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Editorial

The 'Leaky Pipeline'

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'Leaky pipeline' is the phrase commonly used to describe the progressive loss of capable women from more senior roles in STEM disciplines. The topic has been the subject of many studies and articles, commentaries and reports have been published, sometimes leading to conflicting conclusions, as a result of the type of data being considered. There is an element of negativity in the use of this metaphor, suggesting that the leak, like leaks from pipes, is a total loss. It is true that women are significantly under-represented in senior academic posts and high-tech industries. However, it is important also to recognise that the choice of pursuing a career in science is always a personal one, which needs to take into account individuals' situations, talents and passions. There are plenty of examples of STEM graduates, both men and women, who, having taken steps along the 'science and engineering road', chose alternative pathways resulting in great success: Margaret Thatcher was a chemistry graduate from Oxford University who became British Prime Minister from 1979 to 1990; Brian May obtained a BSc in physics from Imperial College London before becoming the lead guitarist of rock band Queen; Angela Merkel was awarded a doctorate in physical chemistry and worked as a researcher before becoming a politician and Chancellor of Germany; Rowan Atkinson studied for an MSc in electrical engineering but then opted for a career as an actor; Virginia Wade graduated with a Bachelor of Science at Sussex University and then pursued an outstanding career as professional tennis player.

Nevertheless, loss of budding talent in the supply pipeline is a loss of future capability within the world of technology, science and engineering and the evident under-representation of women in STEM careers needs to be acknowledged and understood if measures to address it are to succeed. Mason and Goulden have been carrying out very interesting research on the topic 'Do babies matter?' benefitting from the Survey of Doctorate Recipients Database in the USA, which allowed them to study not only the impact of having a family on career progression in men and women but also its timing. Their data concluded that if a baby arrives within five years of completing doctoral studies, men are 38% more likely to achieve a permanent academic position compared to women.[1] Too often the 'leaky pipe' is associated and indeed justified by career breaks and family commitments. However, even though this is certainly an important factor, it is not the only one. In the UK in 2014, the Science and Technology Committee presented a report that highlighted the urgent need to provide support to women in their career progression, identifying gender bias as one of the key issues requiring attention, and recommended that diversity and equality training should become compulsory[2] for students, researchers and employers in general.

The presence of gender bias in all aspects of academic careers such as recruitment,[3] authorship,[4] and funding,[5] is well documented and known to negatively impact career progression of women. Another interesting example involves invitation of women speakers to international conferences. A recent study by Casadevall and co-authors in 2014 highlighted how the presence of women in a conference selection committee had significant impact on the gender distribution of the line-up of speakers.[6]

There are promising measures that can be implemented and that are known to have an encouraging impact on retention of female talent but all depends on the scientific community acknowledging the existence of gender bias and agreeing the need to address it. This is an area where important steps forward have already been made with positive outcomes.

In 2005 in the United Kingdom the Athena SWAN Charter was established with the purpose of encouraging and recognising commitment to advancing the careers of women in science, technology, engineering, maths and medicine employment in higher education and research. Institutions are invited to apply for bronze, silver and gold awards that recognise their activities and implementation of specific policies aimed at achieving gender equality. These have already started to make a significant difference and since May 2015 the charter has been expanded to recognise work undertaken in all other areas such as arts, humanities, social sciences, business and law, to more broadly address gender equality in education and research.[7]

In 2013 a report by the Higher Education Statistics Agency in the UK showed that across all faculties only one in five academics at a professorial level is female. In Science and Engineering subjects the proportion of women is even lower. Data provided by HESA and available through the Royal Society of Chemistry allow comparison of numbers specifically for

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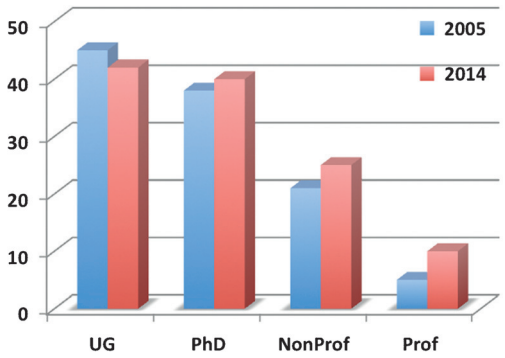

Figure 1. Comparison of the percentage of women in Chemistry in the United Kingdom in different categories between 2005 and 2014 (UG = undergraduates; PhD = doctoral students; NonProf = non-professorial academics; Prof = professorial academics). Data obtained from the RSC Public Tableau.[8]

chemistry.[8] Figure 1 shows how the percentage of women in chemistry at the different stages of an academic career has changed between 2005 and 2014 in the UK.

The number of female chemistry undergraduate students is relatively constant, moving between 45% and 42% which indeed is positive and encouraging, especially in comparison with other subjects, such as physics, maths and engineering where the gender imbalance at undergraduate level is already an issue. The data for the percentage of students enrolled in doctoral programs in chemistry shows a slight decrease compared to undergraduates, but still very good at 40% for 2014. Unfortunately, the percentage of women in academic non-professorial positions drops significantly to 25% for 2014 followed by an even more dramatic drop to 10% for women professors.

The graph clearly indicates that in nine years the overall trend has not changed and women scientists are not progressing in their career as expected. However, there is a positive trend over the period. The percentage of female academic non-professorial staff has risen from 21 to 25% while for professorial women the percentage has doubled from 5 to 10%. This is a very significant and encouraging change, which suggests the successful implementation of initiatives. As the number of women in academic careers increases, so does the number of role models, so there is reason to be optimistic that the trend can continue.

The question arising from these data regards the large fall in the number of women progressing at the end of their doctoral studies.

In 2008, a report was published by Jessica Lober Newsome for the UK Resource Centre for Women in SET and the Royal Society of Chemistry titled 'The Chemistry PhD: the impact on women's retention'.[9] The report identified important findings as a result of surveys, discussions and focus groups among UK doctoral students in chemistry. "There is a clear difference on how female and male PhD students in chemistry experience the whole PhD. Chemistry PhD programmes and academic careers are modelled on masculine ways of thinking and doing, which leaves women neither supported as PhD students nor enthused to remain in research in the longer term. Cultural as well as procedural changes are required to address this".[9] The report identifies supervision as a key feature playing a major role in the decision to pursue a research based career. Too often the role of a PhD student is simplified to a 'generator of experimental data' and the quality of the student measured by the number of publications and their impact factor, forgetting that the focus of doctoral studies should be the training and development of the individual as a person, in preparation for a future career choice. Multidisciplinary and multisectorial aspects should be included together with significant transferable skills and pastoral care.

The current environment in academia where metrics are playing an increasingly major role and success is quantified frequently on parameters such as grant income, number of papers and impact factors does not favour the implementation of such a model. In addition there is the general assumption that when a young researcher is first appointed to an academic position, as a result of outstanding scientific achievements, they will automatically be able to lead a research group and supervise others effectively. Typically, however, researchers tend to implement the model of supervision that they have themselves experienced, not necessarily well geared to the particular supervisees, and limiting the opportunities for innovation and improvement. Given the small proportion of female academics currently in chemistry, there is a risk that the more 'traditional' model will continue to play a major role. It is important that Higher Education employers implement infrastructures that support doctoral students and provide training on PhD supervision for all supervisors, where gender bias and tailored supervisory requirements are highlighted, recognising that supervisors play an important role in addressing the 'leaky pipeline'. There are indications that structured initiatives and cultural changes are improving talent retention. The challenge lies in accelerating the change and avoiding any relapse.

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