WISE a campaign to promote women in science, technology and engineering

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# "Not for people like me?" Under-represented groups in science, technology and engineering

## A summary of the evidence: the facts, the fiction and what we should do next

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# Contents


3 Foreword

5 Introduction

6 Highlights

A summary of evidence on STEM uptake by under-represented groups:

8 Where are we?

11 Does it matter?

12 So why do students from some backgrounds reject physics and engineering?

15 If we want to focus on under-represented groups, how do they differ from the majority group – white middle class boys?

19 What are the important factors in influencing choice for under-represented groups?

21 What can be done to make STEM qualifications and careers more attractive?

25 What works and what doesn't in schools?

26 The importance of self-identity and 10 types of scientist

29 Appendix: Recommendations from WISE about what works for girls

30 Women working in STEM: the changes from 2012 to 2014

# Foreword

Network Rail is delighted to be working with WISE and Professor Averil Macdonald, Diversity Lead for the South East Physics Network, to help make **STEM for people like me.**

GB plc needs to double the number of STEM* apprentices and graduates if we're to meet projected demand by 2020. We also need to create working environments that celebrate diversity; enabling people to feel true to themselves and able to contribute their best. This is the type of environment that will support innovation and creativity, enabling GB plc to compete globally.

In the report Professor Averil Macdonald brings together research from social science and the STEM community to show that when it comes to encouraging women into STEM, we just haven't got the messaging right.

Many people, particularly girls, typically give up on STEM careers as they perceive they are **not for people like me.**

To enable girls to picture themselves in STEM roles, we need to help them to reconcile the conflict between their self-identity and their perception of STEM careers. In the report Averil describes how we can achieve this by changing the way we describe STEM education and careers.

I trust the report will inspire you to target messages about STEM careers in a way that connects better with women both inside and outside your organisation. Collectively we can help create an environment where more people perceive STEM careers are **for people like me.**

**Jane Simpson**
Technical Services Director, Network Rail

Copies of the report can be downloaded from the WISE website: *www.wisecampaign.org.uk*

* Science, Technology, Engineering and Mathematics

*"Britain produces 12,000 engineering graduates a year – and there are currently 54,000 vacancies."*

**Sir James Dyson**
From ***"Shortage of engineers is hurting Britain"*** – The Telegraph, 5th September 2013.

Nature Editorial (March 2014) noted that:

**" Some argue that setting a quota for women in leading academic positions such as professorships will result in mediocre female candidates being promoted. But there is a gap in reasoning here. Women and men are equally talented, so if men occupy a large majority of high-level posts, there must be an awful lot of mediocrity among their number."**

*http://www.nature.com/news/science-for-all-1.12535*

" Women are supposed to be very calm generally: but women feel just as men feel; they need exercise for their faculties. It is narrow-minded in their more privileged fellow-creatures to say that they ought to confine themselves to making puddings and knitting stockings, to playing on the piano and embroidering bags. It is thoughtless to condemn them, or laugh at them, if they seek to do more or learn more than custom has pronounced necessary for their sex."

**Charlotte Bronte, *Jane Eyre* (1847)**

*www.youtube.com/watch?v=XP3cyRRAfX0*

" In any complex business environment, companies with a strong representation of women on their boards increase their chances to outperform competitors."

**Marie-José Nadeau**
Chair of World Energy Council and EVP of Corporate Affairs, Hydro Québec

" For me, the most compelling reason for diversity is that we need to access the best talent."

**Stephanie Hazell**
Group Strategy & Corporate Development Director, National Grid

Both from ***"Talent at the table: index of women in power and utilities"*** Ernst & Young 2014.
*www.ey.com/GL/en/Industries/Power---Utilities/Women-power-and-utilities*

*"Young people are too dumb to understand the advantages of an engineering career ... or they are too clever to overlook the disadvantages."*

**Frank Stefan Becke**
From ***"Why don't young people want to become engineers? Rational reasons for disappointing decisions"*** – 2010.

# Introduction

It is well-documented that UK STEM industries report significant difficulty recruiting people with the Science, Technology, Engineering or Mathematics (STEM) skills they need. It is also frequently noted that the projected number of STEM qualified people will fail to fulfil industry needs as older employees retire and that this is a serious risk to UK economic growth.

The accepted response to these facts is that female, black and minority ethnic and disadvantaged young people are under-represented in STEM study and the STEM workplace and that, if only we can enthuse / inspire / encourage these particular groups to enter STEM fields, then the skills shortfall will disappear.

This report reviews a large proportion of the recent research* in this area and sets out the facts and the fiction. I explain why many years of activity, energy and money focused on addressing this problem have made little, if any, impact. Instead I identify what the research really indicates we should be doing if we want a more diverse STEM workforce.

The unique element of this work is the new emphasis on the importance of self-identity. Matching the type of people and aptitudes that lead to success in the range of careers from STEM qualifications can address the barrier that is articulated by so many: that STEM is **'not for people like me'**.

**Professor Averil Macdonald**
Diversity Lead for the South East Physics Network (SEPnet)

SEPnet
South East Physics Network

**More about the author:**
Professor Averil Macdonald D.Univ CPhys FInstP FRSA

Averil Macdonald is Professor of Science Engagement and is leading on Diversity across nine Physics departments for the South East Physics Network (SEPnet) Project. She has two daughters currently at university.

Averil sits on the Boards of WISE, the Science Museum Group and the Cheltenham Festivals, as well as being the UK representative and advising the EU commission on Diversity as part of her role on the Helsinki Group for Gender in Research and Innovation.

Averil is a high-profile advocate for STEM and passionate about encouraging everyone, especially girls, to choose STEM subjects.

*Apologies to any whose research is not reported here.

# Highlights

## Where are we?

- Every year, the UK produces 36,000 fewer engineers than it needs.
- It is a myth that girls and women are not choosing STEM qualifications.
- Girls outnumber boys in STEM qualification choices overall.
- Girls outperform boys in STEM qualifications at all levels.
- The fact is that girls are NOT choosing physics post 16 and are losing or rejecting the opportunity to choose engineering post 18.
- The percentage of girls choosing physics hasn't changed over 30 years despite our efforts.

## Does it matter?

- There is a business case for a diverse workforce to increase productivity and creativity.
- The UK has the lowest participation of women in the STEM workforce in Europe particularly in engineering and ICT.
- Female participation is increasing, but from a very low base – except at technician level, where it is falling.

## Why is STEM rejected?

- Careers from STEM are not popular aspirations for students age 10 -14.
- Pupils from age 10 start to self-identify as 'not STEM'.
- Teachers often have lower (stereotypical) expectations of under-represented groups in STEM reinforcing their non-STEM self-identity.
- Experience in schools and high quality, unbiased careers guidance are critical elements in students' subject choices.
- The quality of teaching, the availability of triple award science and teacher CPD enhance achievement in STEM subjects and are essential in students having the confidence and being able to progress beyond GCSE.
- STEM focused enhancement activity does encourage students into STEM but must be applied consistently through the school career.
- Interventions work up to a limit but don't work if teaching quality is poor, particularly for girls.

## Which factors influence choice?

- There is untapped potential in the family as an important encourager or influencer for young people, particularly in the Asian population.
- It is important to ensure that parents, particularly in lower income groups are aware of the full range of careers available.
- Mothers in particular, need to know their daughters could be happy in a career from physics/in engineering, and that the working environment would be supportive.
- Girls, in addition to parental support, need to resolve the conflict between self-identity and STEM identity in order to see STEM as offering careers **'for people like me'.**

## How to make STEM careers attractive?

- The messages focusing on what pure scientists and engineers 'do' are NOT sufficient to persuade the under-represented groups.
- Careers from STEM need to be described in terms of the personal characteristics required.
- Young people and their influencers need to be convinced that STEM careers offer what they are looking for.
- Employers need to ensure they DO provide a supportive work environment with flexible working to retain the best talent.
- To recruit and retain the best, employers need to ensure that unconscious bias is not influencing their recruitment and promotion processes.

## What works and what doesn't?

- One-off interventions don't work – consistent approaches are essential.
- Initiatives that seek to 'encourage' girls into STEM are misplaced.
- The evidence is that girls are making entirely logical careers choices based on the information available.
- There should be NO implication that girls must change.
- The needs of girls and young women, including supportive employment conditions and the ability to progress while working part time, must be consistently embedded into all messaging from the STEM sector.
- Above all, girls need to be able to self-identify that **'science is for people like me'.**

## There are 10 types of scientist requiring differing aptitudes

- We should describe the 'person spec' as well as the 'job spec' of roles in STEM, when talking to young people. Use adjectives as well as verbs when talking to students.
- Emphasising the 'types of people' that are successful in the range of STEM careers would address the concern, particularly amongst girls, that STEM careers are 'not for people like me'.
- Enabling under-represented groups to resolve the conflict between self-identity and STEM identity will allow them to see STEM careers as **'for people like me'**.

# 1 Where are we?

## A summary of evidence on STEM uptake by under-represented groups.

### There is a clear shortage of people with STEM skills in the UK:

The CBI's survey in 2014 found that 39% of businesses who were seeking employees with STEM skills had difficulty recruiting those staff. In addition, the UK Commission for Employment and Skills reports that 26% of core STEM vacancies in England are hard to fill.

***"Engineering our Future: Stepping up the urgency on STEM"*, CBI, 2014. *"The Supply of and demand for high-level STEM skills"*, Evidence report 77, UKCES, November 2013.**

EngineeringUK's report *'The State of engineering'* in 2013 estimated that between 2010 and 2020, there will be 1.86 million new jobs needing engineering skills giving a net increase in jobs in the sector of 204,400. This means that we need to double the number of graduates and apprentices in the engineering discipline alone by 2020 to meet demand.

***"The State of Engineering"*, EngineeringUK, 2013.**

EngineeringUK in 2014 confirmed that whilst the UK is currently producing 51,000 engineers per year, the profession and industry require some 87,000 engineers to meet projected demand. This 36,000 shortfall is the most pressing challenge facing the industry. The engineering sector is currently contributing upwards of £1.1 trillion to the UK economy, an amount that represents 24.5% of the turnover from all UK enterprises.

***"The State of Engineering"*, EngineeringUK, 2014.**

The CBI also noted that STEM qualifications alone aren't enough – many employers find that applicants lack employability skills (36%) and workplace experience (37%).

***"SET for growth - Business priorities for science, engineering & technology"*, CBI, August 2010.**

UK Commission for Employment and Skills (UKCES) projects that by 2020 there could be significant regional shortages of high level STEM skills in the following English regions:
– East Midlands
– Yorkshire and the Humber
– North West England
– North East England

***"The Supply of and demand for high-level STEM skills"*, Evidence report 77, UKCES, November 2013.**

*http://sciencecentres.org.uk/reports/underserved/UK%20Science%20and%20Discovery%20Centres%3b%20Effectively%20engaging%20under-represented%20groups%20(May%207%202014).pdf*
Also at: *http://tinyurl.com/l8bcuxg*

**Note:** The names of all reference sources have been included in full; however, where the URLs for these have been split over more than one line, a **tinyurl** has been included to aid linking to the source material.

## Fortunately numbers studying science at school level are increasing:

Exam board figures show a steep rise in the numbers of students of both sexes taking AS-level physics, from 36,258 in 2006 to 61,176 in 2013 and 64,790 in 2014. There has also been a significant rise for A2 physics, from 27,368 in 2006 to 35,569 in 2013 and 36,701 in 2014, according to data from the Joint Council for Qualifications.

*www.jcq.org.uk/*

## But disadvantaged schools are not preparing students so well for STEM A-levels:

Unfortunately in 2012, while 83% of year 9 pupils at selective schools opted to study triple science (separate sciences, biology, chemistry and physics) at GCSE, only 31% of state school students did the same. In addition, schools with a high Free School Meals (FSM) eligibility were found to have lower levels of uptake for the separate sciences. Worryingly by 2011 the proportion of schools where it is compulsory for all pupils to study at least double science had fallen significantly, with more schools reporting it is only compulsory for their higher performing students.

***"The effects of the English Baccalaureate"*, Ipsos MORI for the DfE, 2012.**

This is important as National Audit Office found that students studying 'triple science' GCSE (separate biology, chemistry and physics) are more likely than those studying combined science to continue science study at A-level and to achieve higher grades having done so. Compared with other students, students from more deprived backgrounds achieve relatively larger improvements in their future A-level science and maths outcomes when offered triple science at GCSE than when offered only combined science. NAO confirmed that triple science is less widely available in areas of higher deprivation, where it could potentially have the greatest impact on take-up and achievement.

*www.nao.org.uk/wpcontent/uploads/2010/11/1011492es.pdf*

EngineeringUK also noted that the numbers of students studying the subjects necessary to pursue engineering has increased – over the past ten years the numbers of students studying chemistry and physics has grown by 224.2% and 218.9% respectively – but EngineeringUK comments that we are yet to see this growth mirrored in the numbers of young engineers.

***"The State of Engineering"*, EngineeringUK, 2014.**

## But more students, especially girls, drop physics more than other subjects at A-level, preventing them taking engineering in most universities at degree level:

Unfortunately, physics loses more students than most subjects after AS-level and girls are more likely than boys to drop the subject. By A2, the second year of A-level, only a fifth of physics students are female. Across all subjects, the dropout rate between AS and A2 was 37% in 2013. In physics, the figure was 39.9% overall: 37.8% for boys but 46.7% for girls.

*www.bbc.co.uk/news/education-27596247*

## Institute of Physics statistics show:

- 10% of all those who are eligible to take A-level physics choose to do so.
- Physics is the fourth most popular subject for boys – 24,000 or 15% of eligible males choose physics.
- Physics is the 19th most popular subject for girls – around 7000 out of more than 150000 eligible girls take physics.
- 49% of state schools in England and Wales send no girls to study A-level physics while girls from single sex schools are 2.5 times as likely to study A-level physics. School culture is the predominant factor in this.
- Girls make up 20% of those taking A-level and 21% of those taking degrees in physics – a percentage that hasn't improved over 30 years of interventions.
- Maths is the most popular degree subject for girls who have taken A-level physics.

*www.iop.org/education/teacher/support/girls_physics/file_58196.pdf*

***"It's Different for Girls: The influence of schools"*, Institute of Physics, 2012.**

*www.iop.org/education/teacher/support/girls_physics/different/page_61620.html*
Also at: *http://tinyurl.com/mdtgrb4*

***"Closing Doors: Exploring gender and subject choice in schools"*, Institute of Physics, 2013.**

*www.iop.org/education/teacher/support/girls_physics/closing-doors/page_62076.html*
Also at: *http://tinyurl.com/qcas2nf*

## And it's not that girls can't do science and/or maths or that they avoid harder subjects:

The puzzle is that girls, on average, achieve a quarter of a grade higher than boys – a quarter (25.2%) of female candidates achieved an A in AS-level physics, compared with just over a fifth (21.4%) of male candidates and at A2 35.5% of female candidates achieving an A or A*, compared with 29.9% of males.

*www.bbc.co.uk/news/education-27596247*

Even though girls attain well at physics GCSE, female participation begins to fall at A-level. Just 21% of A-level physics students, 39% of maths students and 29.5% of further maths students are girls. The situation is different for biology and chemistry, where 58% of biology A-level students and 48% of chemistry A-level students are female.

*www.bbc.co.uk/news/education-23181672*

Girls do not lack ambition and now comprise 60% of all medicine undergraduates and 75% of those studying veterinary science.

***"Higher Education in facts and figures"*, Universities UK, 2013.**

But more female undergraduates are studying languages than are studying engineering, computing, physical sciences and mathematics combined. The number of male undergraduate students in these scientific subjects is more than three times that of female students.

***"Higher Education in facts and figures"*, Universities UK, 2013.**

## Girls also outperform boys in the vocational pathways – even though very few follow that route:

In 2013, girls made up only 5% of students taking engineering at BTEC Level Two, taken alongside GCSEs. That amounts to 810 girls, a rise from 680 in 2012. More than a third (37%) of these girls gained a distinction, compared with 20% of boys. At BTEC Level Three, the proportion of female engineers was just 4% – but again they performed better than their male classmates, with 14% achieving the highest grade, as opposed to 9% of the boys. In information technology (IT), girls made up 38% of the cohort at Level Two but around a third (31%) gained a distinction, compared with 21% of the boys.

The proportion of girls taking the more challenging Level Three in IT was just 18% but again their grades were strong with 15% gaining the top grade, compared with 12% of their male classmates.

*www.bbc.co.uk/news/education-23181672*

## Conclusion 1

- **The UK is producing 36,000 fewer engineers EVERY year than it needs.**
- **It is a myth that girls and women are not choosing STEM qualifications.**
- **Girls outnumber boys in STEM qualification choices overall.**
- **Girls outperform boys in STEM qualifications at all levels.**
- **The fact is that girls are NOT choosing physics post 16/17 and are losing or rejecting the opportunity to choose engineering post 18.**
- **The percentage of girls choosing physics hasn't changed over 30 years despite our efforts.**

# 2 Does it matter?

## There is a clear business case for diversity in the workforce:

The Society of Biology stated that *"increasing women's participation in the UK labour market could be worth between £15 billion and £23 billion* [1.3 – 2.0% of GDP], *with STEM accounting for at least £2 billion of this"* while the 2013 Perkins report noted *"it would benefit the economy to substantially increase the supply of engineers entering the labour market"*.

*www.societyofbiology.org/policy/policy-issues/equality-diversity/women-in-biology*
Also at: *http://tinyurl.com/o65rldq*

*www.gov.uk/government/uploads/system/uploads/attachment_data/file/254885/bis-13-1269-professor-john-perkins-review-of-engineering-skills.pdf*
Also at: *http://tinyurl.com/oyuffhu*

The Royal Academy of Engineering notes that *"Diverse teams produce better results in engineering, where different experiences and ways of thinking often lead to innovative outcomes."*

**Inspiring Women Engineers (2009) at:**
*www.raeng.org.uk/policy/diversity-in-engineering/resources#General*

The 2014 report from Lord Davies, *"On balance in the boardroom"*, showed the FTSE 100 companies who had made the most progress in balancing their boards were among those willing to publicly share their targets. Following the initial Davies Report of 2011, 39 of the FTSE 100 companies set their own public and voluntary targets of at least 25% female board representation. Since then 19 have already met or exceeded those goals – a year ahead of the deadline.

*www.gov.uk/government/uploads/system/uploads/attachment_data/file/297519/bis-women-on-boards-2014.pdf*
Also at: *http://tinyurl.com/nqff2ho*

## Women remain seriously under-represented in the STEM workforce – particularly in the UK, which has the lowest levels in Europe:

Despite women representing 46% of the UK labour force, women are under-represented in STEM, making up just 13% of those in STEM occupations. They are extremely under-represented in engineering where only 8% are women. In the workplace, 27% of science and engineering technicians are female, 15% of ICT professionals and 5.5% of engineering professionals are women.

**Labour market statistics, February 2014. Office of National Statistics, February 2014.**

*www.ons.gov.uk/ons/rel/lms/labour-market-statistics/february-2014/index.html*
Also at: *http://tinyurl.com/q5egrso*

*http://sciencecentres.org.uk/reports/underserved/UK%20Science%20and%20Discovery%20Centres%3b%20Effectively%20engaging%20under-represented%20groups%20(May%207%202014).pdf*
Also at: *http://tinyurl.com/l8bcuxg*

## *EngineeringUK* statistics showed in 2011:

***"An investigation into why the UK has the lowest proportion of female engineers in the EU"*, EngineeringUK, April 2011.**

- **Only half** of women with an engineering and technology degree work in the sector compared to **2/3 males**.
- Average starting salary for engineering and technology graduates **15.7%** higher than average for graduates overall.

Across Europe a few (mainly ex-Soviet) countries have around 20% women in STEM, Western European countries such as France and Spain (17% each), Denmark (16%), Germany (15%), Finland (15%), and UK (9% – the lowest) bringing the European average down to 17%.

**EngineeringUK/Association of German Engineers.**

## But numbers are rising – albeit from a low base:

WISE analysis of the Labour Force Survey shows that from 2012-2014:

- STEM occupations have grown slightly as a proportion of total employment – 17.6% to 17.8% (4,700,000 men, 690,000 women in June 2014).
- Women are choosing STEM occupations at a higher rate than men – 8.2% increase for women, 6.95% for men.
- 12% increase in women choosing non-health-related STEM occupations to 429,000 (6% increase for men to 4,473,000).
- 50% increase in female science professionals to 65,000 (30% for men to 91,000) so women make up 42% of this category.
- 104% increase in number of female engineering professionals to 26,000 (9% for men to 427,000 but women only make up 5.7% of this category).
- 173% increase in number of female building professionals to 46,000 while the number of men has reduced by 5% to 181,400.

- But ICT is being taken up at a much greater rate by men with a 7% increase in the number of male ICT professionals to 723,000 (3.5% for women to 125,000). Women make up only 15% of this category.
- And there has been a 15% decline in the number of female ICT technicians to 40,000 (4% increase for men to 146,000). Women only make up 21.5% of this category in 2014 compared with 25% in 2012.
- There has been a very worrying reduction of more than 6,000 in the number of female science, engineeering and production technicians, a drop of 10% compared to an increase of 13% in the number of men. Women now make up 22% of the total compared to 26% in 2012.

An interesting correlation is that median hourly earnings for women working full time in the UK in 2013 were £1.36 less than the average for men working full time. Part of the explanation for this 10% gender pay gap is that occupations where women are in a majority pay less than jobs traditionally done by men.

*www.wisecampaign.org.uk/files/useruploads/files/resources/wise_utc_advice_guide.pdf*
Also at: *http://tinyurl.com/k36brl2*

Research from the British Computer Society (BCS) shows that in tech occupations the pay gap is almost 23%.

*http://policy.bcs.org/sites/policy.bcs.org/files/Women%20in%20IT%20scorecardv2.pdf*
Also at: *http://tinyurl.com/l29nxq9*

## Conclusion 2

- **There is a business case for a diverse workforce – diverse teams have increased productivity and creativity.**
- **The UK has the lowest participation of women in the STEM workforce in Europe particularly in engineering and ICT.**
- **Female participation is increasing, but from a very low base – except at technician level, where it is falling.**

# 3 So why do students from some backgrounds reject physics and engineering?

## Pupils age 10-14 start to self-identify as 'not-STEM':

Institute of Education TISME research found that:

*http://tisme-scienceandmaths.org/the-tisme-research-projects/upmap/*

- STEM careers (excluding medicine) are **not** popular aspirations among 10–14 year olds.
- By the age of 10 or 11 a significant proportion of pupils have already decided that the idea of studying science after the age of 16 and the idea of a career in a STEM area is **'not for me'**.
- Most young people form their attitudes to science between the ages of 10 -14, a time when most receive little or no careers education to support or inform their ideas.
- Many middle attaining students enjoy mathematics and/or science but do not see post-16 participation as possible for them. They see science careers as only for the **'brainy few'**.
- Pupils are more likely to continue with mathematics and/or physics after the age of 16 if they recognise that studying one or more of these subjects post-16 stands them in good stead in terms of achieving a well-paid and interesting job.

## The danger of master classes:

Universities often hold master classes or events for a small, select few. This reinforces the idea amongst those not selected that STEM is for the elite and not open to others. Contrast this with humanities or arts where school trips are non-discriminatory, inviting the whole year group to the theatre or history visit. Under-represented groups lacking confidence in their STEM ability, if not part of the elite, chosen group, will conclude that STEM is not for them.

## Schools play a big role in students' decisions to study STEM subjects:

National Foundation for Educational Research has demonstrated positive links between students' self-belief in STEM subjects, and their actual achievement. Higher self-belief also impacts on the likelihood that students will choose to study STEM subjects post-16.

Disadvantaged students' belief in their ability to succeed in education, and the amount of time they spend studying STEM subjects, has a positive impact on their educational outcomes.

*www.nfer.ac.uk/publications/BGAS01/BGAS01.pdf*

## Teachers' expectations and bias have a negative effect:

Wellcome Trust research has found that *"primary teachers' knowledge and confidence in science has* [a direct effect] *on students' attitudes towards science and their attainment and progression in it."*

**Wellcome Trust, 2008.**

*http://www.wellcome.ac.uk/Education-resources/Education-and-learning/Our-work/Teacher-training/WTS052326.htm*
Also at: *http://tinyurl.com/mfeg4c7*

The National Foundation for Education Research showed that *"female, working-class and some minority ethnic students lack confidence and experience lower teacher expectations of their abilities – even when they achieve well. This is exacerbated within high-status, 'masculine' subjects. The gender, socio-economic and ethnic inequalities in STEM participation are deep seated. They are not simply the product of individual preferences but are profoundly influenced by social norms and processes".*

*www.nfer.ac.uk/publications/BGAS01/BGAS01.pdf*

There is considerable evidence of *"teachers favouring boys and perceiving them to be 'better' (and more 'naturally able') at science than girls, giving them higher marks for work, even where attainment data indicate otherwise".*

Spear, M. (1987) *"The biasing influence of pupil sex in a science marking exercise"*, in A. Kelly (ed.), *"Science for girls?"* (pp. 46-51), Milton Keynes, Open University Press; WSC06 [TISME] Archer, L., Osborne, J. & DeWitt, J. (2012) *"The Case for Early Education about STEM Careers"*, (p.8), London: The Science Council; Institute of Physics, *"Closing Doors: Exploring gender and subject choice in schools"*, December 2013.

*www.iop.org/education/teacher/support/girls_physics/closing-doors/page_62076.html*
Also at: *http://tinyurl.com/qcas2nf*

IOP Research Review shows girls and boys respond differently to teacher quality: leadership; interactions with students; questioning techniques in the classroom etc. Science teachers on average were found to have poorer relationships with girls than humanities teachers have with girls and this was a key factor in developing girls' learning, but not a key factor for boys.

*www.iop.org/education/teacher/support/girls_physics/review/file_41599.pdf*
*Also at: http://tinyurl.com/l7mcxee*

The National Audit Office found evidence that participation by teachers in Science Learning Centre programmes (CPD) is associated with improved teaching and learning, and higher take-up and achievement in science at their schools, but take-up of CPD by teachers varies between areas.

*www.nao.org.uk/wp-content/uploads/2010/11/1011492es.pdf*

## Enjoyment is important in subject choice, but isn't enough:

EngineeringUK found that enjoyment of a subject and attainment are equally important in a student's likelihood to pursue that subject further. All students experience physics to be increasingly difficult, partly due to the mathematical demands of the subject. But girls develop feelings of 'not being able to do physics' even though this is not borne out by the reality of girls' performance and this reinforces their self-identity as 'not STEM'. This is not helped by careers information, advice and guidance that is still reinforcing gender stereotypes.

***"An investigation into why the UK has the lowest proportion of female engineers in the EU"*, EngineeringUK, April 2011.**

Teachers often advise students that a combination of maths, chemistry and biology at A-level keeps more doors open, particularly for medicine, and there is a perception, amongst girls in particular, that A-level physics limits options. This leads undecided students to avoid physics and, therefore, exclude themselves from engineering in the majority of HE institutions.

*http://www.iop.org/publications/iop/2013/closingdoors/*

## Why are apprenticeships not more popular?

The Education and Employers Taskforce and PricewaterhouseCoopers found that:

***"Closing the Gap: How Employers Can Change the Way Young People See Apprenticeships"*, 2012.**

- In a survey of secondary school teachers 52% were 'not at all confident' about advising young people on apprenticeships.
- A key concern among potential female apprentices is that non-traditional workplaces will be unfriendly towards them. Furthermore *"there is a default view that apprentices are stereotypically male, and are narrow in terms of the vocational or occupational choices available".*

- Large majorities of teenagers surveyed like the idea of jobs which have structured training and want to know more.

*http://www.educationandemployers.org/research/closing-the-gap-how-employers-can-change-the-way-young-people-see-apprenticeships/*
Also at: *http://tinyurl.com/n2kxsf2*

EngineeringUK statistics showed in 2011:

- Only **430** female engineering apprentices, compared to **13,900** males.
- **3 vacancies for each trained technician**; 5 trained hairdressers for each vacancy.

***"An investigation into why the UK has the lowest proportion of female engineers in the EU"*, EngineeringUK, April 2011.**

YouGov (2011) found that teachers underestimate the extent to which parents, young people and employers value apprenticeships as a realistic alternative to academic study while GradCracker found:

- A survey of 1,080 secondary students suggests that despite a drive to raise the profile of apprenticeships, these routes remain largely unknown.
- Of students aged 14 -16 years old, 46% had received no information about apprenticeships.
- Results also suggest that there is a trend towards steering girls away from technical routes in favour of university.

*www.gradcracker.com/*

In 2011/12 TUC statistics confirmed that:

- Half of all apprenticeship starts were female.
- Women are significantly under-represented in the STEM and higher-pay sectors such as engineering (4%).
- Men are under-represented in lower-pay sectors such as the children's and young people's workforce (7%).
- A third of the men reported being encouraged to take an apprenticeship in school. Just 17% of women received the same advice.
- Pilots looking at how to increase diversity within apprenticeships found that although employers saw the main issue was low demand for apprenticeships from young women, not all employers had considered unconscious bias in recruitment practices and work environments.

***"Under-representation by gender and race in apprenticeships"*, TUC, 2013.**

At a roundtable, organised by WISE in April 2014, to discuss policy levers to increase the number of women choosing a STEM apprenticeship, a young woman doing a higher apprenticeship in engineering at Rolls Royce indicated she had to fight with her school to be allowed to go to the open day in Derby, because the school had ear-marked her for university. *"Apprenticeships are for the naughty boys"*, was the message.

## What is thought to make a difference?

Surveys conducted by the National Audit Office with 1,274 children and young people suggest that the following are critical success factors in improving take-up and achievement STEM subjects:

- Careers information and guidance.
- Quality and quantity of science teachers.
- Quality and quantity of school science facilities.
- Image and interest.
- Availability of separate GCSE sciences ('triple science').

***"Educating the next generation of scientists"*, Department for Education & National Audit Office, November 2010.**

*www.nao.org.uk/wp-content/uploads/2010/11/1011492es.pdf*

Furthermore the NAO research found that:

- Only 19% of science teachers across the system are physics specialists. As the level of specialist qualification of the teacher has been found to be the second most effective predictor of pupil performance in physics, this is deeply concerning.
- In mathematics, a quarter of teachers have not studied maths to degree level nor as part of their initial teacher training.
- Schools using outreach/enhancement programmes have a greater proportion of pupils studying STEM subjects, and several programmes are associated with increases in take-up and achievement of separate sciences at GCSE, and maths and science at A-level. However, it is difficult to establish whether this is a direct consequence of participating in the programmes, or whether schools with an existing focus on science tend to access more such programmes as a result.

But engaging disadvantaged groups can be particularly challenging in the UK where significant effort is often required to engage lower-performing schools and where there is a multitude of widening participation initiatives targeting young people – with a risk of ***"initiative fatigue"***. Where UK STEM partners have been successful in engaging schools, they have a track record of successful delivery; allowed significant time to recruit

schools prior to delivery; and gained senior leader commitment. They have achieved the support of senior leaders through demonstrating the benefits of engaging, e.g. how activities will link to the curriculum and impact on students' progress and achievement.

**OECD, 2011; JRF, 2010; DfE, 2011; Hoare et al., 2012; Martin et al., 2013 and Sutton Trust, 2011.**

*www.nfer.ac.uk/publications/BGAS01/BGAS01.pdf*

## Conclusion 3

- **Careers from STEM are not popular aspirations for students age 10-14.**
- **Pupils from age 10 start to self-identify as 'not STEM'.**
- **Teachers often have lower (stereotypical) expectations of under-represented groups in STEM reinforcing their non-STEM self-identity.**
- **Experience in schools and high quality, unbiased careers guidance are critical elements in students' subject choices.**
- **The quality of teaching, the availability of triple award science and teacher CPD, enhance achievement in STEM subjects and are essential in students having the confidence and being able to progress beyond GCSE.**
- **STEM focused enhancement activity does encourage students into STEM but must be applied consistently through the school career.**
- **Interventions work up to a limit but don't work if teaching quality is poor, particularly for girls.**

# 4 If we want to focus on under-represented groups, how do they differ from the majority group – white middle class boys?

## Views of girls:

The Girlguiding annual Girls' Attitudes Survey is particularly insightful here. The survey explores the opinions of more than 1,200 girls aged 7-21, not just those participating in Guiding.

**Girls' Attitudes Survey , Girlguiding UK, December 2011.**

*http://girlsattitudes.girlguiding.org.uk/about_the_survey/past_surveys_-_2011.aspx*
Also at: *http://tinyurl.com/nxhk6l3*

With specific reference to STEM, they have found the following:

- The top career choice among girls in the 2009 survey was hairdresser or beautician, and few girls would consider a career in science or engineering.
- More than half of girls say that hairdressing is what girls are interested in (57%), while they veer away from engineering because of a lack of interest (51%) and lack of female role models (60%). There is also a perception that not many girls or women do this kind of job (47%), and that they don't know enough about it (43%). By contrast, one in three thinks that hairdressing is popular because it's all girls know about (35%), and because they know others who do it (32%).
- Almost half of girls (53%) think science/engineering is too hard or complicated, 35% say it would be difficult to get a job of this kind, and 22% would be put off by the working environment.
- Three in ten girls (30%) think that worries about sexism in the workplace put girls off a career in science or engineering.
- 43% of girls said they were put off science and engineering careers because they did not know enough about the kind of careers available. 60% said they also were put off by a lack of female role models.
- Some 43% think that girls opt for hairdressing because some jobs are more for girls, and 27% feel that engineering loses out because some jobs are more for boys.

- Younger girls (11 to 16) are particularly likely to refer to girls' or boys' jobs, and girls' interest, or lack of, in certain areas.

In questions about careers and education:

- 57% believe that women have to work much harder than men to succeed.
- 9 in 10 (89%) girls and young women believe that having children would affect their career with 41% expecting this to have a major impact.
- 69% of 11-21 year olds would consider putting off having children to allow them to follow their perfect career. 1 in 3 (34%) would seriously consider this. Just 1 in 5 (20%) would not let their career affect when they have children.
- Nearly two thirds (62%) of secondary school age girls are concerned about getting a job when they finish education.
- One in six (16%) said that they can't afford to study or need to get a paid job, up from 11% in 2009.
- For those who plan to leave education and training at age 18 more than one in five says that this is because they can't afford to study (22%), up from just 8% in 2009.

## Research by Ofsted confirms this:

**Girls' Career Aspirations, Manchester: OFSTED, Ofsted (2013).**

- From Year 3 (age 7–8) onwards girls' views regarding future careers tend to conform to traditional notions of 'girls' jobs' and 'boys' jobs' **(Ofsted 2011)**. These notions are reinforced by parents' views.

  **Professor John Perkins' Review of Engineering Skills: The Department for Business, Innovation and Skills, November 2013.**

  *www.gov.uk/government/uploads/system/uploads/attachment_data/file/254885/bis-13-1269-professor-john-perkins-review-of-engineering-skills.pdf*
  Also at: *http://tinyurl.com/oyuffhu*
- But as they grow older, girls' outlooks become more nuanced. By secondary school girls believe 'all' jobs are open to them, and that they can choose any kind of job irrespective of tradition.
- Girls in Key Stage 3 said they were not sufficiently informed to make the choices their desired career paths required. They lacked information about starting salary, promotion prospects and earning potential. Furthermore, teaching about career breaks, the impact of raising a family and how careers develop through promotion was rare in all of the schools.
- Almost all the girls and young women who took part in the survey were open to the possibility of pursuing a career that challenged gender stereotypes, if the career was of sufficient interest to them. However, this confident thinking was not matched by any noticeable shift away from gender-typical course or career choices. Almost all of these girls said that they were not planning to pursue such a route for themselves.
- For better or worse role models shape the views of young women's career choices. Actively showcasing high-profile women and former female students can be effective, but one-to-one meetings with professionals tended to have a greater impact on girls' career aspirations.
- In the few examples where girls had changed their minds and set out on a new and unfamiliar route, that change had often been caused by a personal experience of either meeting a professional in school, or directly encountering the new kind of work for themselves.
- The influence of school, or of explicit careers education was found to be relatively small in girls' careers aspirations.

## The situation for BME students is different – overall they are well represented in STEM and in HE:

Higher Education data show:

**HESA data, 2011/12, Ethnicity.**

- BME students are more likely to study STEM. In STEM subjects in 2011/12, a fifth of all students were from an ethnic minority.
- BME students are more likely to choose maths, physics and chemistry A-levels and aim for vocational degrees than white British students with the same GCSE levels.
- BME students are more likely to attend university by the age of 19.
- Female Black African students made up a quarter of the cohort of women in STEM subjects while for men the equivalent figure was 21% Ethnic minorities in STEM.

  **Race for Opportunity, 2011.**

The proportion of all BME women working in STEM occupations is also increasing faster than the proportion of all white women working in STEM occupations.

**UKRC Statistics Guide, 2010.**

Research from the Institute of Physics and the Royal Society of Chemistry indicates that, for students of BME origin there is a hierarchy of influences which can be split into three levels of influence:

- **High-influence:** enjoyment of physics and chemistry, future ambitions, perceptions of careers with a physics or chemistry degree, and the relevance of physics and chemistry study to life.
- **Medium-influence:** the way physics and chemistry are taught, physics and chemistry teachers, images of scientists and the work that they do, and family influences.
- **Low-influence:** the difficulty of physics and chemistry, role models, careers advisors and peers.

*www.iop.org/publications/iop/2008/page_38220.html*

The perceptions of careers with a physics or chemistry degree, mostly influenced young people away from physics and chemistry.

BME groups vary enormously. Certain factors were more influential for some ethnic groups than others:

- BME females were more likely than males to be influenced to choose physics and/or chemistry by their enjoyment of the subjects, and to be influenced to drop them as a result of their perceived difficulty.
- Those studying A-level chemistry were more likely than those studying physics to see their study of the subject as a stepping stone to a career outside the subject (e.g. chemistry A-level is a prerequisite for medicine).
- BME undergraduates studying physics or chemistry were more likely than A-level students to have positive views of the careers available with a physics or chemistry degree, the relevance of physics and chemistry to life, plus scientists and the work that they do.

Many BME A-level students explained that they enjoyed physics and chemistry but were not continuing with the subjects at degree level. The reasons for this were:

- Some wanted to pursue a more vocational degree (e.g. medicine).
- Some said that they would be using their physics/chemistry skills in their chosen degree and would continue to enjoy the subjects as part of their studies.
- Some explained that a pure physics or chemistry degree would be too narrow to keep them interested.
- The perception of the careers available with a physics or chemistry degree was a key factor influencing black African, Indian, Pakistani and Bangladeshi interviewees.
- The perception of career was slightly less influential for Chinese and black Caribbean students but did have a negative impact because most of the respondents were not aware of the types of career available with a physics or chemistry degree.
- Some felt physics or chemistry careers were not well paid and not that interesting, and that there were few jobs available outside teaching, laboratory work and research.
- Some felt that a physics or chemistry degree would limit their options after graduation because the field that they had studied was too narrow.
- Some, while recognising that there were many career options open to them with a physics or chemistry degree, felt that a more vocational degree, such as medicine, would offer a safer career route.
- The influence of families was stronger for Bangladeshi and Pakistani interviewees than other groups, and weaker for Chinese interviewees.
- Pakistani and Indian interviewees were more likely than other groups to be steered away from physics and chemistry careers through the influence of significant proportions of their families who were in other professions, such as medicine and pharmacy.
- Some black Caribbean and black African interviewees were told by their families that they had to work twice as hard as other groups to overcome disadvantage.

The Royal Academy of Engineering research looks into the experiences and attitudes of BME people in the workforce indicating no lack of ambition but a sense of having to leave their culture behind to succeed in the workplace and of being overlooked for promotion.

*www.raeng.org.uk/policy/diversity-in-engineering/resources#General*

Runneymede Trust found that BME students are more likely to continue their post-16 study and pursue higher education entry qualifications in further education (FE) colleges than at sixth form.

***"Widening participation and race equality"*, Runnymede Trust, 2011.**

It should also be noted that several studies have found that BME students are less likely to attend higher-tariff universities or achieve a first class degree than white students.

**Student Ethnicity, Hefce, 2010.**

Early work from Manchester University indicates that the 'value add' for UK educated BME students in UK HEIs is less than for white UK students with the same A-level scores, though the extent of the difference varies amongst universities.

*http://www-new1.heacademy.ac.uk/events/detail/2014/Seminars/STEM_PhysSci_26-02-2014*
Also at: *http://tinyurl.com/ly2ndyt*

## Lower income groups have different issues:

**Archer and Hutchings, 2000; Gorard et al, 2006; Sutton Trust, 2008; Panel on Fair Access to the Professions, 2009.**

Participation of students from lower income families remains extremely low in British universities, and has remained close to constant as a percentage of the whole for two decades. Possible reasons for the low participation of these students in higher education are that:

- Their local secondary schools are likely to have poor GCSE results.
- Their parents' lack experience of HE.
- No-one in their community is likely to have a degree.
- Research suggests a low level of expectation of the teaching body that inadvertently 'blocks' pathways to Higher Education.

## Bursaries make no difference to lower income families:

*http://www.offa.org.uk/publications/*

OFFA's reports into the impact of bursaries found that:

- Bursaries have not influenced the choice of university of disadvantaged young people.
- Applications from disadvantaged young people have not changed in favour of universities offering higher bursaries.
- Since bursaries were introduced most of the increase in participation of disadvantaged young people has been in universities offering lower bursaries.
- Bursaries do not improve retention rates.

Even when teenagers from lower income families join a university, their drop-out rate is much higher than for those with middle-class backgrounds.

**Joseph Rowntree Foundation, 2005.**

Sutton Trust (2008) recommendations for the higher education sector to address under-representation by students from lower socio-economic groups are:

- Improvements in HE-related information, advice and guidance provision in schools and colleges so that learners are aware of, and could apply to, the full range of HE provision on offer.
- HE admissions policies should be published and accessible to applicants.
- Schools and HEIs should provide every learner with an opportunity to visit an HE campus during the primary or early secondary school phases.

This is echoed by the report *"University challenge, how HE can advance social mobility"* (2012) which recommends:

- An early start, ideally before GCSE choices are made.
- A structured and sustained programme of relatively intense engagement, rather than a series of disparate and superficial interventions.
- A summer school, to allow students to experience higher education rather than just hear about it.
- An impartial approach that puts the interests of the student first, situating the choice of if and where to study at university in the context of the long-term aspirations of the individual.
- A range of options for students, rather than having a one-size-fits-all approach.
- A link between a student's participation in an outreach programme and being offered a place at university.
- A focus on both driving up attainment, as well as broadening the horizons of students, and providing clear guidance on pathways towards achieving specific ambitions.

## Lack of interest isn't the problem:

TISME research shows that a lack of interest in science is not 'the problem' underlying low post-16 participation rates. Despite liking science (and expressing an interest in further study) many young people do not plan to study science post-16 because:

- They have very narrow ideas about the 'usefulness' of science qualifications.
- They do not feel 'clever' enough to pursue post-16 science and science careers.

*http://tisme-scienceandmaths.org/the-tisme-research-projects/upmap/*

# What are the important factors in influencing choice for under-represented groups?

## Parents are significant players in career choice:

A number of reports indicate that parents and the wider family remain a key influence in career choice for many under-represented groups including girls, ethnic minorities and young people from low income families.

***"Girls in the Physics Classroom"*** **, Institute of Physics, June 2006.** ***"Science for Careers: Report of the Science & Society Expert Group",*** **Science Council, March 2010.** ***"Science for Careers: Exploring the range of role models and Case Studies in STEM careers"*****, Science Council, April 2011.**

While both Wellcome Trust and ASPIRES confirm that families constitute the greatest source of influence on 10-14 year olds' aspirations.

*www.wellcome.ac.uk/search-result.htm?q=wtp052603* **(Wave 2)**

*http://www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf*
Also at: *http://tinyurl.com/p36llo8*

The Science and Society Expert Group in Careers in STEM also noted that 'a high proportion of young people state that their parents are their greatest influence'.

**The Science for Careers Report, March 2010.**

*Public Attitudes to Science Survey 2011* highlights that 'the data suggests parents are somewhat more likely to see science as an activity for boys rather than girls, showing the need to engage parents as well as children' and recommends that it is of key importance that parents and carers are fully engaged in the decision making process.

*https://www.ipsos-mori.com/researchpublications/researcharchive/2764/Public-Attitudes-to-Science-2011.aspx*
Also at: *http://tinyurl.com/mwjqh9t*

The Department for Business, Innovation and Skills (BIS) survey of parents and 11-14 year olds indicated the most common responses to why the parents or children surveyed did not consider engineering as a career choice were that:

- They didn't know anything about engineering.
- They didn't know any engineers.
- They just hadn't considered it.

**"Attitudes to Engineering: before and after", TEW 2013, BIS 2013.**

RAEng noted a close correlation between parents' stated areas of preference for where their children would work by gender and the university subject choices made by applicants by gender. RAEng also report 73% of parents said they believed that other subjects [than engineering] offer better career opportunities for girls – despite the fact that the UK needs 1 million more engineers by 2020.

**The Queen Elizabeth Prize for Engineering: Parents Research, Royal Academy of Engineering, 2014.**

Education and Employers' Taskforce noted over half of the career ambitions of teenagers aged 13-14 or 15-16 (52% in both cases) lie in just three of the 25 broad occupational areas assessed (culture, media and sports occupations; health professionals; business, media and public service professionals). When talking to teachers, young people and parents, engineering has fallen well behind finance and law when they are asked to consider the aspirational nature of these professions. Engineering is simply not thought of in the same bracket, nor is it perceived to offer the same financial rewards, prestige, or the exciting work environment as a career in the City.

*www.educationandemployers.org/news/nothing-in-common-career-aspirations-of-young-britons-mapped-against-labour-market-demand-2010-2020/*
Also at: *http://tinyurl.com/lgkd5rk*

Both the general influence of the family on aspirations, and the correlation between family engagement in STEM and girls' choices are supported by the evidence from Ofsted in 2011.

**Ofsted – Office for Standards in Education, Children's Services and Skills (2011).**

- Only a minority of girls chose a STEM education and career path against their parents' advice.
- Of the 1,725 examples of work placements for young women, only 164 represented non-stereotypical experiences.

The Gatsby STEM Careers Review recommended that students and their parents, as well as teachers and careers advisers need much better access to information about careers and the qualifications that are needed to enter them, and to high quality labour market information (LMI).

**Gatsby Charitable Foundation, November 2010.**

The Science Council indicates that, to diversify the workforce, challenging stereotypes is a basic requirement – diverse examples will meet the needs of a wider audience. There needs to be more ethnic minority case studies and some visible role models with disability – to challenge invisibility.

***"Science for Careers: Exploring the Range of Role Models & Case Studies in STEM Careers"*, The Science Council, April 2011.**

However role models alone will not create change and solve the STEM skill shortage – they need to be part of a progressive engagement with STEM and careers.

***"The Impact Of Targeted Continuing Professional Development (CPD) on Teacher's Professional Practice in Science"*, University of York, February 2010.**

For girls, although their parents are an influence, Wellcome Trust found that *"young women are **more** likely to be concerned about science not being a field for 'people like me' than young men are".*

*www.wellcome.ac.uk/search-result.htm?q=wtp052603* **(Wave 2)**

Research for the WISE Campaign by Oglivy Change, September 2014 (unpublished) reiterates that girls at decision making age, the age when they are trying to work out what it is to be female, seek to conform to the norm and therefore seek to self-identify as 'belonging'.

**The message that few women work in science, technology or engineering makes girls think that as 'normal women' they are less likely to be happy in a STEM career.**

While parents are a significant influence, girls are aware of a wider societal discourse about the 'appropriate' roles for men and women, so that what they are being told about the opportunities to study STEM and take up careers in engineering does not sufficiently challenge their real-world experiences.

***"Going in the Right Direction? Careers guidance in schools from September 2012"*, Ofsted 2012.**

The ASPIRES study indicates the significance of 'science capital' (the extent to which the family is positive towards STEM events and careers and incorporates STEM activities into family time), on children's likelihood of seeing STEM as relevant and of value.

*http://www.kcl.ac.uk/sspp/departments/education/research/aspires/index.aspx*
Also at: *http://tinyurl.com/qjucyhh*

Positive attitudes by the family, such as that identified as 'science capital' will clearly help girls in particular to resolve the conflict between their self-identity and their perception of STEM identity and therefore more able to see STEM as **'for people like me'**.

## Conclusion 4

- **There is untapped potential in the family as an important encourager or influencer for young people, particularly in the Asian population.**
- **It is important to ensure that parents, particularly in lower income groups are aware of the full range of careers available.**
- **Mothers in particular, need to know their daughters could be happy in a career from physics/in engineering as the working environment would be supportive.**
- **For girls, in addition to parental support, they need to resolve the conflict between self-identity and STEM identity in order to see STEM as offering careers 'for people like me'.**

# 5 What can be done to make STEM qualifications and careers more attractive?

## It's clear that more of the same isn't going to work:

Changing Perceptions of Engineering ERA report by marketing agency Luther Pendragon noted that:

*'Although it is clear that the problems facing engineering are not easily resolved,* ***not one of the past or current initiatives has had the game-changing effect necessary*** *to truly shift perceptions and stimulate a much needed influx of young people into the profession. Whilst many initiatives are innovative and well received, most are only chipping away at the problem, arguably* ***appealing to too small an audience, often among those young people already receptive to the profession.****'*

*www.erafoundation.org/changing-perceptions-opening-peoples-eyes-to-engineering*
Also at: *http://tinyurl.com/po5695g*

The *"Project STEM Book of Insights, Research with young people, their parents and teachers"*, identifies the attitudes to STEM with many stereotypical attitudes still remaining despite the interventions over the past decades, most notably the attitude that STEM careers are hard, not creative and traditionally masculine and only for nerds – the concept of geek chic is not embedded in this generation despite the efforts of various organisations. The conflict between individual's self-identity and perceptions of STEM identity remains.

*www.gov.uk/government/uploads/system/uploads/attachment_data/file/351433/BIS-14-899-STEM-book-of-insights.pdf*
Also at: *http://tinyurl.com/ow8zf6j*

The Institute for Public Policy Research report *"Women in Engineering – fixing the talent pipeline"* (Sept 2014) also reiterates that the same barriers remain that have been researched for many years emphasising that approaches used to date have had no effect.

*www.ippr.org/publications/women-in-engineering-fixing-the-talent-pipeline*
Also at: *http://tinyurl.com/lezpk4k*

## Generation Y need different messages:

Sociology research identifies people born between 1980 and 2000 as Generation Y while those born from the early 60s to 1980 are Generation X. Each generation is characterised by certain values and motivators as a result of the experiences during their formative years. Most notably while Generation X (most current teachers and parents) particularly value job satisfaction, personal development and 'me time', Generation Y are motivated by fame and wealth and have a need for stimulation and constant company. Messages designed to attract Generation Y need to address their values and motivators.

*http://en.wikipedia.org/wiki/Millennials*

One US study sought to address the issues and put five of the most prevalent theories of what most increases female interest in physics:

- Discussing the under-representation of women in physics.
- Having a girls-only physics class.
- Having a female physics teacher.
- Having female scientist guest speakers in physics class (role models).
- Discussing the work of female scientists in physics class.

The study concluded that the only intervention to have a significant positive effect was **discussing the under-representation of women in physics** with these girls. Interestingly, girls-only physics classes were not effective unless accompanied by other modifications (which likely also explains why all girls-schools do so much better in physics).

**Hazari, Z. et al.** ***"Factors that affect the physical science career interest of female students: Testing five common hypotheses"*****. Physical Review Special Topics , Physics Education Research, 9, 020115, October 2013.**

## Messages have to consider self-identity:

Professor Louise Archer, Director of ASPIRES, lead coordinator of TISME noted *"Our research shows that it is harder for girls to balance, or reconcile, their interest in science with femininity. The solution won't lie in trying to change girls. The causes are rooted in, and perpetuated by wider societal attitudes and social structures."*

*http://tisme-scienceandmaths.org/the-tisme-research-projects/114-2/*

RAEng quoted a female engineer *"We are regularly bombarded with literature depicting young women in hard hats and high-vis jackets. This says to me – and I expect other women – that the sector is desperate to attract women. Instead of highlighting the problem, we need to get better at saying what's brilliant about a career in engineering, regardless of sex."*

## Perception and reality of the workplace environment are important:

There are undoubtedly issues with 'the product'. Graduate engineers often have a bumpy ride as they transition from study to work and many women report a hostile work environment created by a basic lack of female friendly facilities and a work culture which, due to its predominantly male history, is less than embracing. This can result in low levels of retention and the resulting cost of recruiting replacements.

For employers flexible working can bring increases to productivity, access to a wider talent pool and improved staff retention. For employees it brings better work life balance, including being better able to manage caring responsibilities. It's worth noting that across all sectors in the UK around 96% of employers offer some form of flexible working. Three-quarters of employees make use of some form of flexible working, with a third (32%) reporting they work part-time – the most commonly used flexible working option. A quarter of employees use some sort of flexitime and 20% work from home on a regular basis.

**Flexible working taskforce report, 2009.**

The House of Commons Science and Technology Committee report on Women in Scientific Careers 2014 indicated that companies could market themselves better *"by saying they offer good flexible working practice"*... and noted that *"many senior professionals, including scientists, lack the skills and training to be effective managers of people"*, a problem that *"should be addressed as a matter of great urgency"*.

*www.publications.parliament.uk/pa/cm201314/cmselect/cmsctech/701/701.pdf*
Also at: *http://tinyurl.com/o33d6wr*

CaSE, the Campaign for Science and Engineering, believes a change in culture is required within the workforce to remove any stigma surrounding flexible working and to ensure that those working part time or returning from a career break at every level within organisations are adequately supported and in no way penalised for their choices.

*http://sciencecampaign.org.uk/*

## What are women looking for?

Capability Jane, a recruitment agency specialising in high quality, senior flexible roles, conducted a study in which they asked what factors were a top priority when considering a job? The top five answers:

- An open and inclusive working environment.
- A challenging role.
- A positive organisation culture and values.
- Availability of flexible/part time work.
- Convenience of location.

*www.capabilityjane.com*

The NES Global Talent Survey on attracting and retaining women in the oil industry reveals that:

- 75% of women feel welcome working in the oil and gas industry yet almost half (45%) believe they do not get the same recognition as their male colleagues.
- 95% believe mentors are important for career advancement in the oil and gas industry yet 42% said they were neither a mentor nor a mentee.
- In order to attract and retain female workers, the industry needs to improve its ability to provide mentorship, recognise workers equally and highlight the benefits of studying STEM subjects in schools and universities.
- 39% of respondents would consider taking less money in return for more work flexibility, with many citing a better work life balance and spending more time with the family as the main reasons.

*www.nesglobaltalent.com*

The Atkins report on women in engineering noted that the age when the women surveyed made the decision to be engineer:

- Under 11 = 7%
- 12-14 = 18%
- 15-18 = 55%
- Post 19 = 20%

*www.atkinsglobal.co.uk/en-GB/about-the-group/our-publications*

The Atkins report indicated that the most frequently cited as reasons for choosing engineering were:

- The variety of career options and routes (62%).
- Engineering was a good route to lots of other interesting careers' (56%).
- Good employment opportunities (49%).
- The prospect of a good salary was not been as important as might be anticipated – named as a factor for just over a third of women engineers.
- 45% of women engineers were actively wanting to 'doing something different from the typical roles proposed for women'.

- Over two-thirds of women engineers reported that as a job applicant, being a woman makes no difference. • One in six (17%) believed there was an advantage and slightly fewer (13%) believed their gender had been a hindrance.
- Just under three-quarters (72%) relished receiving new challenges.
- Over half (54%) enjoyed having the opportunity to make a difference.
- For 42% becoming a chartered engineer had been a major milestone.
- 20% of female engineers interviewed work part time.
- 75% work flexibly.

The Atkins' report recommends that *"All too often we hear people talk of the "skills gap" or "gender imbalance" in engineering sectors, particularly energy. Negativity doesn't inspire people and it certainly doesn't help us address these issues. We commit to spreading the word about what a diverse and rewarding career the engineering profession can offer, armed with the many positive statistics and messages in this report."*

## The impact of stereotypes and unconscious bias:

Once girls have opted for studies in STEM there is no guarantee that they will be recruited into the STEM workforce. American research suggests both men and women view female applicants, with identical qualifications to male applicants, as being less capable and deserving a lower salary.

***"Science faculty's subtle gender biases favour male students"*, Moss-Racusin et al, PNAS, 2012.**

*EngineeringUK* statistics showed in 2011 that only **50%** of women with an engineering and technology degree work in the sector compared to 65% males.

***"An investigation into why the UK has the lowest proportion of female engineers in the EU"*, EngineeringUK, April 2011.**

## The importance of the recruitment process:

There are problems with the way that companies traditionally advertise jobs and select applicants. Research by Akzo Nobel found that it may have had trouble attracting women to work in these roles because of the language used in job ads. *"We found that if we put 'forklift truck' on the ad, we would almost instantly alienate women, but if we talked it through with them when they came to the interview, it wasn't really an issue."* The methods for attracting applicants had to be changed, too. *"In the past we would just use electronic job boards, but what we found was that once we had spoken to females about what we were trying to do, they were a lot more excited about it and a lot more keen to apply, so we've had to find ways to talk to people direct."*

*http://www.thesundaytimes.co.uk/sto/public/Appointments/article1378136.ece?utm_source=InclusIQ+Illustrated&utm_campaign=82889a395e-InclusIQ_Illustrated_Early_Summer5_28_2014&utm_medium=email&utm_term=0_19055e3039-82889a395e-152586237*
Also at: *http://tinyurl.com/ppvj7js*

NES Global Talent also noted *"Narrow mindedness in the recruitment process. Recruiters, especially for larger companies, do not recognise transferable skills. Only if you have worked in a particular specific role, or completed specific industry training will you be considered for a certain position. I think this results in the loss of very competent people from the industry."*

*http://www.nesglobaltalent.com/sites/default/files/images/women-in-engineering-report-single_final.pdf*
Also at: *http://tinyurl.com/k2yj7te*

Research on STEM students' responses to job adverts indicated that female students were less likely to apply to an advert if the company appears to be 'arrogant' as they prefer a supportive and friendly environment, if the advert is unclear about what is required as they need to be confident they can do the job and if there is no salary quoted as they lack confidence in their ability to negotiate.

*http://www.hestem.ac.uk/activity/analysis-job-adverts-and-students-reading-job-adverts-identify-barriers-students-applying-j*
Also at: *http://tinyurl.com/lmlaqnv*

## The myth of 'merit':

Recently, research from the US has emerged which suggests a more fundamental problem with merit. The "merit paradox" refers to the phenomenon whereby a focus on merit paradoxically results in more biased outcomes. Initial work on this phenomenon was prompted by the observation that many organisations have introduced performance pay and merit-based reward practices with the intention of making remuneration and advancement more objective, and minimising workplace inequity, but that these practices have not actually increased equality.

*http://asq.sagepub.com/content/55/4/543.short*

Studies established that in situations where merit was emphasised as a basis for selection and performance appraisal decisions, men were more likely to be selected, and more likely to be awarded higher salary increases, compared to equally rated women. This paradoxical effect only occurred where merit was espoused as an organisational value, and was observed in relation to both gender and race.

The most likely explanation for this effect relates directly to gender stereotypes and unconscious bias. Merit can be interpreted as "competence" or "capability" in some domain relevant to the requirements of a role. Research shows that men and women are stereotypically perceived to differ on two dimensions – women are perceived as interpersonally warmer and less competent relative to men, and men are perceived as less interpersonally warm and more competent relative to women.

## The risk of implicit association:

These perceptions form the basis of gender stereotypes and unconscious bias. Once activated, stereotypes and unconscious bias exert an irresistible influence on our decision-making, without our awareness. An emphasis on merit in decision-making simply activates the stereotype that men and women differ in their degree of competence or capability. The stereotype unconsciously influences decision making in the direction of favouring men on performance criteria that are loaded in favour of competence-related characteristics. The upshot is that an organisational process that may have been introduced to make decision-making more objective can actually have the reverse effect by activating more gender bias, and masquerading it as merit.

*http://theconversation.com/the-myth-of-merit-and-unconscious-bias-18876*
Also at: *http://tinyurl.com/mn9c6xz*

The Harvard Implicit Association Test identifies the extent of bias with respect to a range of contexts where stereotyping is prevalent.

*https://implicit.harvard.edu/implicit/*

## Understanding colleagues' views on the employment environment is essential:

Identifying the reasons why employees choose to end their employment in an organisation is crucial to identifying and challenging where poor behaviours and practices may exist. Companies should routinely conduct exit interviews and/or questionnaires with everyone leaving their employment. Careers should not be constructed in such a way that talented women are deterred from remaining and progressing in STEM.

## Conclusion 5

- **The messages focusing on what pure scientists and engineers 'do' are NOT sufficient to persuade the under-represented groups.**
- **Young people and their influencers need to be convinced that STEM careers offer what they are looking for.**
- **Employers need to ensure they DO provide a supportive work environment with flexible working to retain the best talent.**
- **To recruit and retain the best, employers need to ensure that unconscious bias is not influencing their recruitment and promotion processes.**

# 6 What works and what doesn't in schools?

## One-off interventions don't work:

There is evidence from Nuffield and Gatsby suggesting that 'one-off' interventions on their own have little long-term or widespread impact on science choices and participation rates. Instead, there is evidence to suggest the value of more sustained activity to integrate science careers awareness into the mainstream science curriculum.

**STEM Careers Review, Gatsby Foundation, 2010.**
**Practical work for learning: *"Science in the workplace – Research summary"*, Nuffield Foundation, 2012.**

Ofsted (2011) also found that impact of interventions was more effective in an on-going arrangement rather than a one-off activity.

*www.ofsted.gov.uk/resources/girls-career-aspirations*

## Untrained people can be a risk:

The Royal Academy of Engineering noted that *"whilst many of the major engineering companies and institutes run school outreach programmes, these often see an individual with a particular expertise give a talk that is likely only to appeal to a very small percentage of the class. By allowing untrained and narrowly prepared speakers to address this key audience, it could be that these outreach programmes are doing more to discourage prospective engineers than to incite the intended excitement and interest"* and that *"Parents have a huge role in influencing the career choices and aspirations of their children – a fact that to date has not been reflected in the outreach and engagement programmes run by the engineering industry. Mothers in particular wield significant power in directing their daughters down specific career paths."*

The Changing Perceptions of Engineering report (ERA) recognised the need for any communications strategy to look at all the influencers, rather than choosing to focus just on those within the education system. *"We need to start talking to young people in a language and location that resonates with them, using examples that seek to excite as broad a range of audiences and influencers as possible"*.

*http://www.erafoundation.org/changing-perceptions-opening-peoples-eyes-to-engineering/*
Also at: *http://tinyurl.com/po5695g*

There is also a need to move beyond thinking of work experience as a one or two-week spell at age 14–16 to a broad and varied series of engagements, such as workplace visits, mentoring, mock interviews, competitions, project activity and careers advice.

**UKCES 2012.**

## Girls don't need competitions:

The Churchill Fellowship reported that girls don't need competition to thrive. *"Girls can thrive on collaborative and mission-based tasks that have goals to accomplish and achieve. Girls will generally take longer because they do things properly whereas the boys think things are 'good enough'. If you told the students to get their robots to form a square the boys would be happy to get the gist of the task and move on to the next activity even with an imperfect square. Girls on the other hand, are more likely to keep labouring on with the task until their robot draws a perfect square. The boys race ahead in a class. The girls think they're not as good as the boys and lose self-esteem in technical abilities. Boys are less worried and self-conscious about getting stuff wrong"*.

Thus activities that are intended to encourage girls to consider STEM careers need to take this difference in approach into account and not to rely on competitions as the motivator as the subliminal message that girls take away, on losing, that girls are not good at STEM will reinforce the gender stereotypes, confirm their self-identity as 'not STEM' and lead them away from STEM.

A Science Centres report recommends:

- Girls work best in girl-only events with female-only experts.
- Girls are sensitive to the physical environment and how it looks (e.g. is it dirty?).

*http://sciencecentres.org.uk/reports/underserved/UK%20Science%20and%20Discovery%20Centres%3b%20Effectively%20engaging%20under-represented%20groups%20(May%207%202014).pdf*
Also at: *http://tinyurl.com/l8bcuxg*

# The importance of self-identity and 10 types of scientist

## Innate abilities, aptitudes and self-identity:

There is much social science research on identity formation which indicates that a student's identity affects his/her interests and motivations. STEM identity is particularly influenced by the fact that scientists are seen as typically male, white, and middle class so there is an identity conflict for those students whose self-identity does not readily fit with the categories of male, white, or middle class.

Brickhouse, N.W., Lowery, P., Schultz, K. (2000).

*"What kind of girl does science?"* The construction of school science identities. Journal of Research in Science Teaching, 37(5), 441-458. Carlone, H.B. (2004).

*"The cultural production of science in reform-based physics: Girls' access, participation, and resistance"*. Journal of Research in Science Teaching, 41(4), 392-414. Carlone, H.B. and Johnson, A. (2007).

*"Understanding the science experiences of successful women of color: Science identity as an analytic lens"*. Journal of Research in Science Teaching, 44(8), 1187-1218. Hazari, Z., Sonnert, G., Sadler, P.M., and Shanahan, M.C. (2010).

*"Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study"*. Journal of Research in Science Teaching, 47(8), 978-1003. Painter, J., Jones, M.G., Tretter, T.R., and Kubasko, D. (2006).

*"Pulling back the curtain: Uncovering and changing students' perceptions of scientists"*. School Science and Mathematics, 106(4), 181-190. Polman, J.L. and Miller, D. (2010).

*"Changing stories: Trajectories of identification among African American youth in a science outreach apprenticeship"*. American Educational Research Journal, 47(4), 878-918.Robnett, R. (2013).

*"The role of peer support for girls and women in the STEM pipeline: Implications for identity and anticipated retention"*. International Journal of Gender, Science, and Technology, 5(3), 233-253. Syed, M. (2010).

*"Developing an integrated self: Academic and ethnic identities among ethnically diverse college students"*. Developmental Psychology, 46(6), 1590-1604. Wortham, S. (2006).

*"Learning identity: The joint emergence of social identification and academic learning"*. New York: Cambridge University Press. AWE, 2008.

Assessing Women and Men in Engineering website. *www.engr.psu.edu/awe/secured/director/precollege/pre_college.aspx* Also at: *http://tinyurl.com/olo5kq2*

*"Unpacking Secondary School Students' Identity Negotiations Regarding Science and Engineering: A Case Study in the United States"*. Vol 6, No 3 (2014). *http://genderandset.open.ac.uk/index.php/genderandset*

As noted above ASPIRES identified the importance of girls' self-identity, which is helped by a family's science capital, as a significant element in their subject and career choices.

*http://tisme-scienceandmaths.org/the-tisme-research-projects/114-2/*

Individuals develop a sense of self-identity progressively. However, there is a tendency, at least in the UK, to ascribe aptitudes to inheritance even though research shows that environment is a significant influence.

*http://www.telegraph.co.uk/science/science-news/10631319/Is-intelligence-written-in-the-genes.html*
Also at: *http://tinyurl.com/llvb5jw*

Research also shows that, on average, women self-identify using adjectives: helpful, organised, friendly, shy – while men self-identify through activities with which they are involved: jobs, hobbies and interests. Furthermore, men get their buzz in the work environment from an output of their work – a product or achievement (the definitive research paper or sale or deal), while women often express job satisfaction coming from the outcome of their work: the process and its impact on or benefit for others e.g. researching, educating.

Fotaki, M, & N. Harding (2013) *"Lacan and sexual difference in organization and management theory: Towards a hysterical academy?"* ORGANIZATION, Volume: 20, Issue: 2 Pages: 153-172.

Fotaki, Marianna (2013). *"No Woman is Like a Man (in Academia): The Masculine Symbolic Order and the Unwanted Female Body"*. ORGANIZATION STUDIES, 34 (9) 1251-1275.

## The self-identity: STEM identity conflict

Many of the current STEM interventions are based on a very limited range of activities and types of careers, for example the archetypal scientist in a lab or the archetypal engineer building bridges or things that fly. However this misrepresents the range of activities undertaken by people with STEM qualifications in the STEM workforce. It also only really engages those who self-identify as doers – using verbs – and seek an output of their occupation (on average males). It doesn't engage those who seek to understand and identify with the sort of people who do those jobs – those who self-identify using adjectives – and seek job satisfaction from the impact of their work on others (on average females). Only by enabling students to reconcile their self-identity with a STEM-identity will they see STEM as **'for people like me'**.

## 10 types of scientist

The Science Council's report (2011) identified 10 types of scientist, which each requires a different range of skills beyond the technical knowledge and the broader 'transferable' skills often referred to as employability skills. These types of scientist are also different types of people – and may be the 'people like me' that students from under-represented groups identify with.

*http://www.sciencecouncil.org/10-types-scientist*

| Type of scientist | People like me? |
|---|---|
| **Explorer** | People who like to research and seek out new knowledge – the pure scientist undertaking blue skies research – often preferring to work alone and likes to have a really deep knowledge of their specialist subject. |
| **Investigator** | People who are logical and like to piece information together to find the answer – often work in a team so need to get on with other people and be able to listen and understand others' ideas. Need to be able to understand a range of topics and see how they fit together. |
| **Developer/ translational** | People who are creative and imaginative and like to see the potential of an idea and working out how something could be made better to benefit people. The applied scientist or engineer. Needs to be good at empathising with people and understanding what they need to make their life better. |
| **Service provider/ operational/ project management** | People who are organised and like to provide a service to help other people such as forensic science or food analyst. Need to be good at communicating with customers to understand what they need and then able to work in an organised way, or as a project manager. Be good at organising and motivating others to work efficiently, to provide what customers want on time and within a budget. |
| **Monitor/ regulator** | People who have an eye for detail and safety. They like to be sure that everything is safe, legal, honest and conforms to the regulations so that the public is not put at risk and can trust the science and scientists. Needs to be able to spot risks, errors and unforeseen consequences. Might also need a legal knowledge and work as a patent attorney. |
| **Entrepreneur** | People who think laterally and like the idea of taking a new idea to market – they are good at having ideas and can empathise with people so know that their new product or service will be something customers will want. Has also got to be good at organising people and able to understand the financial side of business. |
| **Communicator/ linguist** | People who can empathise with different audiences, who have the combination of scientific or technical knowledge and can write or speak effectively to a range of audiences. This could be useful in journalism, technical writing or TV work. There is a need for people with scientific knowledge who can translate documents into a second language. |
| **Teacher** | People who want to give others the opportunity to understand science and, possibly help them have a career in science. They have scientific knowledge and are skilled in explaining ideas to other people from young children in primary school to university students. |
| **Business/ marketing** | People who are persuasive and can understand what will make others want to buy a product or service. They need to have creative ideas to persuade potential customers. They also have to be organised to work efficiently to deadlines and understand people so that they have customer awareness. |
| **Policy maker** | People who are good at working with and explaining things to others who are not scientists (perhaps politicians). They need a good eye for detail, the ability to find information and write helpful reports in order to make sure that government policies are based on good science evidence so that government spends money sensibly. |

Currently, information in schools about careers in STEM tends to emphasise what the individual will do and makes no reference to the type of people that are suited to the roles. This is contrary to the practice found in many companies which emphasise the need to match individuals aptitudes to their roles, often using well established analytical systems such as the Myers Briggs analysis to enable employees to self-identify. This process is also recognised as enabling employees to understand and be more tolerant of colleagues with different traits.

*http://en.wikipedia.org/wiki/Myers-Briggs_Type_Indicator*

## Resolving the Self-Identity/ STEM-Identity conflict:

To engage under-represented groups, particularly girls, we need to:

- Give students messages that allow them to resolve the conflict between their self-identity and their perception of the STEM-identity.
- Use adjectives to describe the sort of people – their aptitudes – who work in STEM, as well as explaining what engineers 'do', using verbs.
- Talk to parents and students about the wide range of careers in STEM-based businesses – the 10 types of scientist – and not just the standard engineers and scientists.

## Conclusion 6

- **One-off interventions don't work – consistent approaches are essential.**
- **Initiatives that seek to 'encourage' girls into STEM are misplaced.**
- **The evidence is that girls are making entirely logical careers choices based on the information available.**
- **There should be NO implication that girls must change.**
- **The needs of girls and young women, including supportive employment conditions and the ability to progress while working part time, must be consistently embedded into all messaging from the STEM sector.**
- **Above all girls need to be able to self-identify that 'STEM is for people like me'.**

- **There are 10 types of scientist requiring differing aptitudes.**
- **We should describe the 'person spec' as well as the 'job spec' of roles in STEM when talking to young people. Use adjectives as well as verbs when talking to students.**
- **Emphasising the 'types of people' that are successful in the range of STEM careers would address the concern, particularly amongst girls, that STEM careers are 'not for people like me'.**
- **Enable under-represented groups to resolve the conflict between self-identity and STEM identity and allow them to see STEM careers as 'for people like me'.**

Appendix

# Recommendations from WISE about what works for girls

WISE has concluded that girls, parents and teachers do not know about:

- **The demand for people with engineering and technology qualifications.**
- **The variety of roles available.**
- **The attractive pay and prospects – especially compared to female-dominated careers.**
- **The different routes to qualification.**

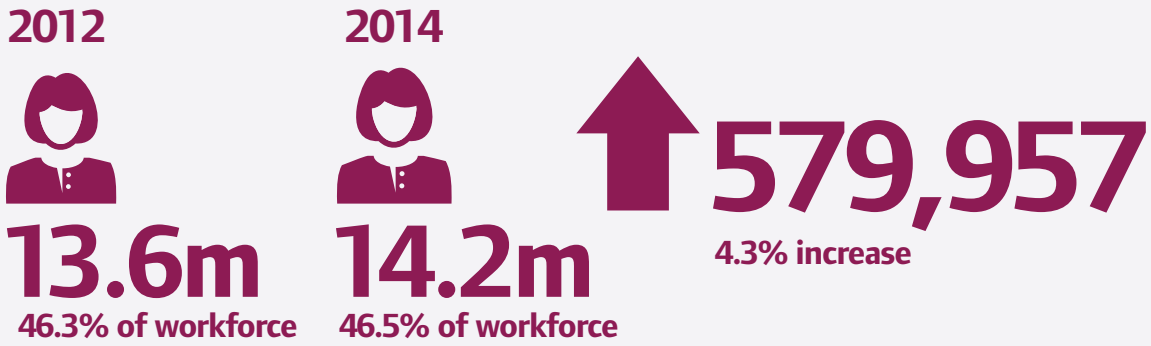
So most choose what they do know.

WISE has concluded that approaches that work include:

- **Emphasise the values and benefits which girls (and their families) care about.**
- **Emphasise the 'types of people' that are successful in a range of STEM careers.**
- **Emphasise the 10 types of scientist rather than archetypal representations.**
- **Provide opportunities to meet a range of young female role models from similar backgrounds – girls don't want to be the odd one out and high flying role models can be daunting.**
- **Offer workplace experience /taster days – particularly girls only events.**
- **Discuss the social pressures that result in stereotypical careers choices.**
- **Offer peer support and mentoring.**
- **Explain what university is for those who don't know – don't assume that all students have the same background knowledge.**
- **Show that there are vocational routes leading to technician and apprenticeship jobs as a positive alternative or stepping stone into higher education.**
- **Communicate with parents who are significant influencers. Use information about the demand for STEM skills and qualifications, particularly the commercial value of mathematics and science qualifications, so that young people and their parents understand that taking these subjects will improve future job prospects. For example, not everyone understands that you can go from taking science at school to an exciting career in broadcast engineering, advanced manufacturing, covert surveillance, robotics, or computer gaming.**
- **Support teachers through CPD on STEM careers and visits or secondments into industry – most teachers have no experience of the commercial/ business world.**
- **To recruit women, employers should use job adverts that state the context – the 'why' or the 'so what' of what you do along with comments about the friendliness of the workplace and a clear salary offer.**
- **To retain women, ensure there is a clear career path for those who work flexibly or part time with recognition and reward based on quality of work and not length of day worked.**

# Women working in STEM: the changes from 2012 to 2014

## Total women in the UK workforce




## Women in STEM occupations

## Engineering professionals

## ICT professionals

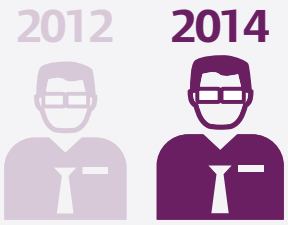
Women
3.5%
to 124,494

Men
7%
to 722,681

Women make up only
15%
of this sector

## ICT technicians

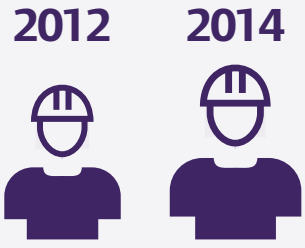
Women
16%
to 39,990




Men
4%
to 146,414

Women make up
21.5%
of this sector

## Science, engineering & production technicians




178,928 202,079

Men
13%

63,367 57,002

Women
10%

**Source:** WISE analysis of Labour Force Survey, April - August 2014.
*www.wisecampaign.org.uk/about-us/wise-resources/uk-statistics-2014/september-2014*

NetworkRail

www.networkrail.co.uk

SEPnet

South East Physics Network

www.sepnet.ac.uk

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