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**Realising Potential; Widening participation in Science and Technology**

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## 1. Introduction .

The United Kingdom of Great Britain and Northern Ireland (hereafter shortened to UK) has a long and distinguished history in the development of science and technology. It hosts some of the oldest and most distinguished scientific bodies such as the Royal Society (founded 1660) and the Royal Institution (1799) and The Royal College of Surgeons (1800). It is the birthplace and home of many of the legends of science from Isaac Newton, whose experiments and subsequent definition of the laws of motion and gravity established modern scientific methodology, to Charles Darwin whose theory of evolution provided the basis of much of biology and todays medicine. The UK scientific community has been at the forefront of all the major advances in 20th century science including quantum mechanics, cosmology; computing, DNA and gene therapy. Indeed the UK scientific community has been awarded the largest number of Nobel prizes in science (after USA and Germany) with 13 alone in the 21st century second only to the USA. The UK's science has always been strongly linked to applications with the UK pioneering the technologies that have shaped the modern world from the construction of the steam locomotive and first railways by Richard Trevithick and George Stephenson, the development of the jet engine by Frank Whittle to the fashioning of the World Wide Web by Tim Berners-Lee. The UK has, through its science and technology, changed the world and the UK scientific community continues to 'punch above its weight' with the average number of science citations of UK authored research papers almost as high as those by the USA ranking first in six scientific disciplines (agricultural sciences; ecology/environment; geoscience; molecular biology; neuroscience; pharmacology and plant/animal Science) and no lower than third in any other category (1).

The 2010 Royal Society report, "The Scientific Century: securing our future prosperity' (2) looked ahead and stressed that science and innovation will be at the heart of the UK's long-term strategy for economic growth and that the translation of scientific discoveries into new industries will be vital for 'sustainable growth and prosperity'. The Hauser report (3) published in the same year recognised that the 'UK has a science capability second only to the US but falls short on translating scientific leads into leading positions in new industries.' The rise of the BRIC countries with their increased (and rapid) investment in Science and Technology (China is set to overtake the USA as the leading publishing country and to have the largest national Science Technology Engineering and Maths workforce within possibly a decade) is causing increasing concern for UK, EU and US scientific and industry communities which believes it will struggle to compete against this new 'competition'. Collaborations at all levels are forming, indeed several initiatives for framing and developing such collaborations have been established by government departments (e.g., BIS) , research councils and the British Council which are aimed at positioning the UK as a hub for global science and innovation. This ambition is declared in the BIS 'Plan for Growth' published in 2011 (4).

However the Council for Industry and Higher Education (CIHE)'s task force argued that there has been an overall fall of total gross expenditure on R&D in the UK relative to GDP from the early 1990s to date, and that business enterprise R&D expenditure in the UK remains low by international standards, even after adjusting for structural differences between countries (5). Furthermore underpinning all Science, Technology, Engineering and Maths (STEM), and hence the ability for the UK to exploit Science and Technology as an economic tool is the presence of a well trained workforce capable of embracing the rapid scientific and technological changes that the next decades will bring. It is this necessary to ensure that STEM is open to the whole potential workforce such that the UK can 'mobilise' its human resources to meet the scientific and technological challenges facing the country in the next decades.

## 2. **Widening participation in Science and Technology; The Challenge**

The most recent statistics on Science, Engineering and Technology from BIS report 2013 (6) stated that in 2011 4,138,000 in the UK workforce held a HE qualification in science or engineering subject of whom 3,615,00 were economically active and 3,484,000 were in employment (a below average unemployment rate of <4%). Similarly a study by the Royal Academy of Engineering (7) reported 3.6 million STEM professionals or some 12% of the 30 Million UK workforce of whom 'just over half (1.9 million) are technicians or skilled SET operatives'. Nevertheless attracting people into science and technology remains a challenge to business and educators alike. A study by the Royal Academy of Engineering (7) estimated that 830,000 graduate-level STEM experts and 450,000 technicians will be needed in the UK by 2020. UK HE currently graduates some 90,000 STEM graduates (including international students who presently cannot obtain visas to work in the UK after graduation) in contrast India graduates some 700,000 students; in engineering alone the UK graduates some 23,000 a year while India is producing eight times as many, and China 20 times as many. Furthermore since a proportion of STEM graduates choose non science occupations (26% of engineering graduates for example) the study, by the Royal Academy of Engineering, estimated that 100,000 STEM graduates will be needed a year just to maintain the status quo.

To meet immediate need many UK firms are already recruiting STEM experts from abroad but this is probably not sustainable long term as many of these may return to their home countries as STEM in their homeland grows and becomes more competitive. Accordingly the UK needs to address this shortage in

STEM by maximising its own workforce by widening the participation of currently underrepresented groups in STEM in HEI but The Royal Society of Engineering report also comment that this 'will not be met by newly graduating students alone' and the report called for STEM experts to be trained through 'other routes' such as apprenticeships and 'retraining' of experienced mid-career employees perhaps following unconventional HE routes.

**3. Widening participation in Science and Technology; The Facts**

The under-representation of women, those from certain ethnic minority groups and people with disabilities in SET occupations is well documented (8). There is also evidence of under-representation of people from lower socio-economic groups amongst those applying for STEM degrees (9).

Recent reviews reveal significant gender differences across STEM. 2,142,000 men and 1,996,000 women hold STEM qualifications but if we preclude more medical oriented sciences (where women may be a majority) the percentage of women in the STEM workforce falls to some 13% with only 6% of the engineering workforce in the UK being female (10). As a recent Institute of Physics (IOP) report highlighted, such gender disparities are observed in the choice of A levels English, biology and psychology having a balance towards "girls" and physics, mathematics and economics towards "boys"(11). The report states 'many students may be influenced by the stereotypical reputation of the subject. And in those cases, the reputation – along with the fact that it might not be appropriately addressed – means that students are being denied opportunities that they might otherwise have taken.' The IOP report also stated that 'An implicit finding is that single-sex schools are significantly better than co-educational schools at countering the gender imbalances in progression to these six subjects.' The IOP's earlier report 'It's Different for Girls' clearly showing this effect in relation to physics and the other sciences (12).

Once at University the percentage of women progressing through Postgraduate degrees and (in academia) full time employment and subsequent promotion through to Professor falls rapidly with only 7% of UK STEM Professors being female. The 'gender challenge' is highlighted by the IOP which reports men account for 80% of undergraduate physics students, 84% of physics academic staff and 95% of professors and again evidencing such a gap opens at school where in 2012 physics was the fourth most popular subject for boys but only 19th for girls.

Less research and statistics are available for such diversity in race. An older Royal Society report (2005) reviewed ethnicity in Science Engineering and Technology attributing 1,329,900 to the SET workforce, with fewer medical and clinical employees being included, placed an emphasis on more physical and engineering sciences (13). In this survey males outnumbered females 1,122,800 to 207,100 of which 1,059,900 and 189,000 were white respectively. There were some 38,300 'Asian' 6,800 Chinese and 12,700 black (African and Caribbean). Such figures do not reflect the ethnicity of the UK population (in 2005 8% being ethnic origin with half of these being 'Asian' and a quarter describing themselves as Black, either African or Caribbean such that pro rata the SET workforce should have in excess of 53,000 Asian and 25,000 Black SET employees. The results of the IOP survey again suggest that such imbalances are set at an early stage (and physics is probably indicative across STEM) with 90% of those undergraduates who specified an ethnicity being white significantly higher than the 78% average across all subjects. Ethnic minorities, particularly Black, are also under represented in STEM academia and research.

Once again STEM is poorly represented amongst the disability workforce. The Royal Academy of Engineering reports 12 per cent of engineering professionals in the UK report having a disability, against 20 per cent of the working age population whilst the Higher Education Statistics Agency data from 2007–8 revealed that only 1.2% of university physicists declared that they had a disability. This is lower than both the proportion among the employed population, at five per cent, and the average across academic staff in science and engineering, 1.9%.

**4. Widening participation in Science and Technology; What can be done ?**

The need to widen the participation in science by gender, ethnicity and social background has been recognised by all political parties, by STEM professional bodies and by business. The recent government investment in STEM (September 2013) explicitly highlighted the need and desire to attract women to SET (14) while business has supported professional bodies (e.g. IOP, Royal Society of Chemistry, Royal Academy of Engineering) in their gender and diversity strategies. WISE, (Women in Science, Technology, Engineering and Mathematics). which celebrates its 30th anniversary in 2014 years, aims to inspire girls to pursue STEM subjects and seeks to not only increase opportunities for women in science, engineering and technology through support services to business, education and women returners but has targeted that at least 30% of the UK STEM workforce should be female by 2020 (10). WISE also reflects on the seniority of women in the STEM workforce with only 1 in 10 STEM managers or STEM business owners being female compared to 1 in 3 females being owners of non-STEM businesses. Amongst 'Top' companies only 13% of Board Directors are women and 1 in 5 of STEM Companies in FTSE 100 have no women on their Board (15). All of these organisations are seeking to address the issues of STEM gender imbalance at school such that with almost numbers of boys and girls being entered at GCSE the imbalance at A level is reduced with calls by IOP' for diversity to be made a fundamental part of Ofsted inspection criteria, as it would mean schools having to reconsider their approaches and take steps to address any clear gender imbalances'.

The IOP and The Royal Academy of Engineering have also set up groups to support delivery of education material in science, technology, engineering and maths for disabled workers, disabled students and their teachers. It should be noted that the Open University currently provides HE for more than 12,000 students with a disability, health condition, mental health disability or specific learning difficulty (such as dyslexia).

Bringing STEM into the focus of the UK's ethnic minorities is perhaps less developed but manyUK HE have initiatives with local schools and FE colleges and are developing outreach programmes in areas with a higher ethnic population whilst (media) role models are emerging to encourage younger ethnic students.

**5. STEM in Northern Ireland**

Ireland has been a core part of the international scientific community with many of its 'famous sons' dominating modern Science. Historical greats include Robert Boyle and John Tyndall whilst Belfast was the birthplace of William Thompson, Lord Kelvin and where John Bell, one of the leading theoretical physicist, was both born and studied (at QUB). There are, however, fewer role models for women although Dame Jocelyn Bell Burnell, the former Open University Professor of Physics is a notable exception.

Northern Ireland industry and STEM community faces call of the challenges common to the UK discussed above (16). The Northern Ireland Executive's "Programme for Government" and the Skills Strategy for Northern Ireland, "Success through Skills - Transforming Futures", recognises that the future success of the Northern Ireland economy will require increased numbers of skilled workers with Science, Technology, Engineering and Mathematics (STEM) qualifications. MATRIX, the Northern Ireland Science Industry Panel (17), has identified five key STEM sectors for NI which have potential for local economy and stresses the need for a strong STEM workforce. MATRIX has a dedicated member and Champion for STEM and is encouraging NI STEM Businesses to provide ‘Ambassadors’ to work with schools or colleges. Both of NI main campus based Universities (QUB and Ulster) have strong STEM cohorts and are addressing the need to recruit and deliver more STEM graduates to the local economy. In 2011/12 45% of 65,590 NI domiciled students at UK HEIs were studying a STEM related subject with 66% enrolled at an HEI in NI, 27% at an HEI in GB and 7% studying through the Open University. In 2009/10 46% of qualifications gained by students at NI HEIs were in STEM subjects a higher proportion than England Scotland and Wales but a proportion are subsequently lost by migration (mainly to England and EU), indeed proportionately more NI students now leave NI to study in GB than a decade ago. In the last decade the number of NI students going to GB has increased by 24%, those studying with the Open University increased by 38% while NI students at NI HEIs increased by less than 1%. (18)

The fall in STEM uptake at schools and HEIs that led to the commissioning of the STEM review in 2007 appears to have been at least in part arrested with increased enrolment in Chemistry, Physics and Maths amongst the post16 students. The situation in Engineering appears more mixed. Gender issues in NI are common to STEM in UK (and indeed across the EU and G8) and are being addressed by same bodies, for example the IOP in Ireland is actively applying its diversity strategy across the island. It should however be noted that the percentage of women NI domiciled students gaining STEM HE qualifications at UK HEIs is higher (42%) than in many other regions of the UK (19). However more women progress into higher education in NI than males ( in 2011/12 57% females and 43& males. This gender imbalance is observed early on in the educational system with females in NI more likely to stay on in full-time education at age 16. They are more likely to be entered for A levels, more likely to pass them and with higher grades than the males (including many STEM subjects) males are, however, more likely to study at HEIs outside NI.

## 6. Conclusion

The need to develop a strong and growing STEM community is essential for all developed economies. The UK and NI are faced with the demand for a growing STEM workforce if they are to ensure future economic prosperity. Accordingly the UK and NI needs to address this shortage in STEM by maximising its own workforce by widening the participation of currently underrepresented groups in STEM in HEI in particular by encouraging Women to pursue STEM careers. In addition underrepresented ethnic groups, disabled and those from lower socio-economic backgrounds whose needs have not traditionally been met by STEM need to be encouraged and supported in HE study to pursue STEM careers. The need for STEM workforce is unlikely to be met by newly graduating students so STEM experts will also need to be trained through ‘other routes’ such as apprenticeships and ‘retraining’ of experienced mid-career employees perhaps following unconventional HE routes. The Three HEIs in NI (QUB, Ulster and the Open University) are all both well placed and prepared to meet these challenges.

**References;**


1. http://www.timeshighereducation.co.uk/news/how-the-g7-nations-compare-in-research-performance/411986.article
2. http://royalsociety.org/policy/publications/2010/scientific-century/
3. Available at http://www.bis.gov.uk/assets/biscore/innovation/docs/10-843-role-of-technology-innovation-centres-hauser-review
4. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/31584/2011budget_growth.pdf
5. Hughes, A. and Mina A., The UK R&D Landscape. Enhancing Value Task Force, 2012
6. https://www.gov.uk/government/publications/science-engineering-and-technology-statistics-2013
7. 'Jobs and growth: the importance of engineering skills to the UK economy' http://www.raeng.org.uk/news/publications/list/reports/Jobs_and_Growth.pdf
8. UKRC (2010), Women and men in science engineering and technology: the UK statistics guide 2010, UK Resource Centre for Women in SET, 2010
9. Jake Anders (2012), The link between household income, university applications and university attendance, FISCAL STUDIES, vol. 33, no. 2, pp. 185–210 (2012)
10. http://www.wisecampaign.org.uk/
11. 'Closing Doors: Exploring gender and subject choice in schools' An Institute of Physics report (2013) http://www.iop.org/publications/iop/2013/file_62083.pdf
12. 'Its Different for Girls' An Institute of Physics report 2012 http://www.iop.org/education/teacher/support/girls_physics/file_58196.pdf
13. Science, Engineering and Technology and the UK's Ethnic Minority Population Royal Society report 2005
14. https://www.gov.uk/government/news/400-million-will-help-science-and-engineering-students-get-ahead-in-the-global-race-and-encourage-more-women-to-study-these-subjects
15. Labour Force Survey, March 2011-March 2012.
16. Success through STEM http://www.delni.gov.uk/2857p_stem_booklet_v5.pdf
17. http://www.matrix-ni.org/
18. http://www.delni.gov.uk/he-enrolments-2011-12.pdf