This paper provides a brief overview of my 1986 paper “Why are Girls Under-Represented? Suggestions from the Literature”. It discusses the changes in perceptions of reasons for concerns about the under-representation of girls in 1986 and in 1996. Then it overviews the major findings of the research that we have conducted over the past decade.

1986 Paper

In “Why Are Girls Under-represented? Suggestions From the Literature” (Clarke, 1986), I provided an overview of the available published literature in which I argued that the under-representation of girls in formal and informal computing activities was the product of sex differences in the development of attitudes to computers. Although the literature was piecemeal, and lacked a theoretical framework, separate studies addressed individual issues which fell within the broad framework of social learning theory. The studies were used to document the roles of modelling, direct experience, reinforcement and generalization of existing attitudes to explain the development of sex-related differences in attitudes towards computing. It was suggested that these attitudes underlie the decisions of boys to engage in computing activities and the choice of girls to remain uninvolved. In brief, the role models provided in classrooms, in the workplace, at home and in the media were more likely to be male than female indicating that computing activities were sex-typed as male. When using computers, the experience was more positive for boys than for girls — boys were more likely to be rewarded by teachers, parents and peers for showing their prowess, and boys were more likely to find computer games intrinsically interesting as they were generally designed by male programmers and reflected traditionally male interests. These positive effects of computing experience increased the likelihood that boys would choose to engage in further activities to obtain both extrinsic and intrinsic reinforcement. Further, computers were seen as “number crunchers” and hence inherently mathematical, or as “gadgets”, and hence of more interest to boys who generally had a stronger interest in mathematics, science and technology.

Relevance of 1986 Issues in 1996

The role of social learning theory in the development of attitudes towards computers is as relevant in 1996 as it was in 1986, although the role of computers in society and the reasons for concerns about sex differences in computing participation, attitudes and achievement have changed.

If we observe the available role models at computer conferences, in the media and in computer stores, they are still predominantly male. If we study computer games, they still show a strong male bias. If we ask secondary and tertiary students about computers, there is clear evidence of gender-based differences in intrinsic and extrinsic reinforcement as the result of using computers and of sex-typing of computing activities. Students are still learning that computers and computing activities are sex-typed as male.

The major change is in the role of computers in society. Whereas in 1986 a few schools had a small number of computers, and some even had one computer laboratory, in 1996 computers are not only more common in schools, but there are schools where every student is expected to own a personal computer. In Victoria, with the introduction of the Victorian Certificate of Education (VCE) and its Common Assessment Tasks, completed at home and submitted across the school year, most students have discovered the advantages of using computers and word processing and graphics packages to prepare professional looking pieces of work. Generally, computers are being used as tools to achieve tasks, with considerable school-based instruction being in the use of software packages (most commonly word processing) to complete these tasks. However, there remain marked gender differences in the proportions of girls and boys who elect to take VCE studies in computing and who elect to study Computer Science at the tertiary level. In essence, with the increased use of...
computers in all aspects of life, the basic level of computer literacy is increasing, with the gender differences being evident at the more technical levels of computer interest and usage.

The bases for concern about gender differences in computer interests and usage have also changed. In 1986, following the work of Papert, there were many teachers and researchers who believed that learning programming languages and learning to use computers had a major effect on intellectual development. This seems of less concern today, as computers are now seen as one tool to assist the development of intellectual skills, rather than as the solution to all or most educational problems. There is less emphasis on the need to develop computer literacy to survive in the modern society. As the development of basic computing skills takes its place in the school curriculum alongside the development of social skills, numeracy skills and traditional literacy skills, computing is increasingly being viewed as an integral part of everyday life and of the school curriculum, rather than a new phenomenon with unpredictable intellectual and social impacts. However, the concern over gender differences in pursuing studies of computing and careers in computing remains as this is one area where the demand for qualified employees often outstrips the supply of adequately trained personnel. Computing graduates are more likely to obtain a job on graduation than are graduates from most other disciplines, and they are likely to commence on higher salaries than many other graduates. If women are going to participate equally in these higher paid careers, they must be encouraged to participate in upper secondary and tertiary computer studies.

The (Lack of a) Role of General Ability

Some of the assumptions inherent in "Why Are Girls Under-represented? Suggestions From the Literature" have been verified in our later research. In the 1986 paper I argued that there were few sex differences in general ability or in computing ability, and that ability was not a factor underlying observed sex differences in computing involvement. In relation to general ability, several meta-analyses have demonstrated that gender is not an important factor in explaining differences in ability, accounting for less than 5% of the variance in ability scores, and often as little as 1% of that variance. Our own research in the later 1980’s examined gender differences in achievement in a compulsory computing unit within the Deakin University Bachelor of Science program (Clarke & Chambers, 1987). At that time all BSc students were required to complete a unit in introductory computing and statistics. Obviously, for some students this was an area of interest or future major studies, while for others it was an imposition of the course structure which required a pass in a subject which otherwise would have been avoided. We asked all students in this unit to complete a questionnaire in the first week of the semester and we obtained the final assessment marks from the unit co-ordinator. The questionnaire provided data consistent with those commonly being reported in the literature: relative to male students, female students had considerably less computing experience...

that women are as capable as men at performing adequately in tests of computing achievement if required to do so. Thus differences in general ability or computing ability between males and females are not relevant to computing performance, but differences in beliefs about these abilities remains an important factor in decisions to engage or not engage in computing activities.

Single-sex and Co-educational Schools for Girls

In the 1986 paper I cited “Computing in a Social Context” (Clarke, 1985) in which I argued that girls in a co-educational school were more likely to see computing as sex-typed as a male activity than were girls in a single-sex school. This sex-typing of computing was shown to be associated with computing attitudes and with achievement on an end of year test of computing knowledge. As the data for that paper were based on a mere two schools, for many years I was concerned, wondering whether the differences reported in that paper were genuinely the effects of differences between single-sex and co-educational schools, or whether they were the product of some other factors peculiar to these two schools. In 1992, Trudi Jones, one of my honours students, conducted a study which examined the differences in computing experience and attitudes among girls from single-sex and co-educational schools. The findings of her study (Jones, 1992) supported those of my 1985 study, indicating that girls from single-sex schools had more computing experience, more positive attitudes to computing and were less likely to sex-type computing as a male activity.

The Importance of Attitudes for Girls

The 1986 paper also cited another earlier paper “When Attitudes Count” (Clarke, 1985b) which explored the factors that related to the scores obtained by primary school girls and boys on an end of term computing knowledge test. It was
Importance of Diversity of Computing Experience

The CASS provided us with a useful tool to continue our exploration of secondary girls' attitudes to computing (Jones & Clarke, 1995) and to shed light on some aspects of the findings of an earlier paper I had prepared in conjunction with Sue Chambers - “Is Inequity Cumulative?

Why Are Girls Under Represented? Ten Years On

“The consistent with our predictions, we found that the girls in the single-sex schools had more positive attitudes to computing than did the girls in the co-educational schools...”

The Relationship Between Disadvantaged Group Membership and Students’ Computing Experience, Knowledge, Attitudes and Intentions” (Chambers & Clarke, 1987). That paper reported a pre-test post-test study of 951 primary and secondary students in schools into which considerable numbers of Apple II computers were being introduced. Students completed both standardized tests and questionnaires at the beginning of the academic year, before the introduction of computers into the schools, and at the end of the year, after there had been considerable opportunity to work with the computers both in and outside class. Following the Commonwealth Schools Commission reports on computers in schools and on equity in education, disadvantage was defined in terms of sex (female), low school ability, low socio-economic status, and ethnicity (non-Australian origins). Not only were there differences in reported class computing experience, non-class computing experience, computing knowledge and computing attitudes between boys and girls, but there were differences on most of these measures for most of the other disadvantaged groups. Furthermore, there was a cumulative effect of disadvantage, in that the more disadvantaged groups to which an individual belonged, the lower the score obtained on some or all of the computing measures. The effect of introducing considerable computing resources into the schools was to exacerbate rather than reduce the differences between disadvantaged and other students, with the more advantaged students gaining the greatest benefit from the increased resources. Of all the findings, the one we found the most unexpected was the differences reported for class computing experience - it seemed odd that, when testing intact classes, some students were reporting using a greater number of different computing applications than were being reported by their classmates. However, the findings in relation to the cumulative effects of disadvantage seemed to indicate that the important variable was not gender, but the opportunity to gain computing experience and knowledge (either at school or at home) which in turn related to attitudes.

Diversity of Experience and School Type

Further evidence relating to the importance of personal experience with computers was obtained when we addressed the differences in attitudes to computing between girls at single-sex and co-educational schools (Jones & Clarke, 1995). Using the CASS and measures of computing experience, we collected questionnaire data from 231 girls from 5 secondary schools. Consistent with our predictions, we found that the girls in the single-sex schools had more positive attitudes to computing than did the girls in the co-educational schools, but this time we were able to identify reasons for this difference. The girls in the two types of
Schools were comparable in their reports of the amount of time they spent using computers and in their opportunity to use computers, but they differed significantly on two important components of computing experience—the diversity of computing experience (defined as the number of different computing applications they had used), and the number of sources of information about computers. Exploring the data further, we found that diversity of computing experience explained 33% of the variance in the computer attitudes scores, while computer use only explained 7% of the variance and sources of information a further 5% of the variance. What seemed to be happening was that the girls in the single-sex schools were gaining more diverse computing experience which was having a positive impact on their attitudes to computing. It also seemed plausible that, within classes, the advantaged students in the 1987 study were gaining greater access to the teacher and moving to new applications while the disadvantaged students were remaining with the applications with which they were comfortable. The message from “Diversity as a Determinant of Attitudes: A Possible Explanation of the Apparent Advantage of Single-Sex Settings” (Jones & Clarke, 1995) is that the best use of school computer time is to introduce students to a wide variety of computing applications in order to develop an appreciation of the possible uses of computers.

School Holiday Program for Year 10 Girls
Recognising the importance of diversity of experience with computers in developing positive attitudes to computing, a group of women conducted a holiday program for 20 Year 10 girls (Teague & Clarke, 1993). The major aim of the program was to show girls that working with computers could be interesting and fun. Each of the local government secondary schools was invited to offer places to two girls. Activities offered during the five day program included electronic mail, computer music, scientific applications of computers, Lego-Logo, encyclopedic and career information using CD-ROM, desktop publishing, graphics, games, databases, spreadsheets, word processing, the use of a floor turtle programmed in Logo, and demonstrations of the applications of computers to video editing, library management, and the release of students results via telephone and voice response. All girls were very enthusiastic about the week and recommended that many more girls should have the opportunity to attend such a program. Of all of the activities, the most popular was electronic mail.

Different Perceptions of Students and Professional Women
Whilst working with school students, we also conducted studies at the tertiary level, focusing more specifically on why women are under-represented in university Computer Science courses. Thinking that the students might be able to shed some light on this issue, Joy Teague and I conducted a study in which Social Psychology students completed open-ended interviews with 34 male and 34 female Computer Science students (Teague & Clarke, 1991). We were very disappointed with the results, which merely confirmed the existing stereotypes. Overall, the Computer Science students displayed the same gender differences and held the same stereotypes as were common among the wider population and in our school samples. The males had more previous computing experience and were more likely to own a computer. Students believed that women were under-represented in Computer Science as they held stereotyped views of computing, they perceived it to be related to maths, science and technology, they were not encouraged to study computing, they were not interested in computing, or they believed they were not good at computing. The interesting thing which emerged from the data was that the students defined their successes in computing mainly in terms of getting a program to run, and failures were similarly defined in terms of having problems with writing programs, debugging programs, gaining time to complete the required work, and obtaining access to computers—the latter being a significantly greater problem for female students than for male students. These findings seemed inconsistent with what we knew of professional women working in computing, so Joy interviewed a number of women currently active in the workforce. The picture that emerged from these women was very different. They talked about a job in which they did very little programming. They described their jobs as being exciting, challenging, always changing, and generally involving working with people to solve problems. It seemed that the students’ views of Computer Science and the perspectives of the women working in computing had little in common.

Video and Booklet Package
As a result of conducting this study, we decided to make a video to show girls a little more about jobs in computing. Supported by a grant from the Office of the Status of Women, we produced a 26-minute video and accompanying booklet for secondary students, both called “Girls, Have You Considered Computing?” (Clarke & Teague, 1992). This package is available for purchase from the School of Psychology at Deakin University, and is also located in most of the Career Reference Centres. The video shows six professional women, each engaged in a different occupation: a computer-based training manager, a video editor, a project manager, a user support consultant in a research organisation, a contract systems analyst, and a pattern designer. The women talk about their own educational and professional background, the nature of their job, and what they like and do not like about the job. The booklet provides more detailed information to be used in support of the video.

Secondary Girls’ Perceptions of Careers
To find out about the types of careers secondary girls wanted, and their views of computing, Joy and I conducted a qualitative study of 32 secondary girls aged 13 to 17 years (Teague & Clarke, 1995). Girls were interviewed separately and in small groups. When talking about the features they would like in an ideal career, they identified many of the characteristics that professional women in computing careers had identified as the features they liked about their current jobs: variety, challenge, opportunity to earn a high
salary, working with people, and solving problems. However, when asked about careers in computing they talked about them as being boring, involving programming, and working all day in isolation with only a computer for company. Turning from careers to school computing, they talked about having to do formal exercises in class, these often involving copying text to learn typing skills. Their general reaction was that computing classes were boring and irrelevant. By contrast, when asked about using computers at home, they talked enthusiastically about their usefulness in the preparation of assignments, and the relevance of word processing, database and graphics packages. They did not see any similarity between home and school computer use. It appears that the way computers are introduced into schools lacks the relevance and interest to attract girls to choose to study computing.

The Current Problem

On the basis of our qualitative and quantitative work with primary, secondary and tertiary students and with women working professionally with computers, we have concluded that the problem is not with computers or with computer careers, but with the way computing is taught in many schools and at universities and the resultant image of Computer Science and computing careers.

Possible Solutions

As we suggested in “A Psychological Perspective on Gender Differences in Computing Participation” (Clarke & Teague, 1994) in order to attract more women to Computer Science, those already in the field need to recognise that this will provide benefits to the existing students of both sexes, to the faculty, and to the profession. Women need to be supported by mentoring schemes to ensure that they complete their tertiary studies and undertake careers in the area. However, before this can occur girls must choose to study Computer Science at secondary school and/or university. Such choices require a change in the image of jobs in computing to be consistent with the world of work rather than the world of education, and a change in the teaching of computing and Computer Science. Ten years ago computing careers invariably meant programming. Today’s packages reduce the need for third generation language programmers. Different skill are demanded, including interpersonal skills and problem solving skills. Tertiary Computer Science needs to ensure that its emphasis reflects that requirements of the workplace.

At secondary level the changes needed are similar to those I suggested in 1990 in “Girls and Computing: Dispelling Myths and Finding Directions”. Girls must be encouraged to use computers for completing projects in a range of subjects across the curriculum, and given the opportunity to develop an appreciation of the diverse uses of computers. Inaccurate images of computers and computing careers are best dispelled through direct experience, but such experience must be both intrinsically and extrinsically rewarding to facilitate the continuing development of computing skills and appreciation of the breadth of available applications and careers.

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