

Change of Heart

Career intentions and the chemistry PhD

November 2008



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Key findings

- Interest in chemistry is main reason that the majority of PhD students study for a doctorate;
- The proportion of women PhD students planning a career as a research chemist falls from 72% in the first year to 37% in the third year because of factors which become apparent to them during their PhD study;
- Many of the female PhD students who plan to leave research still plan a science related career;
- Overall only 12% of women PhD students in their third year plan to remain in academia compared to 21% of men. Of those women who do plan to remain in academia, on average they plan to remain for less time than men in the same position;
- The supply of research active chemists into the job market is affected as a significant proportion of female PhD graduates do not wish to follow a research career;
- Action is needed to investigate the underlying issues that deter a significant proportion of female PhD students from pursuing a career in research.

Background

In recent years, women have become better represented in science, technology engineering and maths (STEM) in both education and employment, with greater numbers educated to a high level. However, STEM qualified women remain under-represented and poorly retained in employment, and are less likely to occupy high status STEM positions.^{1, 2, 3}

Chemistry attracts a relatively high proportion of women onto undergraduate courses; around 48% of those graduating at undergraduate level in chemistry are female. However, within academic chemistry many women exit the profession prematurely; 30% of chemistry researchers are female, but women represent only 12% of senior lecturers and only 6% of professors.⁴ Figure 1 shows how the proportion of female staff by grade in academic chemistry compares with all academic staff overall. This situation contributes to the gender pay gap which is much larger for chemists (18%), than the mean for those engaged in scientific work (10%).⁵

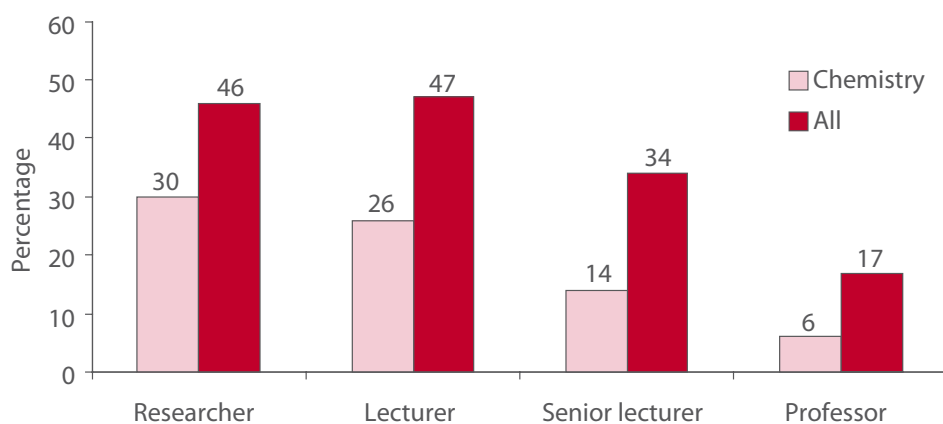


Figure 1: Percentage of female academic staff by grade

Source: HESA

Analysis of Higher Education Statistics Agency (HESA) data in 1999 by the RSC showed that female attrition from chemistry was higher than in the other sciences: retention rates were especially poor at the PhD to post-doctoral researcher transition. As a result of these findings, the RSC commissioned a focus group study to examine why female chemists were less likely than males to stay in academia after completing their PhDs.⁶ The conclusion of that study was that whilst women working in academic chemistry enjoy the chemistry itself ("the good"), many endure aspects of the work and the profession they perceive as "the bad" and "the ugly".⁷ For example, although both sexes saw the "24 hour culture" of chemistry as an issue, women alone said they had been discouraged by the solitude of chemistry.

Strikingly, the research report also comments;

*"Participants were virtually unanimous in believing that it was impossible for a woman to advance in chemistry and have a family: the options were seen as mutually exclusive."*⁸

The study also made reference to attitudinal, structural, cultural and environmental barriers to female recruitment, retention and advancement in academic chemistry.

Other research and commentary regarding possible explanations for female attrition from science has suggested that it may be due to:

- Processes of socialisation which act to lower female self-confidence regarding their ability to undertake STEM tasks; ^{9, 10}
- Science having been defined (with respect to method, epistemology and culture) in terms of masculine identity, exposing women in science to a unwelcoming climate;^{11, 12}
- The structure of scientific work (e.g. the long and unsociable hours demanded, the geographical mobility expected and the timing of entrance to a permanent post) being incompatible with the caring and domestic role many women additionally fulfil; ^{13, 14}

- The fact that in STEM organisations, gender remains a significant organising principle in the education, training, recruitment, retention and promotion of people working in these fields within the EU, which leaves women at a disadvantage.^{15, 16}

The RSC was keen to follow up the findings of the 2000 study. In 2003, the RSC identified human resource management policies operational in certain academic chemistry departments that encourage the recruitment and retention of women to academic chemistry.¹⁷ That project led the RSC to undertake further equality and diversity work to identify, record and disseminate good working practice in university chemistry departments.¹⁸ This work was recently repeated to identify any improvements in practice that had occurred, and the findings have been documented in *Planning for Success: Good Practice in University Science Departments*, published in July 2008.¹⁹

The RSC has also sponsored a CASE (Collaborative Awards in Science and Engineering) Studentship.[†] The research work, in part, involved a survey of doctoral chemistry students' career intentions carried out in 2006. The focus of that survey was wide-ranging, generally seeking to gauge career intentions and provide an indication of future career trajectories.

The 2006 Survey

The following summary details the findings of that survey which relate specifically to the issue of female attrition from chemistry at the post-doctoral stage. In particular, the survey helped to establish whether the women lost to academia after completing a PhD tend to:

1. Leave the science pipeline altogether; or,
2. Leave research, but stay in science-based employment; or,
3. Stay in research, but move to industry.

The survey was administered as a self-completion return-by-post questionnaire and was distributed to students through their university chemistry departments. Almost 2,500 questionnaires were distributed, of which 25% were completed and returned. Both closed questions (requesting respondents to choose a response from a list) and open questions (requesting respondents to write in comments freely) featured in the questionnaire.^{††}

[†] The CASE Studentship was supervised by Professor Judith Glover and Professor Yvonne Guerrier, both of Roehampton University, and Dr Sean McWhinnie of the Royal Society of Chemistry, and funded collaboratively by the Royal Society of Chemistry and the Economic and Social Research Council.

^{††} The 2006 survey was technically a re-run of an earlier survey, run in 1999. However, systematic comparisons between the two surveys are not made. The two surveys were not strictly comparable, (a), because both RSC members and non-members were surveyed in 2006, but only RSC members were surveyed in 1999, and the administration methodology was changed significantly accordingly and, (b), significant modifications to the 1999 questionnaire were made for the 2006 survey although the wording of pivotal questions was the same.

Results

Careers in Science

The majority of respondents to the survey of doctoral chemistry students' career intentions reported that their interest in chemistry had been the main reason behind their decision to study for a doctorate. Reasons related to future career and earnings prospects were the second most popular motivations.

Figure 2 shows the proportion of respondents selecting each reason, by gender. It is interesting to note that the women were more inclined than the men to select 'To further career' or 'To enhance earnings'.

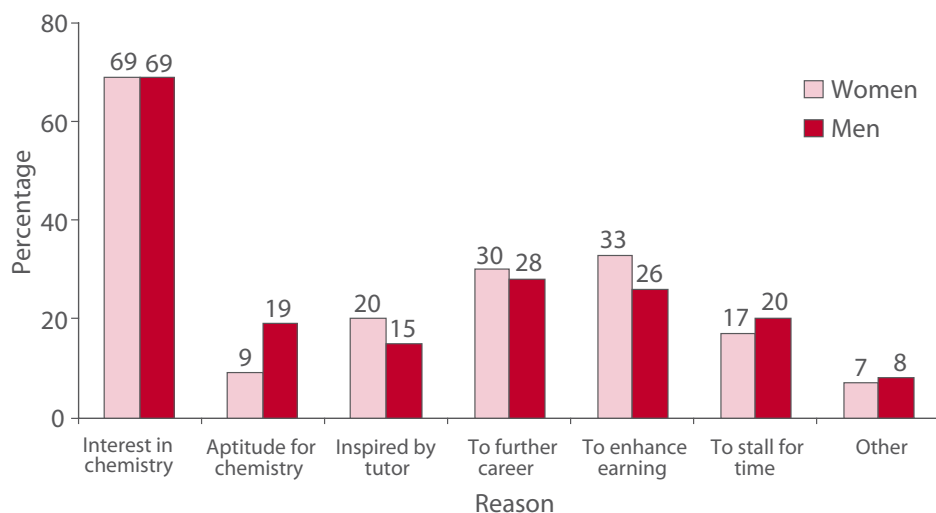


Figure 2: Reasons given for decide to do a PhD?

Whilst women may be less likely to remain in academia than men, a theory evidenced by the fact that only 6% of chemistry professors are female (HESA 2006-07), the survey data showed that overall women and men were equally likely to be intending to pursue a career requiring their scientific background. 80% of both sexes were planning a career requiring their science background while only 3% reported they were definitely not planning a science-related career. Even these respondents tended to have reservations about rejecting science, as this respondent illustrates:

I'm going to look for an office job. I'm attracted to desk jobs: not taking work home, number of available positions and promotion prospects... but it's not chemistry. I may become bored quickly." (female respondent)

However, analysis by year of PhD study showed that a greater proportion of women than men who start out committed to a scientific career are deterred from science during their PhDs and that overall by their third year, a greater proportion of men than women plan to continue in science. The proportion of women wishing to pursue a scientific career fell over the course of PhD study from 85% amongst first years to 79% amongst third years (see figure 3), yet rose amongst men from 73% amongst first years to 86% amongst third years. Corroborating this finding, women were more likely to receive careers advice during their doctoral studies, especially in their second year by which time 71% of women compared with 55% of men had sought and received careers advice (see figure 4), one possible reason for this is to furnish themselves with knowledge about alternative careers in science-based work.

It is worth emphasising however that although some women may be deterred from remaining in science-based careers during their PhDs, that proportion is relatively small.

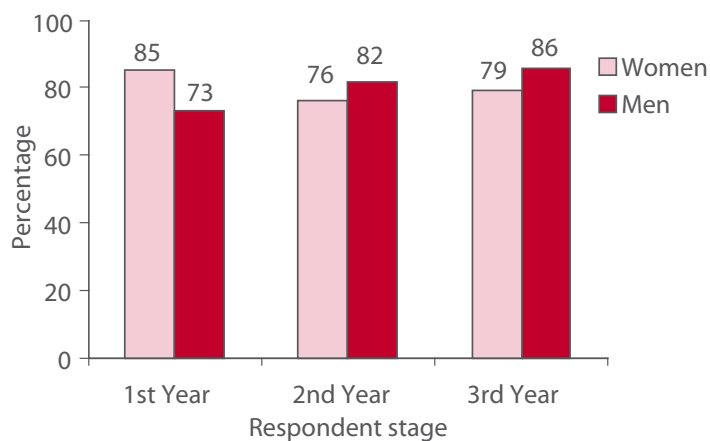


Figure 3: Proportion of respondents wishing to follow a career that requires their scientific background

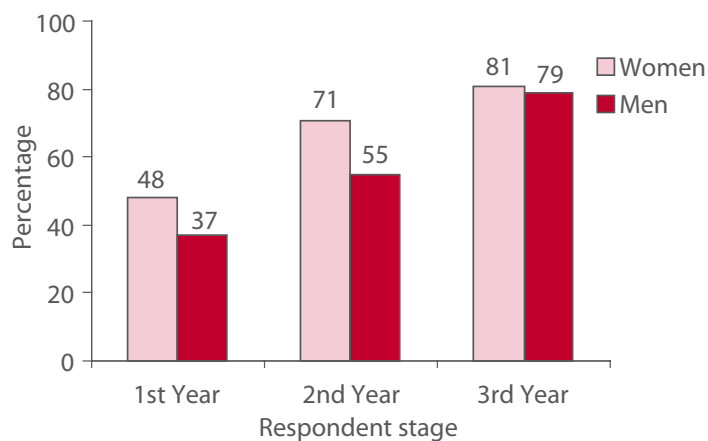


Figure 4: Proportion of respondents who had received career advice

Careers in Research

The survey results suggested that women are more likely than men to re-think their decision to enter a research career over the course of PhD study and therefore look for alternatives. Amongst those in their first year, 72% of women reported planning a career as a research chemist but this proportion dropped to 37% amongst those in their third year. Men's intentions regarding a research career varied far less over the course of the PhD with 61% in their first year and 59% in their third (see figure 5) planning to remain in research.

Undertaking a post-doctoral position abroad is a common plan amongst those wishing to embark on a research career. However, whilst 61% of men intending to post-doc are considering doing so abroad, this was true of only 45% of women.

"To get a high status post in academia you are expected to take post-docs abroad." (female respondent)

"I would like to find a post-doc position at a university abroad (USA, Australia) so that I could continue my scientific career but also travel at the same time." (male respondent)

The proportion of women wishing to work abroad dropped from 66% in the first year to 50% in the third year. In contrast, the proportion of men planning to work abroad rises from 60% in the first year to 72% in the third (see figure 6).

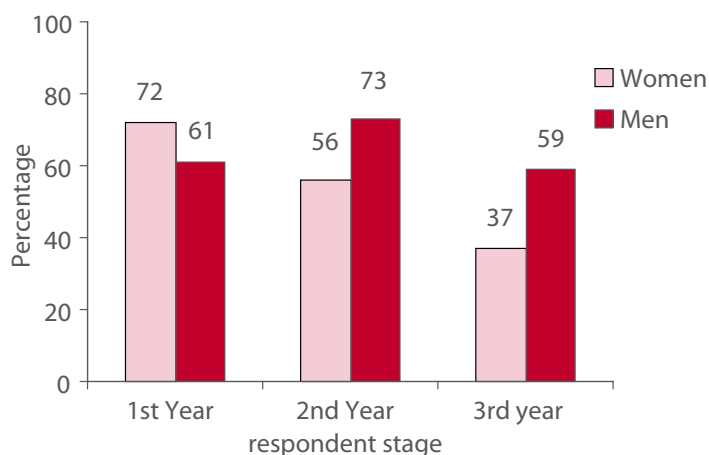


Figure 5: proportion of respondents planning a career as a research chemist

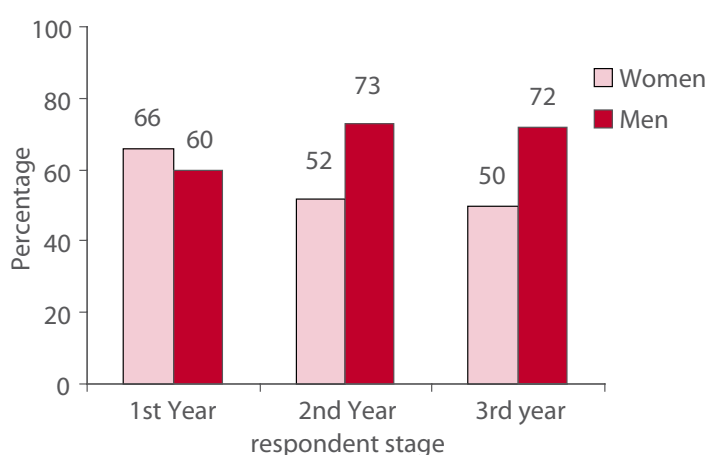


Figure 6: Proportion of respondents considering working abroad after completing their PhD

Qualitative data from the survey suggested that the reason women reconsider their original intention to continue in research is because they come to view the nature of the work less positively. In contrast to men, disillusioned female respondents wrote how they had found chemistry research to be repetitive, slow paced, stressful and lonely.

"Working as a chemist is not always rewarding – it can be very repetitive. And you're working under stress most of the time." (female respondent)

"I feel that researching is a lonely pursuit and miss the human interaction involved in other jobs I have done." (female respondent)

Non Research Careers

Respondents who were not planning to seek employment in research chemistry were asked to select from a range of options that best described what they were considering as an alternative. There was a great deal of diversity in responses and no significant gender differences. Teacher training had the largest share of responses at 37% followed by science policy-related activities at 11%. The grounds for not wishing to pursue a research career varied, with both genders giving positive and negative reasons.

"I was inspired to become a teacher when I really enjoyed a 'researchers in residence' placement. I hope the PhD will help me become head of department quickly." (female respondent)

"I feel a little bitter that after what will be almost 8 years in higher education there is little reward in academic posts. Lecturers are massively under-paid for their responsibilities. Teaching in a private school appeals to me." (male respondent)

Research Careers in Academia

Overall, 63% of women and 56% of men were not considering working in the university sector after completing their PhD.

Analysing the results by the number of years into PhD study showed an academic career was much less popular amongst women after their first year of study, strongly suggesting that initially women are as likely as men to want to pursue an academic career, but become deterred from doing so during their PhD. Considering only those respondents who indicated that they were planning a research career, 51% of women in their first year of doctoral study regarded staying on in academia as an option for them, amongst third year students the figure falls to 33%. The comparative figures for men also show a fall, from 44% to 36%, although interestingly the figure actually rises to 53% amongst second year students (see figure 7). Overall, looking at all respondents, amongst third year students 21% of men and 12% of women are planning to remain in the university sector.

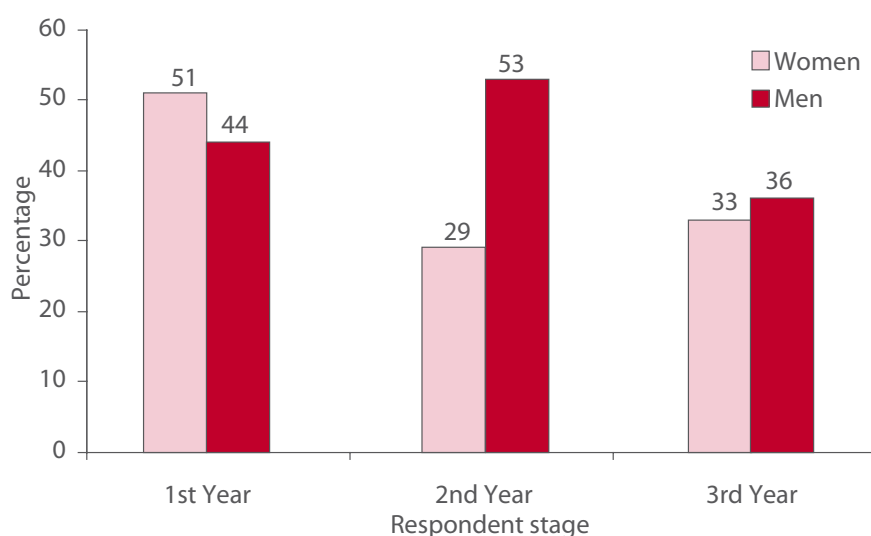


Figure 7: Proportion of respondents wishing to continue in research chemistry in the university sector after completing their PhD

It would therefore seem that while women have not ruled out an academic career at the start of their PhD, unlike men, many do so after their initial experience of university research. Qualitative data collected in the survey suggested women were put off by the lack of security in post-doctoral employment, and also perceived many aspects of an academic career to be incompatible with motherhood.

"Post-docing means moving every year to two years, and also doesn't offer any stability or normal job rewards, bonuses or ability to get promoted or get a pay rise." (female respondent)

"The post-doc system is appalling, especially if you want to settle down, buy a house, have a family; doubly so for women who 'leave it too late' because they can't get a permanent job until their 30s." (female respondent)

The survey also showed that women who intended to stay on in academia after completing their PhD were less likely than their male counterparts to see themselves staying in academia in the longer term. Furthermore, it appeared that men's intentions vary less over the course of their PhDs than women's. The proportion of men planning to remain in academia for 3-5 years dropped from 51% to 46% from the first to third year, in contrast to 56% to 36% for women. Similarly, the proportion of men planning to remain for 5-10 years after completing their PhDs dropped from 40% to 37% while the proportion of women dropped from 39% to 25% (see figure 8).

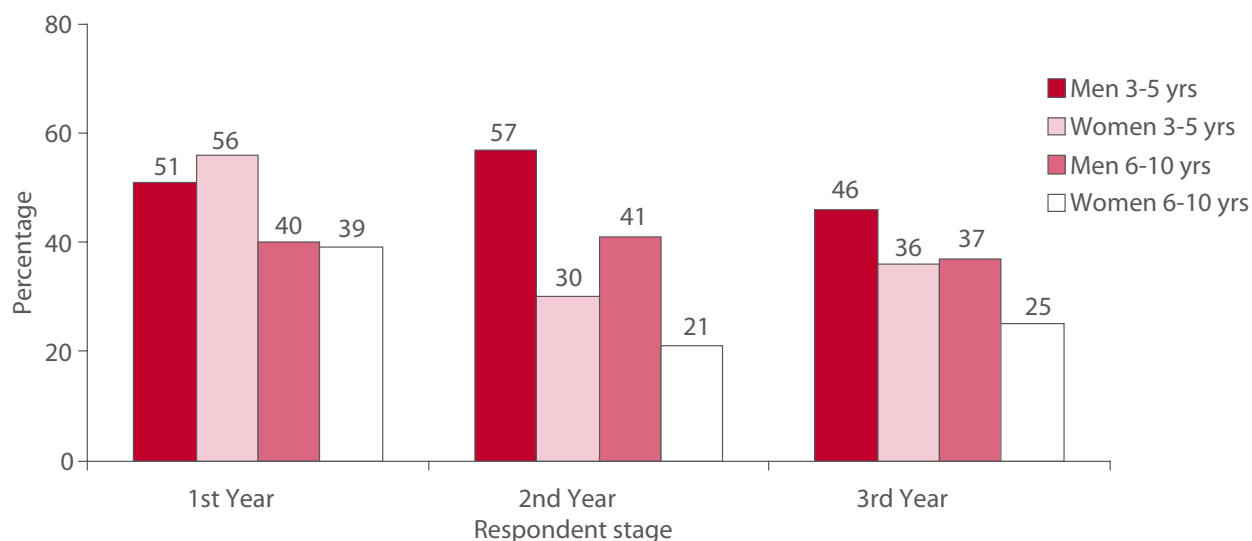


Figure 8: Proportion of respondents who see themselves staying in academia 3-5 years and 6-10 years after completing their PhD

The qualitative survey data goes some way to further illuminating why this turnabout occurs. Two factors stand out. First, many women seem deterred by the all-consuming nature of scientific work, and the isolation it entails (particularly in the academic sector).

"I have been put off an academic career since starting my PhD as it takes over your whole life. I would like a job where you work 9-5 and have no extra work to do when you get home." (female respondent)

"I do enjoy science but during my PhD I have realised how slow and isolated research is." (female respondent)

Second, many women are daunted by a perceived incongruence between the characteristics of an academic chemistry career and motherhood:

"Chemistry is a very male dominated research area and because I am a woman I would have to work very hard to get anywhere in academia. It seems it would be very difficult, even impossible to pursue this direction if I wanted to have a family." (female respondent)

"I plan to pursue a career in academic research. However, my ability to do so in the long-term will depend on the availability of flexible funding and employment regimes compatible with having to raise a family." (female respondent)

Research Careers in Industry

The survey also aimed to find out whether a significant proportion of those women deciding not to continue in academia after finishing their PhD, look for and take up research posts in industry.

The survey, found that female and male PhD students were equally likely to be considering a career in research in the chemical or pharmaceutical sectors. Just under a third of both women and men were considering pursuing a research career in the chemical industry or in the pharmaceutical industry (respondents were asked to indicate all sectors in which they would consider employment).

Responses to the open questions indicate that doctoral students are informed as to how scientific careers in the various chemical science sectors might differ. Most respondents are clear about what they see as the relative merits and downsides of the main sectors and in light of these where they would prefer to work. A key distinction is

between a scientific career in academia and a scientific career in industry.

Many respondents favoured academia, this tended to be because of the intellectual freedom and autonomy academics are perceived to enjoy. On the other hand, concerns were frequently expressed (mainly by men) about the working conditions, pay and prospects for academics.

"Industrial chemistry is boring and repetitive compared to academia." (male respondent)

"The chief negative about staying in academia is the 'killer combo' of poor job security and poor pay. In an ideal world I'd stay in academia if the reward was commensurate to my work and if I felt like I was appreciated by government/university for my work. Hence I'm off to industry where I'll enjoy it less but get paid for my expertise." (male respondent)

Women thought an industrial career would be a better choice for them than academia. They believed industry to be more compatible with having a family.

"I enjoy the excitement and variety of work in academia – at the moment anyway. Perhaps in the future, the job security, the salary and the more social hours of industry will be more tempting – probably if I have a family." (female respondent)

"The world of academia is a very tough one, with real funding problems. Particularly as a woman, this really puts me off it. As well as the long hours required, necessity to travel to conferences regularly as group leader, the battle for funding would not go well with hopes to have children one day." (female respondent)

Conclusion

This summary has presented evidence that both female and male doctoral chemists have reservations about planning to pursue a research chemistry career in the longer term, especially one in the academic sector when industrial alternatives appear the more attractive option.

However, the results of the survey strongly suggest that the career intentions of male and female chemists diverge during the course of PhD study. By the end of their doctoral research, female chemists are markedly more likely than men to hold reservations about pursuing a research career.

As the proportion of females graduating from undergraduate and postgraduate programmes in chemistry reaches 50% and 40% respectively, the fact that a significant proportion of female PhD graduates do not wish to follow a research career has a significant effect on the supply of research active chemists into the job market. Women are also less likely than men to pursue a research career long-term and so this will further affect the supply of research chemists.

Action is needed to investigate the underlying issues that deter a significant proportion of female PhD students from pursuing a career in research.

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