National Policy Centre for Women's Enterprise Evidence Paper

Women's Enterprise and SET

Dr. Rebecca Harding, Delta Economics, March 2009

Executive Summary

Women are still under-represented in Science, Technology, Engineering and Mathematics (STEM). Even though there is evidence that there are differences in women's participation in STEM by discipline and sector, there is an issue of very high attrition between the stages of engagement with STEM subjects. Although there has been an increase in the number of girls taking STEM subjects at "A" level, there has been a greater increase amongst boys.

The reasons for this are
1. General factors that affect women's participation in the labour force.
2. Specific practices in relation to STEM subjects and employment paths As a result, some 76% of women with SET training are not working in SET sectors compared with 51% of men.[1]
3. The "gendered nature" of specific science disciplines which tend to be self-perpetuating and lead to a decline in participation as women progress up the STEM professional ladder.
4. Structural reasons why women are less engaged in STEM-related self-employment including the lack of information targeted at science disciplines to highlight commercialisation of science as a viable career choice as well as lack of dedicated funds to promote women technology entrepreneurs.

The under-representation is not uniform across all STEM subjects nor across all sectors and does not apply to women innovators, where prevalence in the entrepreneurial population is higher. However, the fact that women are under-represented in academic life, STEM employment and STEM self-employment simply suggests that any skills shortages or innovation shortages in these areas could be addressed by increasing female participation. This leads to the following policy recommendations:

> The women in STEM agenda has to some extent taken a back seat to other initiatives to increase female entrepreneurship more generally. A review of policy initiatives and their success using available data would identify where some of the market gaps still are and, similarly, where some of the success stories have been.

> There is data available online from the UKRC but nevertheless, there is no central publication that merges quantitative data on women in academic STEM employment with data on women in employment and self-employment. One, ideally annual, publication would provide comparative and readily available data for the purposes of monitoring and measuring policy performance.

> Finally, there are specific and practical measures that can be taken to increase awareness of STEM entrepreneurship amongst school-age and student populations that, combined with dedicated funding for women's STEM businesses, maybe starting with Life Sciences, would help to increase the numbers of sustainable enterprises emerging from women's research.

The Context

In 2002[2] the Greenfield report on Women in Science, Technology, Engineering and Mathematics stated that, "The under-representation of women in science, engineering and technology threatens, above all, our global competitiveness. It is an issue for society, for organizations (as strategy and policy-setting agents), for employers and for the individual." It argued first that, although there were more women participating in Science, Engineering and Technology (SET) subjects at school, this was not translating into more women employed in the science base, either as researchers or practitioners. Second, it suggested that there was little or no evidence that the increasing numbers of women in SET at school and university had been in any way influenced by the 70 or so projects, organizations and initiatives dedicated to raising their participation.

The report called for a comprehensive and strategic overhaul of policy and organizational design, consistent across all agencies with responsibility for "managing and nurturing" the nation's scientists and engineers" and ranging from schools and colleges through to employers and government.

This spawned the "Strategy for Women in SET"[3] whose key objectives were to:

> Establish a resource centre for women in SET.

> To provide "pump-priming" funds to the resource centre (which should be matched by private sector money) to support pilot schemes to raise the participation of women in SET.

> To use the governmental machinery to ensure that all departments are good SET managers and employers.

> To establish and independent "Expert Group" to oversee strategy progress.

> To improve the monitoring of SET initiatives with the provision of gender disaggregated data.

The resultant UK Resource Centre (UKRC) and the Expert Group established in 2004, alongside the UKRC's provision of gender disaggregated data on request suggest that many of the strategic targets have been met.

Yet women are still under-represented in Science, Technology, Engineering and Mathematics (STEM). In 2002, just 18.1% of employees in all STEM professions were female. By 2007 this figure had barely changed and rested at 18.5% of all STEM employees[4]. Even though there is evidence that there are differences in women's participation in STEM by discipline and sector, with some sectors, such as teaching and research and scientific "professionals" having much higher levels of participation than, say, STEM management or Engineering professionals, there is an issue of very high attrition between the stages of engagement with STEM subjects. And although there has been an increase of 8.4% in the number of girls taking STEM subjects at "A" level since 2004, this compares to an increase of 9.5% amongst boys[5].

1. Prowess/UKRC (2007): "Under the Microscope: Female Entrepreneurs in SECT." http://www.prowess.org.uk/documents/UndertheMicroscope_000.pdf
2. Greenfield, S., Peters, J. Lane, N., Rees, T. and Samuels, G (2002): *Set Fair: A Report on Women in Science, Engineering and Technology for the Secretary of State for Trade and Industry*. .
3. http://www.berr.gov.uk/files/file10556.pdf
4. UKRC 2009: own data inquiry
5. http://www.ukrc4setwomen.org/

The background literature on the subject broadly summarises into three principle reasons for the lower levels of female participation in STEM:

1. General factors that affect women's participation in the labour force[6]: These include specific tax and benefit systems, childcare and workplace practices or employer strategies[7] that may systemically rather than deliberately deter women from participating in the workforce.

2. Specific practices in relation to STEM subjects and employment paths: These include the available career paths, workplace practices and performance measures which tend to be "individualistic and competitive" and therefore may militate against women's sustained participation[8]. This may affect women's experiences of employment in STEM roles since success within these environments, it is suggested, involves "coping" with the inherent masculinity of SET rather than challenging it[9]. As a result, some 76% of women with SET training are not working in SET sectors compared with 51% of men.[10]

3. The "gendered nature" of specific science disciplines which tend to be "self-perpetuating"[11]: in specific subjects as women progress through STEM from school to university and then into careers, they come in contact with "masculine" cultures (language, humour, work style and management and appearance). Women's experiences of these appear to have changed little in twenty years[12]. Evidence comes from the fact that women tend to drop out as they progress through the system: representation is more equal at lower levels of study and employment and becomes progressively less equal the higher up the employment ladder one looks.[13]

4. There are structural reasons why women are less engaged in STEM-related self-employment[14]: There are in any case fewer women going into entrepreneurship as a career choice with men far more likely to go into self-employment than women in Information and Communications Technologies (ICT) and engineering[15]. Such structural issues include the lack of information targeted at science disciplines where women dominate to highlight commercialisation of science as a viable career choice as well as lack of dedicated funds to promote women technology entrepreneurs.

The problem of under-representation of women in STEM is not unique to the UK and not unique to one sector. Nor is it one that can, or indeed should, be solved with one "magic bullet": the number of supra-national and national policy initiatives over at least 30 years is testimony to that. However, as the UK seeks to emerge from the current economic crisis as a "high end innovative economy" that can compete in terms of the numbers of practicing STEM graduates and post-graduates, the fact that women are under-represented takes on a renewed policy poignancy, for economic as well as for social reasons.

Just How Under-Represented Are Women?

The following section presents the data for women and girls from "A" levels and their representation in academic STEM careers through to employment and self employment in comparison to men[16]. Figure 1, for example, highlights the fact that, although girls are increasingly studying STEM subjects at "A" level, so are boys.

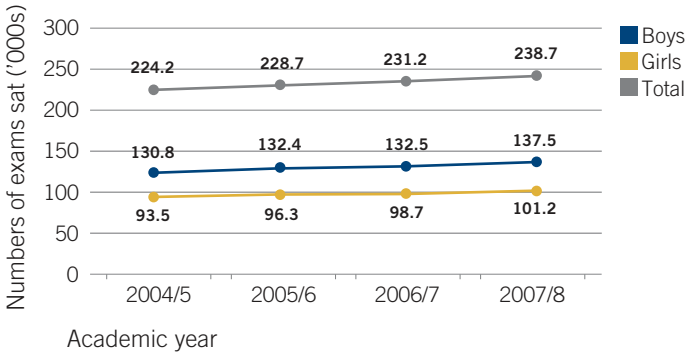

Figure 1: Number of STEM exams taken by gender, 2008
Source: UKRC 2009

Women are still less likely to study STEM subjects than men and although this has improved by 8.4% over the period, the level of male participation has increased by 9.5%. Yet where women are taking STEM subjects they do proportionately well compared to men. Figure 2 shows the numbers of students, by gender, gaining A grades in STEM subjects.

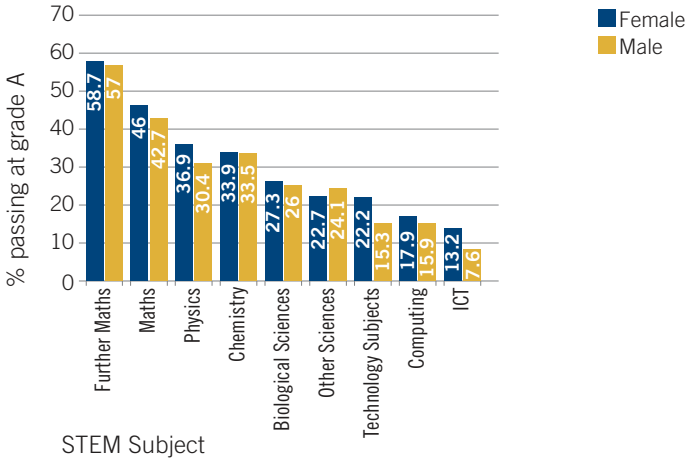

Figure 2: A level STEM subjects passed at grade A by gender (2008[17])
Source: UKRC 2009

6. OECD (2007): "Women in SET – strategies for a global workforce." .
7. Rüst-Archamault, E with von Tunzelman, N., Iammarino, S., Jagger, N., and Miller, L. (2008): "Benchmarking policy measures for gender." European Commission, .
8. This is a theme common to most of the literature surveyed for this briefing and is discussed by the OECD (2007) and the European Commission reports cited. Additional analysis of this comes from Pooran, W. (2006): "An International Investigation into Gender Inequality in Science, Technology, Engineering and Mathematics (STEM)", Guest Editor, Journal of Equal Opportunities International, Special Issue, Volume 25, issue 8, December. 8 or Phipps, A (2008): "Women in Science, Engineering and Technology: three Decades of UK Initiatives." Trentham Books, Stoke on Trent.
9. Bagilhole, B., Powell, A., Bernard, S., and Dainty, A. (2008): "Researching Cultures in SET: An Analysis of Current and Past Literature." UKRC, 2008, http://www.ukrc4setwomen.org/downloads/research/BAGILHOLE_REPORT_2008_06_16.pdf.
10. Prowess/UKRC (2007): "Under the Microscope: Female Entrepreneurs in SECT." http://www.prowess.org.uk/documents/UndertheMicroscope_000.pdf
11. Phipps, A (2008): "Women in Science, Engineering and Technology: three Decades of UK Initiatives." Trentham Books, Stoke on Trent.
12. Bagilhole, B., Powell, A., Bernard, S., and Dainty, A. (2008): "Researching Cultures in SET: An Analysis of Current and Past Literature." UKRC, 2008, http://www.ukrc4setwomen.org/downloads/research/BAGILHOLE_REPORT_2008_06_16.pdf.
13. Rüst-Archamault, E. with von Tunzelman, N., Iammarino, S., Jagger, N., and Miller, L. (2008): "Benchmarking policy measures for gender." European Commission,
14. Prowess/UKRC (2007): "Women Friendly Business Incubators and Managed Workspaces in SECT." ; see also Greene, F. and Sakaridis, G. (2007): "Factors Affecting Graduate Entrepreneurship." http://ncge.com/communities/research/reference/detail/1047/4.
15. Greene, F. and Sakaridis, G. (2007): "Factors Affecting Graduate Entrepreneurship." http://ncge.com/communities/research/reference/detail/1047/4.
16. Four case studies were compiled and a further 6 people were interviewed to provide a breadth of experiences and comments. All were conducted between 16th February and 25th February 2009.
17. Provisional data.

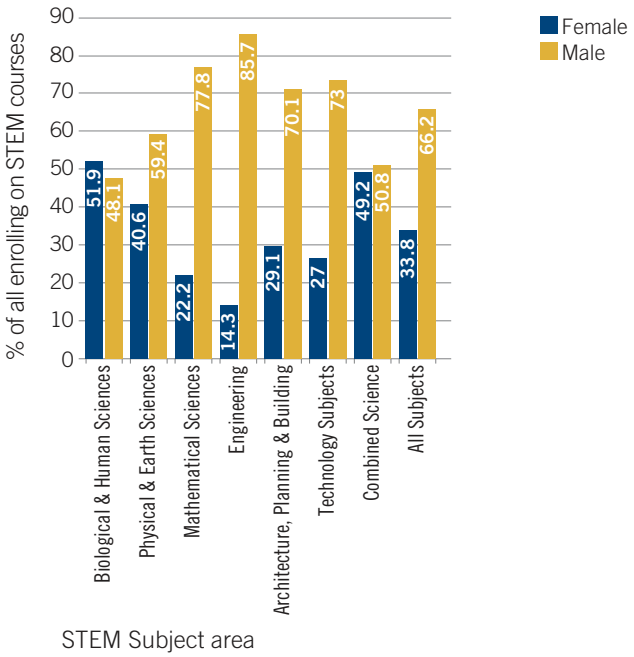

Figure 3: Female and male participation in undergraduate STEM degree courses (2007)
Source: UKRC 2007, own request

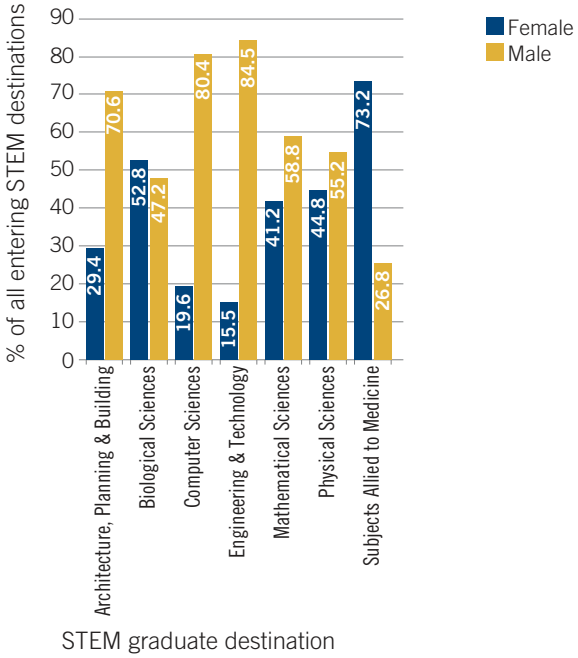

Figure 4: Graduate destinations of STEM graduates into STEM-related employment
Source: UKRC 2009, author's inquiry

Figure 3 shows how this translates into take-up of undergraduate courses in UK Higher Education Institutions.

The level of female participation at undergraduate level is lower than men in all subject areas except biological and human sciences where the participation is higher (51.9% compared to 48.1% of male students). Participation in engineering is particularly low: women represent just 14.3% of students on these courses. As one interviewee noted 'There is no dispute that there are more women in the Life Sciences at undergraduate and post graduate levels. For example, approximately 60% of Life Science undergraduates are women yet 90 to 95% of Life Science based businesses are headed up by men. Therefore Life Science based businesses tend to be run by men who were in the minority up to that point.'

Furthermore, Rüst-Archamault (2008) points out that as women go through the science system and into academic scientific careers, the gap between them and men widens. While the gap for senior academic research and university professorial posts narrowed between 1998 and 2004, women's representation at Professorial level was just 20% of all Professorial appointments. Similarly, although the number of women being awarded STEM research grants rose between 1998 and 2004 from 619 to 1116, this represented a small percentage increase from 20% of all awards granted in 1998 to 23.7% in 2004.[18]

Women scientists become increasingly under-represented as they become more senior, but is this also the case for employment? Figure 4 looks at the graduate destinations of men and women in 2007.

Figure 4 shows that women are more likely to go into related STEM graduate employment in biological sciences and subjects allied to medicine than men but care should be taken in interpreting this data. There are many women within the 'subjects allied to medicine' who go into "practical" courses, such as nursing and, as a result, women are more represented at undergraduate level. Levels of female employment in areas relating to computing, engineering and technology and architecture are low.

Figure 5 illustrates that overall in the labour market, women employed in STEM related areas is low compared to men.

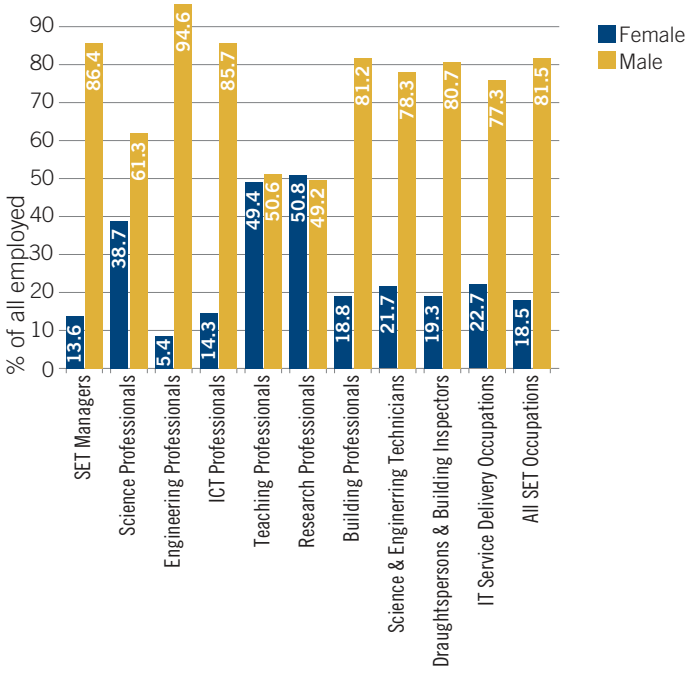

Figure 5: Working age population by gender and STEM employment status, 2007
Source: UKRC 2009, own inquiry

18. Rüst-Archamault, E. et al (2008), op cit

Generally speaking, women are under-represented overall in the STEM labour market at just 18.5% of all STEM employees and the number of women in STEM employment has only increased by 0.4% since 2002[19]. There are sector differences, as Figure 5 shows, with women being more likely than men to be research professionals and almost as likely as men to be STEM teaching professionals. They are under-represented in all other areas, however, and the under-representation in Engineering and SET management is particularly stark. An interviewee noted the paucity of Female Engineers and then suggested 'There are commonly held beliefs that a lot of Science and definitely Engineering and Technology is 'hard' both to do and as an image. This feeds into peer pressure to conform and go for 'softer' careers.'

As is the case with women in academic employment, the data in Figures 4 and 5 might suggest that women exit STEM employment (witnessed by the fact that overall representation is so low) after their initial experiences and, therefore, do not reach levels of managerial seniority. One interviewee suggested that domestic issues will force women to take stock: 'For women, family is nearly always an issue at some point. Women don't push on to senior levels in companies when they have had kids.'

It does not appear from the data, however, that women are any more likely to be entering self-employment in STEM related areas. This is illustrated in Figure 6 which shows the change in women and men's STEM self employment between 2002 and 2007.

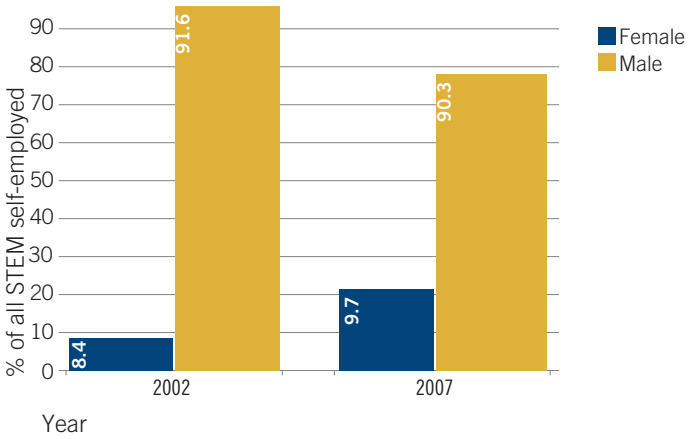

Figure 6: Levels of STEM self employment by gender, 2002 and 2007
Source: UKRC 2009, own inquiry

Women's STEM self employment has increased slightly over the period from 8.4% to 9.7% yet remains exceptionally low in comparison to men's. But why women should not be starting up a STEM based business is noted by an interviewee 'Women tend to be more innovative and are better at employing the available technology to create a market niche. But they do not in general, seem to be as prevalent at actually creating the technology in the first place. Therefore, you do not have as many women involved in the creating technology side of SET but do see them in the applications side.' Furthermore, many women in Life Sciences at post graduate level where they are well represented, do not carry through their ideas and research into its commercialisation as a large amount of funding is required at that stage and the level of commitment often forces a rethink of priorities, commitment and the need for reassurance that the subsequent lifestyle will be as they would want it.

The statistics from the 2007 Global Entrepreneurship Monitor data[20] show the percentage of total early stage entrepreneurial activity (TEA[21]) and established business activity (EB) that are accounted for by new technology[22], high technology sectors[23] and new product or market combinations (a broad proxy for innovativeness).

Figure 7 shows that men are more likely to be setting up and running established businesses that are using new technologies or are in OECD High Tech sectors. However, women are more likely to be "innovative" in the broad sense both in their start up activity and in the owner-managed businesses that they run.

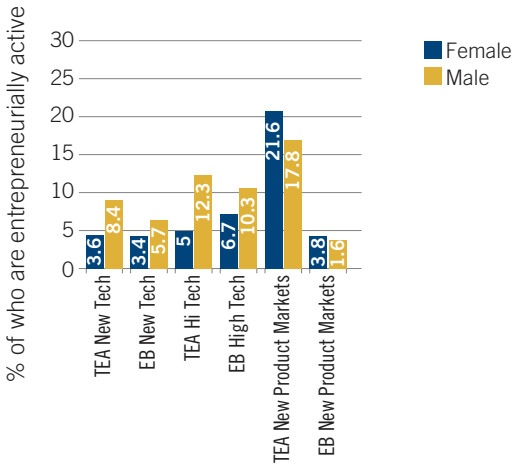

Figure 7: Technology and innovative entrepreneurship in the UK, 2007
Source: GEM UK Adult Population Survey, 2007

19. UKRC 2009
20. Calculations for Figure 7 are based on the 2007 GEM UK adult population survey.
21. Harding, R (2006): UK Global Entrepreneurship Monitor. London Business School, defines TEA as the percentage of people in the UK adult population who are actively engaged in some form of start-up activity that is not older than 42 months. EB is all owner-manager business activity in companies older than 42 months.
22. GEM classifies new technology as all those answering that the technology was not available a year ago or was not available 1-5 years ago.
23. GEM uses the OECD definitions of high and medium tech sectors

Concluding Remarks and Policy Recommendations

Women are under-represented throughout the STEM spectrum despite evidence that girls are increasingly likely to be taking STEM subjects at A level. There is already a substantial rate of attrition as women go through the system, and although this affects men as well, it is to a lesser extent than for women. If there is a lower potential supply of women taking science at school, then, because of the higher drop out rates anyway, this inevitably will lead to greater under-representation at a later stage. The data presented here suggests that this under-representation is not uniform across all STEM subjects nor across all sectors and does not apply to women innovators (where prevalence in the entrepreneurial population is higher). However, the fact that women are under-represented in academic life, STEM employment and STEM self-employment simply suggests that any skills shortages or innovation shortages in these areas could be addressed by increasing female participation.

It is not possible to provide policy recommendations that can easily solve the problem of women's under-representation. Policy makers across the world have attempted different approaches over thirty years ranging from attempts to alter the perceptions of science and technology in schools during the 1970s, through separate and dedicated training and mentoring in the 1980s and1990s through to formal business incubation and addressing the "business case" for greater participation to address the skills shortage in SET by the beginning of the 21st Century[24]. Yet there is still almost as wide a gender gap and no substantial evidence of it declining.

In the opinion of all the literature covered for this policy briefing, however, the fact that the differences are largely social in origin suggests that there is scope for intervention:

> The women in STEM agenda has to some extent taken a back seat to other initiatives to increase female entrepreneurship more generally. A review of policy initiatives and their success using available data would identify where some of the market gaps still are and, similarly, where some of the success stories have been.

> There is data available online from the UKRC but nevertheless, there is no central publication that merges quantitative data on women in academic STEM employment with data on women in employment and self-employment. One, ideally annual, publication would provide comparative and readily available data for the purposes of monitoring and measuring policy performance.

> Finally, there are specific and practical measures that can be taken to increase awareness of STEM entrepreneurship amongst school-age and student populations that, combined with dedicated funding for women's STEM businesses, maybe starting with Life Sciences, would help to increase the numbers of sustainable enterprises emerging from women's research.

24. Phipps, A (2008): *"Women in Science, Engineering and Technology: three Decades of UK Initiatives."* Trentham Books, Stoke on Trent

CASE STUDY

Caroline Smith
Oakley Media

What SET links do you have?
Although not pure Science educated I use the latest Technology in the Design and Media business, so my link with SET is through practical experience of its application.

Are there any issues with SET and women in particular?
Women do tend to have different working patterns which can make it difficult to fit in with most companies and this is made even more obvious when they have children. It is so much easier in larger companies for child care, travelling to meetings, extended leave and can return to the job. These are so hard when you are outside of a large company and have to do all of it yourself. That stops a lot of women setting up and running their own company. Having said that, it is sometimes easier to run your own company, but it depends what it is. It has to match in with your family needs.

I have found that more women are part time than full time and that they work much harder than those who are full time. They seem to be really grateful for the effort the company puts in to let them go part time and they work really hard.

What are your thoughts about Women, education and SET?
SET in education is great, it is very positive, but it targets those schools which would do that sort of thing anyway. Then they are using these initiatives to refine exactly which bit of Science they are going to do, not if they will do any at all. Girls in the ordinary schools need it most but there are fewer initiatives that seem to be going on there. Initiatives tend to be local as well, surely it should be national and then, if it is that important surely it should be part of the curriculum and not a 3 year initiative?

There are few role models who are at the right age and profile for girls to get interested in SET. We do need more inspirational women who they can relate to. In higher education, there is a problem getting women into Engineering. There are few women training as engineers and in universities, most of those are non- UK nationals. We are not producing female engineers. There is a status issue here. In Germany, a technical qualification has really high status, and whilst they also have few women in engineering, there are some countries in Asia and Scandinavia which do seem to have sorted out this issue.

CASE STUDY

Deb Leary
Founder Forensic Pathways

Background
Deb is been building up a company with a focus on supplying scientific equipment for forensic analysis for use in, for example, crime scenes. Her own education was not pure science, but English, and this as she points out, has trained her to identify the relevant facts in a story, which is a similar skillset needed to assess a crime scene. She thinks that being able to think like the person who will use her products has allowed her to produce exactly what is wanted. The success of the Forensic Pathways seems to bear this out.

Can you expand on those transferrable skills which you have developed yourself.
My education trained me to look for clues, to use pieces of information as intelligence, to then apply them to expand a story and complete the whole picture. I applied this thinking and realised there was a market for analysing data. So I developed a set of advanced analytics for datasets. This expanded into due diligence, training and consulting. But it was that applied thinking which set it up initially.

What are your thoughts on Women in SET, and educational initiatives?
I know that I remember stories rather than facts. They help to explain to me *why* I need to know things. So placing Science in a context where it tells women or girls why and how rather than just what will encourage more women into SET. That is based in education and revolves around the teachers being allowed to digress a little away from the curriculum in order to place things in context, to make Science relevant as well as interesting.

Industry weeks and other initiatives are critical in getting this message across. Role models, initiatives, options, experiences, choices available. All are needed all the time, not just as initiatives. If they are so good why are they not permanent in the curriculum? There are so many competing things for younger women. They are bombarded by celebrity focus, but this is totally unrealistic. It is dangerous to broadcast as even a remote chance as a possible career option as it doesn't actually exist. It has a knock on effect too. Instead of slowly building up skills, it encourages no effort and a 'lottery' mentality, where some time soon you will get everything on a plate.

CASE STUDY

Julie Eyre, Founder And Director
Bronte Business Networks

What is your background in SET and what does the company do?
I am at the IT end of Technology. We provide IT support for businesses and specialise in reacting very quickly to problems to solve them.

What is your personal experience in SET?
My SET experience is all on the job experience, the training I have had has been minimal. There are very few women in IT. It is very male dominated and they do tend to put barriers in the way if you are female. This is less so in bigger companies.

What do you think of SET initiatives in schools, colleges, universities and elsewhere?
I like school SET initiatives as if as a woman you get the experience of Science when you are young you can make an informed choice as to what careers are open to you. It is all about having the experiences which can lead into opportunities. This is best away from formal education settings. Sometimes women, or girls, get put off by the 'cloak and dagger' way that men often do things. That can be a real barrier for women. This is more true in SET than other areas of work. But if the interest is there or has been developed, then it will happen. In the end it's a choice that you make. So, just throwing money at women in SET can be a waste of time. It is good to show the routes that are possible, but if the interest is there, they'll do it anyway.

Are there specific issues to do with being female and running a SET business?
If you are running a business, any business, the family issues become really important sooner or later. Then if your business is a reactive one like mine, where we are on 'call' and respond immediately, then you have to do a balancing act with your family.

What would make it easier to run your business?
There are plenty of pots of money out there for all sorts of qualifications and training, but none that I have found for a sector specific qualification at a higher level. The 'softer' skills are really well catered for, like management issues but not the 'harder' skills, like industry standard training that, to be honest are the ones that really count.

The National Policy Centre for Women's Enterprise (NPCWE) provides a central knowledge base for research and data related to women's enterprise. The NPCWE, funded by BERR works at national, international and regional levels, collaborating with strategic partners to facilitate best practice and knowledge-sharing to create a long term increase in the number of sustainable women-led businesses.

Contact the NPCWE team:
National Policy Centre for Women's Enterprise
CAN Mezzanine,
32-36 Loman Street
Southwark
London
SE1 0EE

Telephone: 0207 922 7972
Email: info@npcwe.org.uk
Web: www.npcwe.org.uk

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Acknowledgements

Many thanks to all those who provided case studies.

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CASE STUDY

Fiona Cruickshank,
SCM Pharma

What is your background both personally and the business?
I have a degree in Pharmacology and developed my own company selling medicines whose licenses had run out. I now run another company which runs clinical trials. The sale of the first business has bankrolled the current one. I will soon have some interesting choices to make: Which type of additional finance to go for to pay for the next phase of the business, an investor partner of maybe Venture Capital.

What are your views on women, education issues and SET?
Getting more and better SET education for women will lead into more women who are actually in SET afterwards. This is the sheer numbers game. Put simply, the more women there are who are educated in SET, the more there will be who end up running a SET business.

There is a wider cultural issue with a premium placed on being a celebrity and trading on your looks. This, of course, is fuelled by the media. So Women in SET need more role models who really connect with those who we are trying to attract. Unfortunately, there are not the numbers of role models and stories to tell. This situation seems to compound itself.

Experiences need to be in more than one setting, for example, women in SET in schools is not enough as it is competing with so many other more powerful issues.

There is also the issue that if it has to be more than an initiative, it has to be mainstream.

Myself, I had my ideas shaped at an early age during GCSE equivalents when two factors combined. I was told I needed to be financially independent and I found out that Pharmacologists had a 99.9% post-graduating employment rate.

Domestic issues are a major problem with almost all women at some point in their careers and this is largely still not tackled. The legislation is there, but it doesn't always tackle the issues as and when they are needed.

Should women be specifically encouraged in SET?
I do not believe in positive discrimination. I think that women, like everyone else have a choice. I think that all opportunities should be shown, that experiences should be available, and then once women are doing SET, then they should be kept in, allowed to grow and thrive. Those are infrastructural and support issues.