

BULLETIN

Women in science, engineering and technology

Introduction

The publication of the Greenfield Report on women in science, engineering and technology (SET) (2002) stated that women are significantly underrepresented in these disciplines, especially in higher employment positions. This Bulletin summarises the position and progress, albeit slow, of women in SET from compulsory to post-compulsory education, and in training, higher education, academia and employment. The barriers that impede women choosing SET, and how they may be overcome, are also highlighted. The data presented in this Bulletin are based on a project undertaken by IER, funded by the Office of Science and Technology, in which data¹ from various sources were used to produce commentary and graphical expositions of women in SET.

Although the number of women appears to be increasing in SET occupations and women are progressing in SET, the number of girls and young women undertaking SET subjects in compulsory education, post-compulsory education, vocational training and higher education shows a very mixed picture.

The number of women undertaking specific SET subjects such as Physics, Computer Science, Engineering, Mathematical Sciences and Chemistry is decreasing, which has implications for women progressing into SET occupations in the future.

Women studying SET subjects

On the basis of test results, girls are continuing to outperform boys in compulsory and post-compulsory education and more significantly in Information Technology (IT), English, Physics and Mathematics. These differences are in evidence throughout the period 1992-2002. As they complete their compulsory education, girls are opting for general and combined science

qualifications and not Physics and Chemistry. Generally, girls are outperforming boys in Science and in the specific sciences, with the exception of Physics where boys are doing marginally better than girls. For instance, in England (2001) 233,800 girls opted for the GCSE Science Double award compared to 230,600 boys.

In compulsory and post-compulsory education, the number of girls studying Physics is decreasing whilst in higher education the number of women accepting and attaining qualifications in Physical Sciences is increasing. A lower number of girls were attempting GCSE Physics in 2001 compared to boys: 15,000 girls compared to 23,000 boys. The number of young women opting for Physics at 'A' Level has decreased by 16 per cent over the period 1992-2002 compared to a 22 per cent decrease in the number of young men. Larger decreases in the number of Physics candidates are observed for Scotland. In comparison, the number of female undergraduate acceptances for Physical Science degree courses increased by three per cent over the period 1997-2001. The number of women attaining qualifications in Physics increased by 16 per cent over the period 1995-2001. Overall, the number of first degree undergraduates in Physics is decreasing with only one in five first degree Physics undergraduates being female.

In contrast, although men have always dominated IT subjects, the number of women studying these subjects is increasing, and they are continually outperforming men. At 'A' Level there are significantly more male candidates for IT subjects than women, which was also the case in Scotland for the SCE Higher and New Higher qualifications. Female 'A' Level students in England and Wales have higher success rates² than their male counterparts. More men were studying undergraduate courses in Computing Science than women: 18,100 men compared to 4,565 women in 2001. Twenty per cent of the undergraduates studying Computer Science subjects are female – a proportion that has been unchanged since 1995/96. However, the number of women attaining higher educational qualifications in Computing Science has increased by 74 per cent compared to an increase of 46 per cent in the number of men over the period 1995-2001.

¹ The data sources used include statistics from several government departments, from the Labour Force Survey, the New Earnings Survey Panel Dataset, the Higher Educational Statistics Agency and the IER Graduate Career Paths Survey 1998/99. The views expressed are those of the author and should not necessarily be attributed to project sponsors. Contact: sally-anne.barnes@warwick.ac.uk at IER.

Men dominate engineering courses but their numbers are decreasing whilst the number of women is increasing. On engineering undergraduate courses, the percentage of female applicants and acceptances through the Universities and Colleges Admission System has remained stable at 14 per cent. In contrast, the number of women attaining higher educational qualifications in engineering has increased by 14 per cent over the 1995-2001 period compared to a four per cent decrease for men.

Although more men are applying for, accepting and obtaining higher education qualifications in SET and SET-related subjects³, the number of women is increasing at both undergraduate and postgraduate level. However, significant numbers of women are still rejecting SET courses. Few women are being funded to undertake postgraduate qualifications in SET subjects, but in 2000/01, 55 per cent of those receiving funding for qualifications in SET were women. Overall, the number of SET degree holders has increased from 1.1 million in 1992 to 1.5 million in 2002. This is mainly due to the increase in Science degree holders.

Over the period 1994/95-2000/01, the percentage of females undertaking postgraduate qualifications in SET subjects increased from 35 per cent to 55 per cent. Until 2000/01, more men undertook SET doctorates than women. The number of male SET doctoral students has decreased by 30 per cent for full-time students and by 21 per cent for part-time students over the period 1994/95-2000/01. The number of full and part-time female doctoral students has increased by 56 per cent and 42 per cent respectively over the same period.

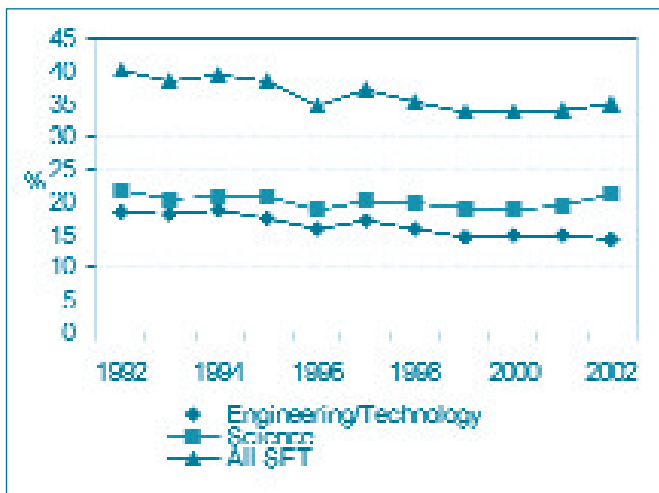


Figure 1: Percentage of male SET degree holders, 1992-2002. Source: Labour Force Survey, Spring Quarter 1992-2002

Fewer women were funded for postgraduate qualifications in SET subjects than men until 1999/00. In 2000/01, 55 per cent of female postgraduate students in SET subjects were being funded, which has increased from 35 per cent in 1994/95. The number of

² Success rate in this instance is defined as the total number of grade A-E passes as a percentage of the total number of attempts.

³ SET degrees include Biological Sciences, Physical/Environmental Sciences, Mathematical Sciences and Computing, Engineering and Technology.

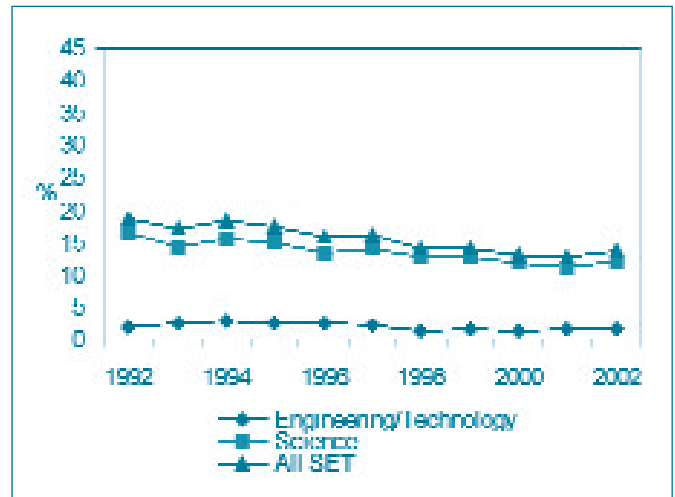


Figure 2: Percentage of female SET degree holders, 1992-2002. Source: Labour Force Survey, Spring Quarter 1992-2002

self-financed female SET postgraduates has increased from 36 per cent in 1994/95 to 55 per cent in 2000/01.

To summarise the picture revealed by higher education data, men still dominate SET and SET-related courses, particularly in Physics, Mathematical Sciences and IT, and the number of women is not increasing significantly if at all (see Figures 1 and 2). However, engineering courses are the exception as there has been a small increase in the number of women undertaking and attaining qualifications in this subject, but the data suggest that a third of these graduates will enter employment in the health and social work sector. The small number of women gaining SET qualifications may in part explain why men continue to dominate academic positions in SET academic departments and persistently dominate higher academic positions in those departments. It should be noted that there are only high proportions of female professors in IT and Systems Science departments.

SET vocational qualifications

The largest gender difference between men and women is observed in those attaining SET vocational qualifications and starting apprenticeships in SET related sectors. Men are choosing and attaining vocational qualifications in engineering, and science and mathematics subjects, whereas women are opting for and achieving qualifications in IT, education and health care subjects. Gender differences are also noted in apprenticeship starts in which men are choosing traditional male sectors such as engineering and construction whilst women are choosing childcare and hairdressing.

In engineering manufacturing and the construction sectors women are massively underrepresented: three per cent and one per cent of women respectively as a percentage of total starts in those sectors. Gender differences in skill-based vocational qualifications may be explained by the stereotyped advertisement and recruitment for the enrolment of these courses.

Women's employment in SET

Women continue to be underrepresented in SET occupations⁴ regardless of whether they hold a SET degree or not. High percentages of women with SET first and postgraduate qualifications are entering employment in health and social work sectors. The percentages of men and women with a first degree in a SET subject entering managerial and administrative occupations are relatively even.

In 2002, there were 412,000 male SET degree holders employed in SET occupations compared to 81,000 female SET degree holders. The employment of male and female SET graduates in SET occupations has increased over the period 1992-2002. However, the increase in the number of women is significantly higher than that of men. For instance, over the period 1992-2002 the employment of male SET graduates in SET occupations increased by 21 per cent compared to a 64 per cent increase in female SET graduates employed in SET occupations. Female SET graduates dominate scientific occupations. Younger SET graduates are more likely to be employed in a SET occupation than older SET graduates, who are more likely to be in teaching occupations. Women with postgraduate qualifications in SET subjects are more likely to work part-time than their male counterparts.

There are significantly higher proportions of men employed in SET occupations than women (see Figure 3). Over the period 1991-2001, there was a higher percentage of men employed in SET occupations than women: on average, nine per cent of all employed men and two per cent of all employed women were employed in SET occupations (see Figure 3). There has also been an increase of 1.7 per cent to 2.1 per cent in women employed in SET occupations as a percentage of total female employment.

The gender pay gap is smaller for SET occupations than that of non-SET occupations. However, men's hourly earnings are higher than those of women and increase with age, whereas women's hourly earnings remain relatively constant across age groups.

Women's employment in higher education institutions is different and unequal to that of men, especially in SET cost centres and departments. There is a continuing and persistent trend for men to dominate academic positions in SET cost centres and particularly higher academic positions. In SET academic departments in 2000/01, nine per cent of professors 'wholly institutionally financed' were female and 15 per cent of professors 'financed by other sources' were female.

⁴ SET occupations are defined as: Natural Scientists; Engineers and Technologies; Computer Analyst and Programmers; Architects, Town Planners and Surveyors; Scientific Technicians, Architectural and Town Planner Technicians; and Draughtspersons, Quantity and Other Surveyors. The 2001 and 2002 data of the Labour Force Survey uses SOC2000 which has expanded the occupations listed under each category.

⁵ These include PPARC, NERC, BBSRC, EPSRC, MRC, CCLRC and ESRC together with the scientific academics – the Royal Academy of Engineering and the Royal Society.

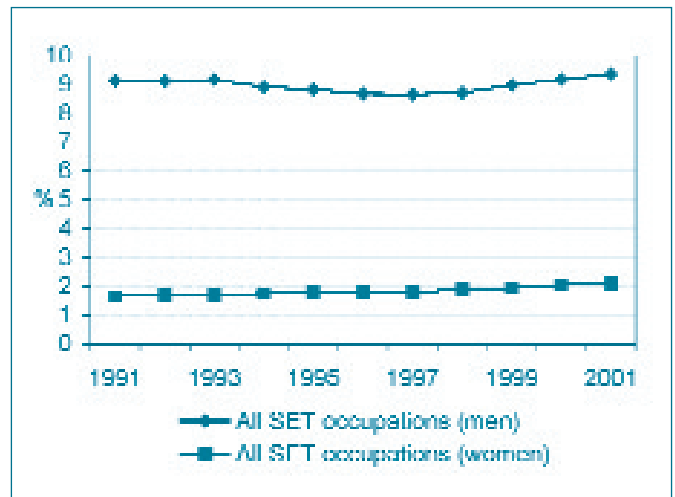


Figure 3: Percentage employed in SET occupations by gender, 1991-2001.

Source: New Earnings Survey Panel Dataset, 2001

Research funding for women in SET

Although there are still significantly more men applying for funding from research councils and scientific academies⁵, the number of women is increasing. The application/beneficiary ratios for funding show that the numbers of men and women awarded funding are, at present, relatively equal. However, men dominate research council and board membership together with the chief executive and research Chair positions, but the EPSRC and ESRC Chair positions are at present held by women and the BBSRC appointed a female Chief Executive in 2003. There are a higher number of female employees for each of the research councils compared to male employees. However, women dominate administrative positions whilst men dominate research and technician positions in the research councils.

Public Appointments in SET

For public appointments, the percentage of women as a total of all the councils and boards in SET and SET-related fields has doubled, from 12 per cent in 1992 to 24 per cent in 2002. Eighteen of the 38 councils and boards in SET-related fields have doubled, or nearly doubled, the percentage of female members since 1992.

Explanations of women's slow progress in SET

Explanations for the continuing trend of girls rejecting Science, Mathematics and IT subjects are varied and complex (Warrington, Younger and Williams 2000). Girls from an early age are more likely to reject science and technology subjects. This raises the concern that educational subject choices are influencing and determining higher education choices and future employment possibilities.

The explanations for the continuing trend of girls rejecting SET subjects involve both home and school environments which may be explained by: parental attitudes which are believed to have a

greater influence on girls than on boys; educational careers of girls and boys may reinforce stereotyped views gained prior to entering education; stereotyped views of the skills that boys and girls possess; and the negative images and perceptions of scientists and engineers.

It may well be the case that post-16 year olds are determining their career paths and choosing qualifications at an early age. With stereotyped views about 'scientists' and the work of scientists already embedded, their post-compulsory education choices may have been predetermined. Young women may be choosing not to enrol in SET courses at this level because they do not wish to take these subjects at degree level and enter into a SET occupation.

Although both home and school environments may affect and/or influence the educational subject choices of both boys and girls, these do not account for girls outperforming boys in Science, Mathematics and IT subjects. The suggested reasons for gender differences in performance may be the result of:

- Selection effects – if girls are discouraged from science, then only those who are good and have a keen interest will persist at GCSE and A/AS Level. Hence, those who continue in science subjects could have better scores than boys.
- The high exclusion rates of boys from school.
- Student attitudes – girls and boys have very different attitudes to schoolwork and examinations. Girls are more likely to work harder, be more confident and have a greater understanding of the consequences of achieving low grades or failing than boys. Boys can be more disruptive and less concerned with long-term goals and future plans.
- Types of assessment – girls perform better in assessments than examinations and achieve better success rates when the assessments and teaching styles are varied. A combination of assessments is more appropriate to female learning styles.
- Changes in the National Curriculum – the combined Science GCSE does not give students 'the knowledge, skills and confidence' to choose an 'A' Level in a specific science area, such as Physics or Chemistry. For female students, prior knowledge and skills in a subject are important factors in the decision making process.

There are many suggested reasons for gender differences in subject selection at different education levels. The number of GCSEs attained in science and mathematics may affect women's participation in post-compulsory education. This could arise if they, or those who advise them, consider that they lack the right knowledge or confidence to continue in the subject area. A perceived lack of knowledge and skills in specific science subjects may explain why some young women are rejecting science. This is linked to the idea that men and women have different attitudes to education. For instance, young women select subjects in which they believe they can attain a good grade.

The embedded stereotypes and preconceived ideas about those in SET occupations may be deterring women from choosing SET subjects at A/AS Level and SCE Higher and New Higher Grade. Men and women may hold stereotyped ideas and attitudes about traditional *men's jobs* and traditional *women's jobs*. It is also argued that men and women have already determined their career paths at a relatively early stage and choosing subjects is merely an element of attaining those goals.

The job opportunities available after the completion of degree courses may influence subject choice and degree choice in higher education institutions. This, together with the high proportion of male staff in the Science and Engineering departments in higher education institutions, may explain why few women enrol on courses in SET subjects.

In order to attract and retain women onto SET higher education courses and into SET occupations several ideas have been suggested (see, for example, Ayalon 2003; Blättel-Mink 2002; Dench *et al.* 2002; Greenfield *et al.* 2002; Higgins *et al.* 2003). For instance, student support and good teaching methods are argued to be essential; teaching styles and the design of the SET subject degree courses may be dissuading women from enrolling on these degree courses which may be addressed by institutions offering women-only courses and more collaborative learning environments; stereotypes about the skills needed to undertake SET degrees and enter employment in SET occupations need to be challenged; and the image of SET needs to be more positive.

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