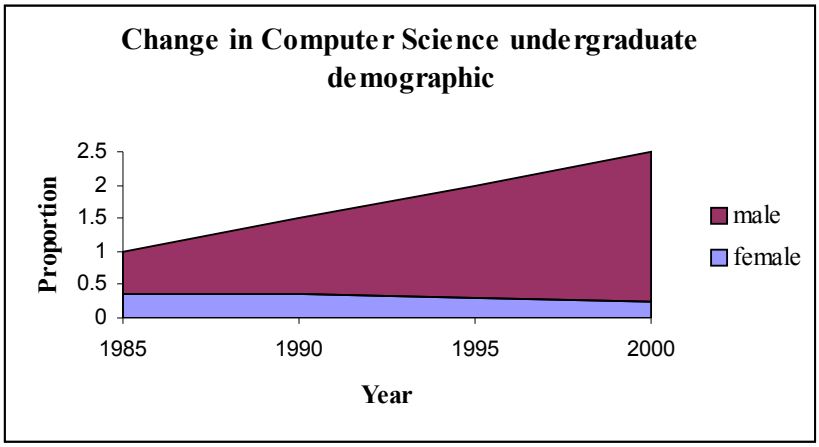

Figure 1

Anecdotal evidence suggests that any discouragement / lack of encouragement that female students perceive is likely to occur at the pre-university level. Indeed it can easily be argued that the battle to encourage female applicants has been won by the time they are actually registered for the degree. Thus we are looking at the possible adoption of a liberal or radical feminist epistemology for any new initiatives to address the decline in the number of female CS undergraduates. This paper presents the results of the first stage of the research. Current female CS undergraduates have been interviewed in order to determine their views. If we are to make changes that affect the students we need to ensure (as far as is possible) that they deem the changes appropriate. It would be sad, and pointless, to make changes that alienate the female students we still retain.

The picture isn't all doom and gloom. Many UK CS departments run 'conversion' MSc courses; one year full-time intensive courses which provide the basics of a CS degree to students who already possess a degree in another discipline. The proportion of female students on such courses is often

greater than 50%. It is, however, a shame that these students do not feel the urge to pursue a CS degree first time around.

There are very few restrictions applied to CS admissions. Achieving a certain number of A-level points (or equivalent) is all that is required; specific subjects are not asked for, except occasionally A-level Mathematics. Research has shown that A-level subject mix has no effect upon final CS degree classification (Boyle, Carter & Clark, 2001).

There have already been several initiatives aimed at encouraging girls to consider Computing as a career choice. The pressure group Women Into Computing (WIC) has organized most of these; a national organization whose main aim is a commitment to encouraging more girls into computing (Wusteman, 1984). This year IBM has also held special "introduction to a career in IT" days at their Hursley Park site for female students.

Possible causes?

Various reasons are cited anecdotally, without recourse to references, as the cause of the current worsening gender imbalance situation. Three major factors repeatedly present themselves as culprits:

1. The increase in the use of computers in schools combined with the introduction of Information Technology (IT) as a core strand within the National Curriculum.
2. The lack of any current female role models.
3. A decline in the number of students previously attending single-sex rather than co-educational schools.

Here we take a more detailed look at these three main contenders and some of the evidence that suggests that they may truly be of some import.

1. National Curriculum

In the mid 1980s computers slowly began to be introduced into mainstream UK secondary schools. At first schools had very few computers, both because they were expensive and because many teachers knew very little about them. The computers were often locked away in a special room and school pupils were only allowed access if they were members of a "computer club" or similar; many schools did not have the funding to provide enough machines for mainstream teaching purposes other than possibly the new A-level Computing. As the importance of the new technology rose so did the number of computers in schools. In fact in 1990, when the National Curriculum for England (and Wales at that time) (DFEE, online) was introduced, the then government deemed Information Technology and computer use to be important enough to make the subject "core". Teaching computing could no longer remain the province of the handful of teachers that were hobbyists and enthusiasts; every Mathematics and Science teacher was expected to teach the new curriculum, often without the benefit of training. It is still the case that many IT teachers know less about the subject (now deemed to be a "key-skill") they are teaching than some of the pupils they teach (Carter, 2001).

Up until this point girls had been happily playing with computers in school (admittedly in lesser numbers than the boys) but Deakin warned at the time that female disinterest could easily become an issue (Deakin, 1984). They have been avoiding Computer Science at university level in ever-increasing numbers ever since.

The timing fits; the apparent perception that Computing is "all about word processing" fits with the content of the curriculum: word processing, spreadsheets, databases, www and email. It is unsurprising that some feminist researchers argue that it has to be a major culprit (Deakin 1984, Spender 1995).

2. Role Models

Women have been associated with, and taken an active role in, Computing ever since the first computer was invented. There have been many female role models in the past, the most famous being Ada Lovelace and Grace Hopper, who was awarded the first Computer Science Man of the Year Award, presented by the Data Processing Management Association in 1969. Since the mid-1980s and the beginnings of the PC revolution things have changed dramatically. The role models are not only all male, but are noted for their business acumen and their "geekyness" (Cringley, 1993). Bill Gates, Scott

McNealy, et al are very different kind of role model and they represent something that may not appeal to women.

Early in the nineteenth century Charles Babbage invented the "analytical difference engine"; it was a mechanical, analogue device which performed simple calculations. Ada Byron King, Countess of Lovelace, (daughter of Lord Byron, the Poet Laureate) was an able Mathematician and she worked with him on this project. Whilst Babbage created the machine Ada devised a way to talk to it; creating a set of simple instructions which controlled the calculations it performed. The notation she devised for describing the sequencing of these instructions has been recognised as the first programming language (Tap: the Ada homepage, online).

The first digital computer was created in America during the 1940s, and this project involved a large number of women. During the Second World War a group of seventy-five female American Mathematics graduates were employed as "computers" to perform calculations and make decisions about the firing trajectories of the large guns being used by the US military. The need to calculate the trajectories more quickly prompted the development of ENIAC, the world's first digital electronic computer, in 1946. A number of the human "computers" worked as part of the development team to create the programming and to write the user manuals, which enabled others to use the machine (Past notable women of Computing, online).

As the new digital computer evolved, it became possible for it to perform a wider range of tasks, and as a result the programs became too complicated and unwieldy. It was difficult to translate the increasingly complex high-level requirements into the low level instructions the computer understood. A female Computer Scientist, called Grace Murray-Hopper, solved this problem by inventing the first compiler. Itself a program, the compiler translates a high level programming language into the low-level instructions a computer understands (The Hopper homepage - the lady and her ship, online). This paved the way for a multitude of different programming languages (including one called Ada, named after Ada Lovelace), each focused upon a particular type of task. This in turn led to an increase in the range of tasks the computer could perform. As computers became more accessible, Computer Science began to be recognised as a separate subject, distinct from its mathematical roots. As Computing broke away from Mathematics, electronics hobbyists began to play with their own much simpler 'computers'. They could program them by flicking switches and the output consisted of a row of flashing lights. A group of American students and entrepreneurs developed this into a practical MicroComputer and the Personal Computer revolution was born (Cringley, 1993).

3. Co-educational Schools

As Higher Education has expanded, students have been drawn from increasingly diverse backgrounds; there has been a dramatic increase in the numbers of students entering with non-traditional qualifications. What is less often considered is the type of school previously attended by our undergraduates. When looking at tables denoting the "top n schools by A-level grade" it should be noted that many of the schools near the top of the table are single-sex. It is these schools that traditionally provided our entrants, but there are ever increasing numbers now entering from co-educational establishments. In fact the number of single-sex schools is also slowly being eroded as often two smaller single-sex schools will merge to form one larger co-educational one for reasons of financial expediency, or a single-sex school has become co-educational to enjoy the benefits of being awarded technology school status. Past research (Draper, 1992) has noted the effects of merging two single-sex schools to form one large co-educational one, but since the advent of the National Curriculum school based research has been focused upon teaching effects – hence the introduction of literacy and numeracy hours – rather than social ones. Even the East Anglian village college experiments, where pupils are segregated by gender for lessons, are being ignored despite the apparent initial success. This is depressing news for the Computer Science gender ratio as the majority of our remaining female undergraduates are from single-sex schools. A similar state of affairs has been noted in Germany, but not, significantly, in Ireland. Ireland still retains a high proportion of single-sex schools.

Qualitative research in Computer Science Education

Methodology links epistemology to methods and the underlying epistemology adopted by mainstream Computer Scientists is a positivist one which is aligned with that of the 'hard' sciences. When calculating packet routes and software performance times objectivity can be achieved and is appropriate. It does, however, cause problems for qualitative researchers. Qualitative methods are not

widely used, if at all, and the concept of subjective rather than objective research and results is often unthinkable; it is difficult to shift from the certainties of modernism to an acknowledgement that there is no single 'truth' to be obtained. There is much ongoing debate about the nature of Computer Science Education research (Holmboe et al, 2001) simply because it is so alien and novel to Computer Scientists. Lack of experience and lack of knowledge of the underlying educational theory can lead to weak research, which in turn reinforces the mistrust of qualitative methodologies.

The Approach

The first step towards collecting relevant data is to choose an appropriate method. Kelly et al (1992) point out that qualitative research has become the definitive research style when investigating gender-related issues; indeed many feminist researchers reject quantitative methods of data collection as impersonal and exploitative, arguing that the notion of objectivity is merely an illusion (Jayaratne & Stewart, 1991). Stanley and Wise (1983), however, suggest that "methods in themselves aren't innately anything" (P159) and Harding (1987) argues that researchers should use any appropriate method provided it is consistent with the research goals and ideology. Holland & Ramazanoglu (1993) further remind us that our own background affects our standpoint in relation to the subject of the research, and that our conclusions should always be open to criticism. The use of qualitative methodologies can be problematic within science-based disciplines, although they are unquestionably appropriate when collecting opinions, thoughts and feelings. Even within the Computer Science Education Research community there are many who still believe that the only valid research methods are quantitative; "we must apply the same basic principles of scientific research to our education studies that they do to their research projects" (Dale, 1996).

When researching gender-related issues one cannot ignore feminist theory and the fact that the preferred methodology of proponents is quintessentially qualitative – although, surprisingly, many current feminist researchers distrust quantitative methodologies less than scientists do qualitative ones (Jayaratne & Stewart 1991, Oakley 1981, Reinharz 1992, Stanley & Wise 1983). We agree with the sentiment expressed by Stanley and Wise when they argue that methods in themselves aren't innately anything; it is the use to which research is put that is important.

The Study

The research has been based within the Computing departments of two traditional UK Universities: the University of Kent at Canterbury (UKC) and the University of Leeds (UoL). UoL is a large inner-city institution in the north of England, whose major non-academic appeal to undergraduates is the night-life, whilst UKC is a much smaller institution in the south of England; its biggest non-academic enticement for students is said to be the sporting facilities (Red Mole, online). UoL has three distinct degree programmes with differing levels of emphasis: Computer Science, Computing, Information Systems, whereas UKC offers just one Computer Science programme. Previous work has shown that the academic profile of the two departments is similar (Boyle, Carter & Clark, 2001), and this suggests that it is both practical and profitable to pool the findings from both institutions.

What did we talk about?

Female students from all undergraduate years, and at UoL all degree programmes, were asked to participate in semi-structured interviews, which were tape recorded and later transcribed, with questions based loosely around the following themes.

1. Their academic and social background
2. Why they chose Computer Science
3. What they were expecting it to be like
4. What it is actually like
5. Did they know the gender ratio before arriving at university?
6. Is it a problem / issue?
7. Suggestions for enticing more female applicants
8. Any other points that the students feel strongly about in relation to the research aims

Findings

Our lives are not understood in a logical chronological sequence, but rather as a complex multiplicity of memories. The documentation of the students' opinions, memories and experiences may be a simple task of transcribing their comments from the interviews, but any interpretation is necessarily influenced by our own biases. The phrasing of the questions, and even the questions themselves, reflect the biases of the researcher. Because of this there now follows a short educational autobiography through which readers may themselves interpret the interpretation of the findings that follow.

My secondary education was gained at a large, co-educational, rural comprehensive in Cambridgeshire. There was a great push to ensure that all pupils deemed "capable" went to university; the school was trying to improve its reputation. The ethos was "irrespective of subject – just get them there". Despite this ethos my four A-levels necessarily included typing, because it would "be beneficial when seeking a secretarial post".

I recall several WIC talks and events. One particular trip sticks in my memory; we went to Huntingdon Tech. to see the computers and were allowed to print out pictures of Snoopy on dot-matrix printers. After that I attended the lunchtime computer club – it was winter and cold – where I wrote a simple multiplication-testing program. I didn't read CS at university, but chose Mathematics and Philosophy instead. I did, however, choose some programming options. Now I teach mathematics to CS undergraduates, via stints as both an NHS Information Officer and a Maths and IT teacher in a girls' grammar school.

Results

Presented here are summaries of the responses categorised by question / theme before starting to draw some tentative conclusions.

1. Background

Seven of the fifteen students had previously attended a single-sex school. At almost 50% this is significantly higher than the national proportion of pupils attending single-sex schools. The type of school: grammar, high, comprehensive varied between Education Authorities; thus nothing can be read into that. This can best be interpreted in the light of the findings of previous research which shows that of the female students attending the two institutions those who attended a single-sex school are more comfortable and confident with computers than those attending co-educational establishments (Carter, 2001).

Most of the schools had provided IT and Computing A-levels, but six still had no IT teachers who were qualified in the subject.

- *Our IT teacher was a qualified teacher, but she wasn't qualified in IT. She had a Latin degree.*
- *IT was taught by the maths and geography teachers. We knew more than what they did.*
- *It was really good in my school. The IT teacher knew what he was doing and he was really keen. He just made it interesting for us.*

The social backgrounds of the students varied widely, as did the level of encouragement provided by parents and teachers but no pattern emerges.

- *My dad works with computers.*
- *They all just accepted it ... No one said I shouldn't do it because it is a boy's subject.*

None of the girls actually received active discouragement from pursuing a computing oriented degree or career, although one father *"thought it was just a fad at first"*. Another participant was, however, pressured by teachers to stay at school rather than go to college; she wanted to take her A-levels at college in order to do A-level Computing which was not offered at the school. Fortunately she received encouragement from her parents. Only one was actually encouraged by her teachers: *"... there was just pressure to excel in what you were good at and I was good at IT"*.

2. Why choose CS?

Two of the students had previously started, but not completed, a degree in a totally different discipline and had changed to Computing after a closer inspection of what Computing degree courses entailed and job prospects upon completion. One had started a German degree and found it unsatisfactory; her

boyfriend was studying Computer Science and it appealed: *"what he was doing was more interesting than what I was doing"*.

The other had begun a European Drama degree and became disenchanted after a couple of months. When she left she took a job in an IT company and became fascinated by some of the work that was done there. *"I just got hooked. I was just fascinated by it all"*.

The students who entered the degree programme directly after completing their A-levels presented a variety of reasons, some more positive than others:

- *Money was a factor. People say you can get a high paid job.*
- *I didn't enjoy my A-levels so I did Computing instead. It was something I hadn't done before.*
- *I didn't know what else to do.*
- *I didn't want to do nursery nursing or travel and tourism.*
- *Computing seemed most interesting I suppose.*
- *All I had to go on was my GCSE but I wanted a challenge.*
- *I'm interested in computing because of my boyfriend.*
- *Computing, or at least programming, was something I enjoyed.*
- *I really wanted to learn proper programming.*
- *I discovered that architecture was boring, repetitive and slow and simultaneously that computing wasn't!*
- *I went to a technology school. I was just fascinated, and I did well at school.*
- *Getting 'the computing bug' ...!*

Some respondents talk about being good at, interested in, or fascinated by, aspects of the subject, whilst others simply found it less boring than other choices they could make. None of them appear to have questioned their choice, or why they made it.

3. What did you expect?

Responses to this question were basically a variation on the theme of "I don't know":

- *I expected it to be more interesting than what I was doing.*
- *I really didn't know what to expect with programming.*
- *I didn't know what to expect.*
- *I thought it would be like my A-level.*
- *Not sure what I expected, but I thought it would be more technical.*
- *I thought it would be more like using packages and stuff.*

The obvious follow-up to this was to ask about advice from careers teachers and others at the school. Responses to this were worryingly unanimous:

- *The careers teacher didn't know anything about it*.

4. What is it actually like?

The students were invited to tell us what they thought of the degree programme. They were not asked if, with the benefit of hindsight, they would have chosen an alternative subject. Rather, they simply said what they felt appropriate:

- *I love it. It is good fun. There are so many aspects you can just choose the ones that appeal the most.*
- *I hate programming.*
- *It is more boring than I expected but I suppose I would still choose it.*
- *The logic thing takes patience. You have to adhere to a structure, but if you persevere you can make it do what you want.*

- *Oh that feeling when you actually make it compile and run.*
- *It's a practical course. You can't just tell people what to do, they have to just do it – give it a try.*
- *The first year was boring, but everyone knows different stuff when they arrive and we all need to know all of it, but now we can choose the bits we like and its good.*

5. Did you know about the gender balance before you arrived?

All the participants said that they were aware, to some extent, that they would be in a minority.

- *I had an idea it would be mainly lads and not many girls.*
- *I came to an open day. My mum asked because there were three girls there and he said it was a good turnout.*

6. Is it an issue?

'Knowing' and experiencing can be very different, and over half of the students said that it had initially been a shock when they first walked into a lecture theatre to see a sea of male faces.

Girls become friends quicker because there are so few of you.

- *If you're into it they don't care if you've got bumps and wear a skirt.*
- *The guys are alright. You can sit next to anyone.*
- *Quite a few people went to single-sex schools before. It must be quite hard for them to get used to.*
- *I was apprehensive at first but it doesn't make any difference at all.*

So the gender imbalance isn't an issue for the students, just for those of us who would prefer the numbers to increase rather than decrease. This does not, however, imply that it is not a factor in the decision of female students that decide not to apply for a CS degree. Two further gender-related points did emerge:

- *At first I felt like giving up 'cos everybody else knew so much and I knew nothing, but one guy came up and said "we must know enough else they wouldn't let us on the course".*
- *If we ask for help they ask us how to do it afterwards. The boys don't ask staff for help. We'll just ask anyone in sight.*

Proponents of social learning theory argue that all school curriculum subjects are stereotyped as either male or female (with Computing falling into the male category) and that this causes an almost automatic lack of confidence when girls attempt subjects which are branded as male. Previous studies have shown that female students do lack confidence in this domain and that one significant corollary of this is often an underestimation of their own ability (Scragg 1993, Wilson 1993). The comments made by the respondents do not relate specifically to the subject here, but to more general issues.

7. Suggestions?

One key aspect of this research project is to highlight problems and to suggest a course of action that could improve the situation. If the students had any suggestions they could be incorporated into any initiatives contemplated in the future. Most of them could not think of anything that would have any impact, but those that did have something to say were unanimous in the view that more information about the content is crucial.

- *An information booklet saying there is more than just programming. It has so much variety and you don't know that until you start.*
- *When you apply for maths or geography or whatever you know what it is about, but this is something new, it means you don't have a clue.*
- *If there were more proper teachers and more girls could do A-level it would help.*

Discussion

In the mid-1980s the "computer revolution" began to take off and people who knew about Computing could command higher salaries. This fact, combined with the economic climate of the time, may have encouraged a temporary increase in the numbers of female students undertaking Computing degrees; there were too few, if any, computers in schools for girls to discover what they were about. Girls appear to be less fascinated by computers than boys, taking a much more pragmatic approach to the subject, so it can be argued that it is not surprising that as computers began to appear in schools and PCs became more widely available the proportion of female CS students simply returned to previous levels. Unfortunately the original level was approximately 25% and it is now below 10% and still falling, so this cannot be the case.

The female students who participated in this study do not appear to have encountered any noteworthy gender-related problems with their career choice to date; at least, no problems that they wished to mention, but some did mention less than satisfactory school experiences. In order to discover something about the school perspective, and to redress the balance somewhat, the careers teacher from a local girls' school was also interviewed.

She began by providing an historical overview of how Computer Studies and IT have become integrated into the school. There has been a shift of emphasis during recent years, from courses that were introduced for interest towards a more functional approach. If this trend has been replicated in other schools it is not surprising that girls are no longer interested. She suggested that the girls from this school are always conservative about their choice of degree programme, and that they are never keen to embark upon something totally unknown at such a major transition point. She claims that girls have a tendency to opt for a traditional course that they actually studied at A-level. If this is truly the case then the lack of information alluded to by the students could be a key factor in deterring many female applicants. Research has shown that institutional change can play a significant role in polarising gender stereotypical behaviour (Meyenn, 1984).

A brief history of Computing within the school was also provided. The first computer network was installed in 1987. LOGO (a simple programming language designed for educational use) and word processing were taught to girls in year 7, and word processing was taught to girls in years 10 and 12 "to enable them to present their coursework impressively". No other year groups were given timetabled lessons, but the pupils were allowed access to the computers at lunchtime. The following year Pascal programming (a full programming language) was introduced as an option for 6th form General Studies. It proved to be popular, so the following year A-level Computer Studies was also offered. One of the female Mathematics teachers had studied CS at degree level, so she taught it. The course stopped being offered when the teacher left; her replacement was chosen on mathematical ability only. This heralded the change in emphasis towards computers being useful only as tools.

In the absence of any teacher with relevant qualifications the teaching of Computing is given solely to Mathematicians and Scientists. No one else appears to have learned the new skills, despite demanding them of pupils. In defence of subject teachers, very few teacher-training establishments offer Computing courses. Perhaps school senior management teams are not alone in their disregard for the technology revolution. This may excuse the teachers at the chalk-face, but does not help boost the image of the subject in the eyes of the school pupils.

Deakin (1984) recommended tailoring courses specifically to girls by recognising and embracing their pragmatic approach; an argument which is similar to Kelly's (1981) liberal feminist approach to encouraging girls into science. The fact that this has not happened may not be entirely due to the National Curriculum. There has been a steady transition from teaching Computer Studies to the proficient use of computers as tools, which the National Curriculum advocates. IT rarely, if ever, features in other subject lessons, despite being considered a "cross curricular subject" and a "key skill". If an English department (for example) demands that pupils use such features such as spelling checkers and thesaurus programs for coursework their use is rarely incorporated into the English syllabus. There are many dangers in suggesting that this one interview could possibly represent a general picture. This school is unlikely to be representative of all girls' schools, let alone boys' schools or co-educational establishments. In 1995, Spender (Spender, 1995) noted that research in this area is sadly lacking, and it still is.

This brings us to the crux of the school issue. Many IT teachers know little more about Computing than the use of packages taught in IT lessons.

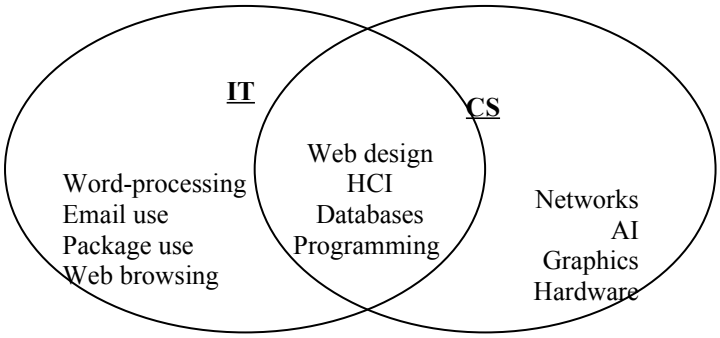

Figure 2

They do not know what CS is, let alone that it is different and distinct from IT. Figure 2 shows a simplistic breakdown of the differences and overlaps between IT and CS. This is not a trend that is unique to the UK.

> "Within many educational systems, there is a blurring of the distinction between Information Technology (IT) and Computer Science (CS) since it is not clear where one stops and the other starts. Many high-school teachers are not even aware that the subjects are different. The distinction does, however, become apparent once University level is reached" (Carter & Boyle, 2002).

An Issue to Consider

Research literature suggests that female students are not as confident as male students with domains such as Computing (Bjorkman 1998, Carter 1999, Davies 1984). The corollary of this is that women may underestimate their ability, which is demonstrated at UoL by a disproportionately large numbers of female students seeking to attend the optional extra tutorials that are offered. No such tutorials are offered at UKC, where help is offered on a more informal and often one-to-one basis. A previous study, using a simple Likert scale, showed a statistically significant difference of opinion between UKC and UoL students on the issue of whether or not male students are better at programming than female students; UoL students said "yes" and UKC students said "no" (Carter & Jenkins, 1999). This is a factor that could not be ignored when analysing the results here. The only distinction that could be drawn between students from the two institutions relates to the backgrounds of the students attending state schools. The UKC students attended grammar schools and the UoL students mainly attended comprehensives. This is unsurprising given that the county of Kent still maintains a selective system. Delving deeper into the comments made by students, and categorising them by institution yielded no differences.

What next?

Anecdotal evidence from teaching staff suggests that there is a perceived difference in the way in which male and female students approach the subject:

- Female students ask for help more often – they are (in general) more willing to ask for help, so they tend to get more help: *"My gut feeling is that they are more conscientious than the boys"*.
- *"Female students treat computing as a subject just like any other subject and some of the male students are into the programming / systems side of the subject as a hobby as well."*

Many colleagues also claim that they can tell the gender of a student simply by looking at the code they produce for programming assignments. Gender does sometimes appear to have an influence on style – an obvious example is handwriting. It is possible, then, that gender has an influence on the style of a student when programming, but the argument remains unconvincing. Coding style is much more likely to be influenced by seminar leaders and lecturers dictates. There is no literature available on this issue, so an empirical investigation is underway asking academics whether certain code fragments were written by male or female students, but more importantly why they believe this to be so (Carter & Jenkins, 2001).

Observation of the interactions between the students during classes could produce further evidence, and possibly highlight areas to ask about during interviews. It could also provide some triangulation of evidence and hence help to increase the reliability of the findings. It is also necessary to balance the

interviews with female students by interviewing some of our male students; their perspective may provide an interesting counterpoint.

One key aspect of this research was to highlight any problems and to suggest a course of action that could improve the situation. In this study there has been an attempt to identify any gender-related problems that our female CS students have encountered. The study has been on a very small scale, and consequently the results are definitely not generalizeable. Indeed it is beyond the scope of such a small study to do any more than this, however the evidence that has been presented to us by the female students suggests that once they reach University they consider the environment to be favourable. This further suggests that it may be more productive to shift the focus to the computing experience girls receive in schools rather than a comparison of two HE institutions. For the proportion of female CS undergraduate students to increase it is essential to look at how computing is portrayed to girls; we need to encourage more girls into Computing if we are ever to make it a more female friendly place (Spender, 1995). A "chicken and egg" situation appears to be emerging, but if any reasons can be established it may be possible to effect policy changes which will encourage more girls to try the subject.

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