

THROUGH BOTH EYES

THE CASE FOR A GENDER LENS IN STEM



**SCIENCE
GRRL**

‘THINK OF A GENDER LENS AS PUTTING ON SPECTACLES. OUT OF ONE LENS OF THE SPECTACLES, YOU SEE THE PARTICIPATION, NEEDS AND REALITIES OF WOMEN. OUT OF THE OTHER LENS, YOU SEE THE PARTICIPATION, NEEDS AND REALITIES OF MEN. YOUR SIGHT OR VISION IS THE COMBINATION OF WHAT EACH EYE SEES.’



CONTENTS

| | |
|--|-----------|
| EXECUTIVE SUMMARY | 4 |
| 1.0 INTRODUCTION | 7 |
| 2.0 CHALLENGES | 8 |
| 3.0 SOLUTIONS | 23 |
| SIR PETER LUFF MP: A CALL TO ACTION | 49 |
| REFERENCES | 50 |
| AUTHORSHIP & CREDITS | 51 |

'THE COUNTRY URGENTLY NEEDS MORE YOUNG PEOPLE WITH STEM QUALIFICATIONS, WHICH MEANS WE HAVE TO GET MORE GIRLS AND WOMEN INVOLVED. THIS SHOULD BE AT THE HEART OF EDUCATION AND SKILLS POLICY - IT ISN'T AN OPTIONAL EXTRA LEFT TO A FEW PASSIONATE ENTHUSIASTS. WE HAVE TO MAKE IT EVERYONE'S BUSINESS'

HELEN WOLLASTON, DIRECTOR WISE

'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. WE ALSO NEED TO THINK ABOUT THE WHOLE STRUCTURE OF OUR EDUCATION SYSTEM IN ENGLAND, WHICH ESSENTIALLY CHANNELS CHILDREN INTO NARROW 'TRACKS' FROM A YOUNG AGE'

PROFESSOR LOUISE ARCHER, DIRECTOR OF ASPIRES, LEAD COORDINATION OF TISME

'THE LACK OF GIRLS AND WOMEN IN STEM BLIGHTS OUR SOCIETY AND OUR ECONOMY. THERE IS NO SINGLE SOLUTION, WHICH IS WHY I AM GLAD TO SEE THAT SCIENCEGRRRL HAVE COME FORWARD WITH A WIDE RANGE OF RECOMMENDATIONS COVERING EDUCATION, CAREERS AND THE BROADER CULTURAL CHALLENGES'

CHI ONWURAH, MP FOR NEWCASTLE UPON TYNE

'WE ARE WORKING TO MAXIMISE EMPLOYER ENGAGEMENT TO HELP PUT SCIENCE AND MATHS IN A CAREERS CONTEXT. WE WANT TO SHOW WHAT STEM CAN OFFER, AND EMPOWER A NEW, FAR MORE DIVERSE GROUP OF YOUNG PEOPLE TO REACH THEIR POTENTIAL. I'M REALLY LOOKING FORWARD TO WORKING WITH SCIENCEGRRRL TO LOOK AT SYNERGIES BETWEEN PROGRAMMES TO BUILD SCALE AND IMPACT'

PAUL JACKSON, CEO ENGINEERINGUK

'GIRLS' UPTAKE OF SCIENCE, MATHS AND TECHNOLOGY INCREASES SIGNIFICANTLY WHEN THESE SUBJECTS ARE PRESENTED AND TAUGHT BY WOMEN WHO CARE PASSIONATELY ABOUT STEM AND WHEN CURRICULUM CONTENT PROMOTES THE ACHIEVEMENTS OF WOMEN IN STEM RESEARCH AND DEVELOPMENT. I STRONGLY BELIEVE THAT WE NEED ACTION ON GENDER EQUALITY IN SCHOOL CULTURE AND IN TEACHER TRAINING'

DR VANESSA OGDEN, HEADTEACHER & COFOUNDER GENDER EDUCATION ALLIANCE

'WE WANT TO SEE GIRLS CLAMORING TO GET INVOLVED IN ENGINEERING AND SCIENCE CAREERS. WE WOULD BE DELIGHTED TO PARTNER WITH SCIENCEGRRRL AND OTHER INITIATIVES TO HELP ACHIEVE THIS VISION'
DR PENNY FIDDLER, CEO THE UK ASSOCIATION FOR SCIENCE AND DISCOVERY CENTRES

EXECUTIVE SUMMARY

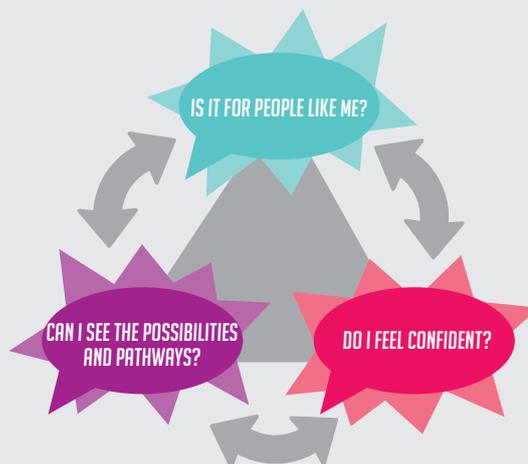
1. It is old news that women are still vastly underrepresented in leadership positions in science, technology, engineering and mathematics (STEM) – and that in areas like physics and engineering, girls and young women aren't even getting a foot in the door. The percentage of female A-level physics students has hovered around 20% for the past 20 years or more, and the UK has the lowest proportion of female engineers in the EU.
2. There is broad recognition that girls and women represent untapped talent, and that enabling them to realise their potential is as much about growing the UK economy as it is about social justice. Why then, despite widespread concern, is progress frustratingly slow?
3. **SCIENCEGRRRL** has looked to the literature and spoken to stakeholders in the STEM sector to explore this question with respect to access to STEM; we plan to examine career progression at a later stage. We find that girls and young women are being kept out by the cultural straightjackets imposed upon them by society. In this report, we use a 'gender lens' to reveal how cultural messages translate into invisible hurdles that are holding girls back and limiting their personal, and earning, potential:

'Think of the gender lens as putting on spectacles. Out of one lens you see the participation, needs and realities of women. Out of the other you see the participation, needs and realities of men. Your sight or vision is the combination of what both eye sees.' – UNESCO (2006)

4. Our society isn't neutral, it is highly gendered. The reason these hurdles are invisible is that they are so deeply embedded. We must look through both eyes to detect the unconscious biases that permeate our society, homes, classrooms and workplaces before we can start to dismantle them. Empowering individuals with real choice and freeing ourselves from social stereotyping and cultural expectations is better for girls and women, but also for boys and men.
5. So, how do we begin to address this? When it comes to choosing STEM at school, university or as a career, the literature is clear that there are three key factors. We have framed them as a mental checklist that applies to all students, regardless of gender:

- i. Relevance of STEM = Is it for people like me?
- ii. Perceived ability = Do I feel confident?
- iii. Science capital = Can I see the pathways and possibilities?

'STEMNET CONTINUALLY SEEKS TO LEARN AND IMPROVE ITS ESTABLISHED SERVICES, AND WORKS WITH PARTNERS TO INSPIRE YOUNG PEOPLE. THE ENTHUSIASTIC TEAM AT SCIENCEGRRRL BRING A NEW PERSPECTIVE, AND WE LOOK FORWARD TO REVIEWING THE FINDINGS OF THEIR REPORT AND CONSIDERING HOW WE CAN ALL FURTHER INCREASE AND IMPROVE STEM ENGAGEMENT IN THE UK'
KIRSTEN BODLEY, CEO STEMNET



6. Young women receive messages about themselves and the opportunities available to them from wider society, family and friends, the classroom and the workplace. The balance of these messages is crucial. The 'girls' toys' that value physical perfection over adventure or intelligence, and the objectification of women in the media are just two examples of how the roles and capabilities of women are diminished in wider society. We are all exposed to these messages. Casual reliance on such stereotypes leads to unconscious bias in all areas of girls' lives. If this is left unchallenged, girls and young women find their cultural straightjackets tightened and they are less likely to say 'YES' to STEM. Stereotypes and unconscious bias undermine real choice. We must start to take them seriously.
7. STEM also suffers from a stereotype that says it belongs to those who are 'white, middle class, male and brainy'. We argue that we must challenge these two competing stereotypes, not conflate them. We don't need to make STEM about lipstick, or make girls and women feel they have to conform. Instead, the solution is to make STEM inclusive by showing that it is about creativity, imagination, changing the world, and that it offers a wealth of opportunity – that there are many ways into STEM, and even more ways to go forwards. Gender is only one aspect of the STEM stereotype, and so an active focus on busting the stereotype open has positive implications for widening the talent pool by appealing to a diverse range of identities.
8. Initiatives that seek to 'encourage' girls into STEM are misplaced. The implication is that girls must change. Instead, we believe the responsibility for closing the STEM gender gap should be placed on the people who have influence in our society and education system. Girls are treated differently in the classroom and careers advice is far from actively inclusive. This separation of girls and young women from the mainstream is the fundamental roadblock.
9. Progress will require integration on two levels. Firstly, the needs and realities of girls and young women must be consistently embedded into all messaging from the STEM sector. Secondly, we need cohesion between the stakeholders attempting to address this problem. In writing this report we have encountered a cacophony of initiatives and organisations, who are often trying to achieve everything alone without taking advantage of tremendous potential for synergy. We are calling on the STEM sector to re-evaluate opportunities for collaboration.
10. We call on the Government to show leadership in this field. There is a wealth of academic knowledge about gender science and gender equality; this needs to be integrated into public policy. We want Government, and the public and the private STEM sectors to work together to empower individual free choice.
11. We see this report as an opportunity to start a conversation between the Government, academics, educators, the STEM community, retailers and the media about how we start to look through both eyes in order to embed gender equality and broader inclusion issues into better STEM education and careers advice for everyone.

'WE ARE LOSING HIGHLY TALENTED YOUNG WOMEN BECAUSE WE ARE FAILING TO ENGAGE THEM IN EDUCATION. SCIENCEGRRRL DO A GREAT JOB, ACTING AS ROLE MODELS, RAISING IMPORTANT QUESTIONS - AND SUGGESTING ANSWERS. I FULLY SUPPORT THIS INITIATIVE TO FIND A WAY TO HELP YOUNG WOMEN REACH THEIR FULL POTENTIAL IN THESE FIELDS'

JULIAN HUPPERT, MP FOR CAMBRIDGE

'THE WORK SCIENCEGRRRL HAS DONE TO HIGHLIGHT GENDER IMBALANCE IN STEM HAS BEEN INVALUABLE. NOW, HOWEVER, THE TIME HAS COME TO STOP IDENTIFYING THE PROBLEM AND START DEVELOPING THE SOLUTIONS. I AM THEREFORE DELIGHTED THAT 'THROUGH BOTH EYES' DOES EXACTLY THAT, THIS IS A DOCUMENT THAT HAS THE POTENTIAL TO REALLY DELIVER THE CHANGE WE NEED AND WANT, BECAUSE UNTIL WE DO, WE ARE ONLY SEEING HALF THE PICTURE!'

STEPHEN METCALFE, MP FOR SOUTH BASILDON AND EAST THURROCK

'SCIENCEGRRRL HAVE COME UP WITH A REALLY IMPORTANT SET OF FINDINGS. I HOPE THAT WE CAN BUILD RELATIONSHIPS WITH OUR PARTNERS TO MAKE THE RECOMMENDATIONS A REALITY. WE'LL HAVE SUCCEEDED WHEN SCIENCE BECOMES AS DIVERSE AS THE REST OF OUR SOCIETY'

IMRAN KHAN, CEO BRITISH SCIENCE ASSOCIATION

RECOMMENDATIONS

1. Leadership on gender equality

Cultural straightjackets are reinforced by stereotypes and social structures. This has long been debated and challenged in the academic literature. We want Government to explicitly support the translation of such literature into public policy – from teacher training, to a 'duty of care' in marketing and retail, to workplace structures.

Owner: Number 10 Policy Unit, Government Equalities Office

Partners: Department of Business, Innovation and Skills (BIS), British Retail Consortium, Scientific Institutions, Academics, teaching specialists, RCUK, Grassroots campaigns and charities, Equality Challenge Unit

2. Rebranding STEM

We would like to see a campaign that is focused on breaking down the STEM stereotype. We believe that current plans for a National campaign to attract women into STEM should use this approach.

Owner: No 10 Policy Unit, BIS, Department for Education (DfE).

3. Role models

We recommend creative partnerships that aim to raise girls' confidence and their families' and teachers' expectations through showcasing non-stereotypical careers, female role models and non-traditional male role models.

Owner: Government Equalities Office, BIS, STEMNET

Partner: ScienceGrrl, Girlguiding, UK Association of Science and Discovery Centres, WISE, WES

4. STEM mentoring and sponsorship

We believe effort must go into increasing and consolidating links between the STEM sector and schools. These provide genuine opportunities for progress. We recommend STEM Ambassador 'Buddy Schemes' for teachers.

Owner: STEMNET, BIS

Partners: The Girls Network, Social Mobility Foundation, FutureFirst, ScienceGrrl, Inspiring the Future, STEM Employers, RCUK, schools, CASinclude

5. Bringing the gender lens to teaching

Teachers' unconscious bias impacts upon girls in the STEM classroom, and on boys in other subjects. We recommend equality and inclusion training be mandatory for teacher training. Funding for leadership positions in schools that have the explicit responsibility of embedding gender equality into a whole school ethos should be considered. We support recommendations that gender equality should be part of the Ofsted inspection criteria.

Owner: DfE, schools, Ofsted, National STEM Centre,

Partners: Academics, Scientific Institutions, Gender Education Alliance, TeachFirst, Science Learning Centre, The Girls' Network, Institute of Physics

6. Primary school science

Identifying with STEM is key to pursuing it and identities develop early. We recommend proactive STEM sector support of primary schools, and increased funding for such initiatives. We support recommendations to incentivise recruitment of specialist teachers.

Owners: BIS, STEMNET

Partners: Funding bodies, Primary School enhancement and enrichment specialists, Tomorrow's Engineers, British Science Association (BSA)

7. Bringing the gender lens into the curriculum

Female scientists and engineers are largely hidden in our society and this influences girls' identity. We recommend a diversity review of STEM curriculum that includes topics covered, pedagogy and assessment, the inclusion of women and non-stereotypical STEM careers.

Owner: DfE

Partners: Academics, Scientific Institutions, Gender Education Alliance

8. Support project based, creative & real world learning

Liking STEM isn't enough: students must engage with it and see how it is relevant to their identity and future. We recommend continued and increased support for the CREST Awards, Tomorrow's Engineers, The Big Bang Near Me scheme and STEM Clubs. These stakeholders must collaborate more effectively and we recommend an open data pledge and progress meetings to capitalise on opportunities for synergy. We recommend that local employers are encouraged to support these schemes.

Owner: BIS, BSA

EngineeringUK, STEMNET

Partner: STEM Employers (public & private sector), DfE

9. STEM resources: technical routes

Cultural straightjackets are restrictive when it comes to following technical routes like apprenticeships and University Technical Colleges, and particularly so for young women. We recommend gender-aware training for teachers to raise the profile of such routes.

Owner: BIS, National STEM Centre, National Science Learning Centre and teaching specialists

10. Unifying the STEM ecosystem

Mechanisms that provide STEM education and careers advice are disjointed. We recommend more rigorous investment in developing core principles for enhancement and enrichment activities and their metrics, based on the RCUK Concordat on Engaging the Public with Research and UK Science and Society Charter. We recommend seeking public and private sector signatories to such a document. The Government should encourage and incentivise collaboration using various tools from procurement and funding processes to policy incentives and kite marks.

Owners: DfE, BIS, RCUK

Partners: STEM Sector

11. Leadership on careers advice

There are currently insufficient resources to fully devolve responsibility of careers advice to schools – a transition plan is needed. We recommend that DfE leads on a clear framework that unifies careers messages across the sector and that this is embedded into teaching using input from BIS on good practice in work-related learning. These messages should include: earning potential; marketability of STEM skills; and that STEM is creative and imaginative, has societal impact and offers diverse opportunities. Lastly, technical and academic routes must be given parity. We recommend this framework be delivered to schools as a single 'STEM careers framework' through DfE.

Owner: DfE

Partners: BIS

'It isn't possible to compartmentalise 'types' of sexism, the ideas and attitudes about women that underlie everyday street harassment are the same attitudes that facilitate injustice in the workplace and wider society. It will not work to fix the underrepresentation of women in business if the media continues to portray women as dehumanised sex objects'

LAURA BATES, THE EVERYDAY SEXISM PROJECT

1.0 INTRODUCTION

SCIENCEGRRRL is a new, grassroots movement springing from a collective feeling that something has to change about the representation of girls and women in Science, Technology, Engineering and Maths (STEM) and in wider society. We launched our 2013 **SCIENCEGRRRL** calendar as a visual response to the EU Commission's decision to advertise their 'Science: it's a girl thing' campaign with a [pseudo-pop video](#). We asked ourselves why, when discussing scientific careers, it felt normal and appropriate to slip into imagery that reduced women to their looks – and more worryingly, their sexual appeal? Where were the real, complex women we meet every day? Our calendar was a deliberately visual project – our attempt to start to redress the totally imbalanced way women are represented in the media today. It should be simple: women are not a homogenous group and neither are scientists, so let's showcase that diversity. It's time to treat women as individuals – and with respect.

SCIENCEGRRRL is now growing as a membership organisation across the UK and our vision is for a world where access to a fulfilling STEM career is decoupled from gender, however gender is defined. To get there we amplify our members' voices through our networks and harness their passion by creating opportunities within existing local frameworks, enabling them to become accessible role models for the next generation. We believe that STEM is for everyone, and that **SCIENCEGRRRL** can help showcase the variety of opportunities that arise from following this path.

There is a need for **SCIENCEGRRRL** because women are still underrepresented in leadership positions in these fields, and in areas like physics and engineering young women are being prevented from even getting a foot in the door. We've chosen some statistics (WISE 2012; IoP 2012) to illustrate this problem – for example, the percentage of A-level physics students who are girls has stayed at around 20% for the past 20 years or more – but our point is that these aren't new shocking facts. This is old news. There is broad recognition that women represent an untapped resource for the STEM sector and that allowing girls to realise their potential is as much about good business sense as it is about social justice. Why then, despite widespread concern, is nothing much changing?

We suggest that this is because the need to challenge pervasive unconscious biases and stereotypes is largely only ever given lip service – if that. Undermining cultural messages and social norms represent invisible roadblocks to the success of girls and women. Such barriers are invisible precisely because they are so deeply embedded.

Action should be positive and collaborative but it's also time to stop talking and take these cultural messages seriously. We must raise awareness about where undermining stereotypes come from, how they affect us and then we must start to challenge them. If we want equality in STEM, if we want equality anywhere, then we need to face facts: we need to start changing our society.

5.5%

OF ENGINEERING PROFESSIONALS

13%

OF THOSE WORKING
IN OCCUPATIONS
CLASSED AS STEM

1%

OF APPRENTICESHIPS IN
CONSTRUCTION, PLANNING
AND THE BUILT ENVIRONMENT

~20%

OF A-LEVEL PHYSICS STUDENTS,
UNCHANGED FOR 20 YEARS

WE SEE THIS REPORT AS AN OPPORTUNITY TO START A CONVERSATION ABOUT HOW WE TRULY EMBED GENDER AWARENESS AND BROADER DIVERSITY ISSUES INTO BETTER STEM EDUCATION AND IMPROVE CAREERS ADVICE FOR EVERYONE

SCIENCEGRR! wants girls and women to feel they have a 'right to be there' when it comes to traditionally male domains and this needs action at all levels of society, education and careers. Whilst a detailed review of workplace culture is out of the scope of this report it is critical to recognise its influence on career choice and progression. For example, we support initiatives that encourage good practice on workplace diversity such as the [Athena Swan Charter](#), the [Daphne Jackson Trust](#) and efforts to ensure equitable hiring and promotion practice.

The scope of this report is to examine the challenges facing girls and young women from an early age and up until the time they decide whether or not to pursue. It goes on to review current solutions to addressing female underrepresentation. Our approach was informed by a strong commitment to explore what is happening on the ground through a literature review and consultation with core stakeholders. It has proved to be a useful strategy and has revealed that these solutions rarely engage with academic literature and rarely embed gender equality into mainstream practice. Women and girls are so conspicuous in their absence that we feel compelled to talk of gender-blindness.

This gender-blindness must be corrected as a matter of urgency and requires all STEM advocates to consider the participation, needs and realities of women. They must proactively use the gender lens to look 'through both eyes'. UNESCO (2006) explains the gender lens as follows:

'Think of the gender lens as putting on spectacles. Out of one lens you see the participation, needs and realities of women. Out of the other you see the participation, needs and realities of men. Your sight or vision is the combination of what both eye sees.'

In this report we use the gender lens to make recommendations that we believe will accelerate substantive and sustainable change. For practical purposes we have assigned 'owners' and 'partners' to our recommendations, we feel that the organisations named have the power and capability to lead a discussion in these areas, but acknowledge that other stakeholders will also benefit from inclusion. We believe that viewing STEM education and careers through this lens can form the foundations for a gender-aware, collaborative approach and we call on education providers, enhancement and enrichment specialists, careers advisers, employers and Government to approach their work looking through both eyes. Importantly, we see this report as an opportunity to start a conversation about how we truly embed gender awareness and broader diversity issues into better STEM education and careers advice for everyone.

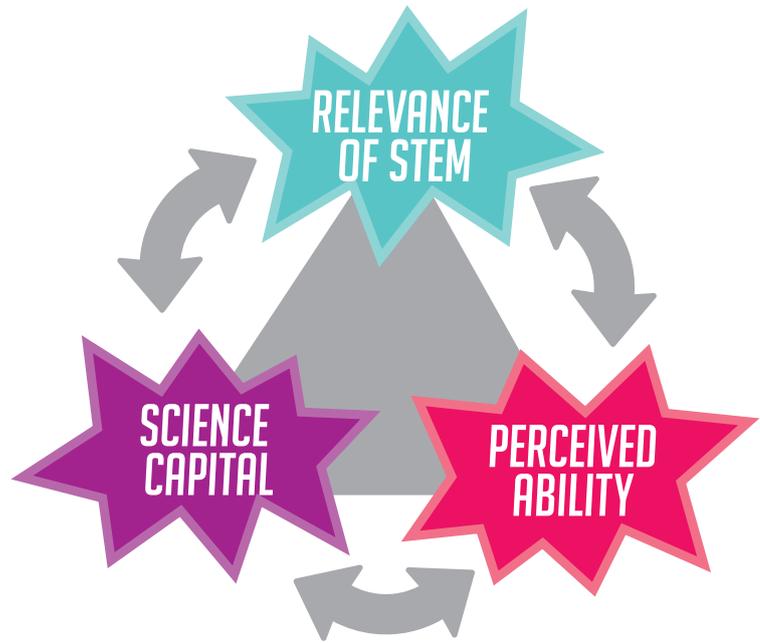
2.0 CHALLENGES

2.1 INTRODUCTION

Differences in the aspirations and motivations of girls and boys are largely shaped by social and cultural expectations, we therefore believe that solving gender inequality in STEM requires wide-angle vision. We start by examining the factors that propel an individual (whatever their gender) to pursue STEM and then examine how these choices might be undermined for girls both inside and outside the classroom. This section begins by reviewing what is currently understood about this crucial decision and goes on to review the evidence through a gender lens.

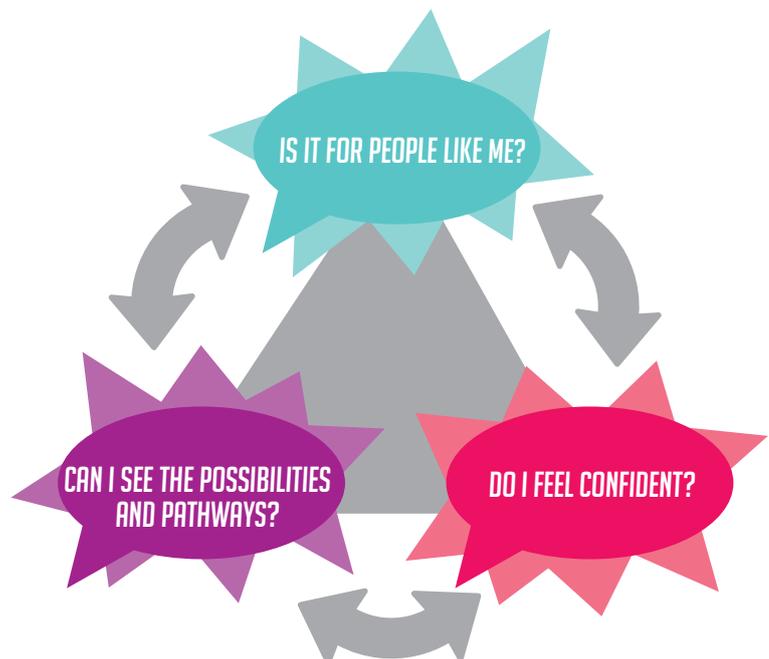
The literature reviewed finds that the main influences on students' decisions regarding studying STEM in compulsory education fall broadly into three categories:

1. Relevance of STEM to sense of identity and future aspirations
2. Perceived actual and relative ability in STEM subjects
3. 'Science capital' – or, experience of STEM, including formal and informal exposure to STEM subjects and careers through the curriculum, schooling, media, culture, family and personal connections.



The single factor that infuses and underpins all others is the cultural messages that people receive from a very young age. We believe that the three factors outlined above correlate with a mental checklist:

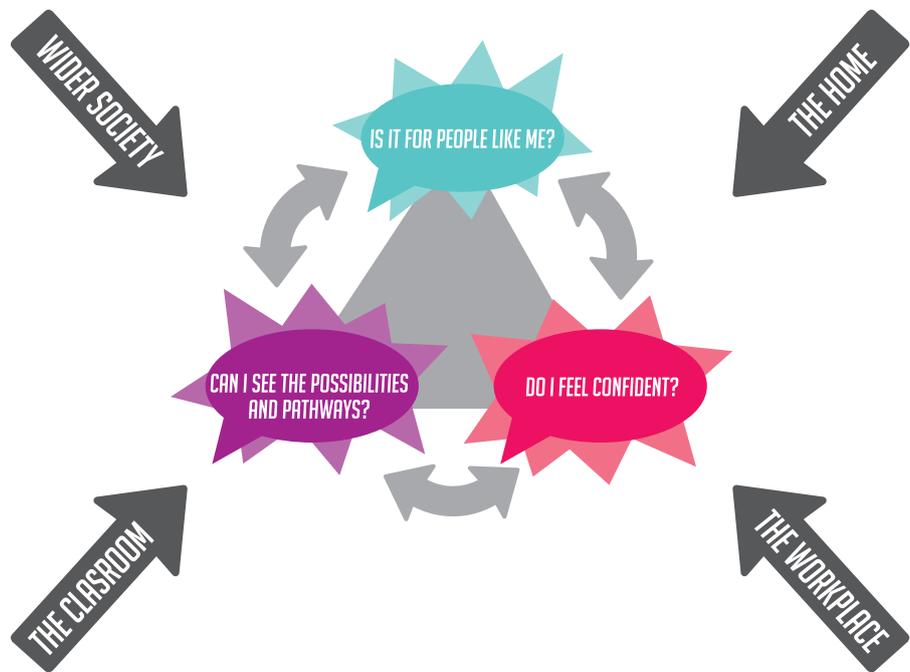
1. Relevance of STEM = Is it for people like me?
2. Perceived actual and relative ability = Do I feel confident?
3. Science capital = Can I see the possibilities and pathways?



WE ARGUE THAT THE EDUCATION SYSTEM AND CULTURAL ENVIRONMENT ARE DEEPLY FLAWED, PUTTING UP BARRIERS FOR GIRLS THAT ARE SO FAMILIAR THEY HAVE BECOME INVISIBLE

Answering 'YES' to all of these questions follows positive reinforcement from a complex interplay of environments: wider society, the classroom, the home and personal networks, and finally, the potential workplace. We argue that currently these environments are gendered to the advantage of boys through the intersection of two stereotypes – gender stereotypes and STEM career stereotypes. Currently, the STEM stereotype is more compatible with the male stereotype and expectations than it is with the female. The solution as we see it is not to conflate these stereotypes as many disastrous campaigns have attempted, but to smash them open. STEM careers are not all about heavy machinery and oily overalls, and being a woman is not all about being beautiful and caring. These are unhelpful stereotypes that are limiting for everyone.

We believe that much of the handwringing – 'but why aren't more girls taking STEM?' unfairly, although perhaps subconsciously, places the responsibility on girls. We argue that the education system and cultural environment are deeply flawed, putting up barriers for girls that are so familiar they have become invisible.



The evidence reviewed finds that perceived ability in STEM subjects is underpinned by both attainment and self-confidence, both in absolute terms and compared to other subjects. Furthermore there is a belief that it is necessary to be 'really brainy' to study science. The Aspires report (2013) finds that many young people with average or good levels of attainment feel unable to continue studying science because they see post-16 science qualifications and careers as being only for the 'brainy' few. Coupled with this is the desire to maximise the number of 'tariff points' accrued from level 3 study to improve level 4 progression opportunities particularly to higher education programmes. Thus students compare themselves to other students, then compare their actual or anticipated performance in STEM subjects with other subjects, and conclude that science is not for them.

Prior achievement is a significant influence on students' course choices in school and college. Predictably, those who do well in maths and science are more likely to study those subjects subsequently (TISME 2013).

Ability is in part about self-confidence rather than absolute ability (e.g. Murphy and Whitelegg 2006). For example, Aspires (2013) found that those who are traditionally under-represented in post-16 physical sciences and mathematics (notably girls, working-class and certain minority ethnic pupils) tend to be less confident in their own abilities, and are less likely to identify themselves as being 'good' at science and/or mathematics – irrespective of their actual abilities and attainment.

Furthermore in a survey of 23,000 12–15 year old girls who want to study physics beyond 16, more have lower confidence in their abilities than boys, despite tests revealing no difference in their actual conceptual abilities (UPMAP project, cited in TISME 2013). Similar findings are reported in the US too (Hill et al 2010).

2.2 WIDER SOCIETY

2.2.1 CULTURAL MESSAGES ABOUT WOMEN

Despite being in an age of challenging gender roles, we still live with the echoes and reality of a patriarchal culture. Recognition of patriarchy (a social order in which men are the primary holders of power and decision making) is not an accusatory statement. It is necessary to look at long-held systems through a gender lens to make real progress towards real equality.

'We have to start talking about substantive equality which acknowledges the historic imbalances between men and women in our society rather than formal equality. Real equality means treating 'as equals' while taking account of the context of our lives'

BARONESS HELENA KENNEDY, (2005)

We've come a long way, but gender inequality in the UK is no distant memory. In many ways, it is just less obvious than in the past. However, present day conversations often occur in a vacuum that doesn't recognise how close that past is. We haven't yet reached the 100th anniversary of (some) women's right to vote, and we're still more than 10 years away from the centenary in 2028 when democratic rights were extended for all women in the UK. The Equal Pay Act came into force in 1970 and we still have a gender pay gap. In 1980 women were allowed to apply for a loan or a credit card in their own names. Marital rape was only criminalised in England in 1991.

Today, girls and women are told they can be whatever they want. They are hearing the words (Ofsted 2011) but how can we expect them to heed the message when we still talk about a 'working mum' but not a 'working dad'? When women are narrowly represented in the media and the toys children are given are gendered so that girls toys are more likely to reinforce domestic duties and physical perfection, whilst the boys get action roles and adventure challenges?

'The toys rated as most likely to be educational and to develop children's physical, cognitive, artistic, and other skills were typically categorized as neutral or moderately masculine. We concluded that strongly gender-typed toys appear to be less supportive of optimal development than neutral or moderately gender-typed toys'

JUDITH ELAINE BLAKEMORE, PROFESSOR OF PSYCHOLOGY, INDIANA UNIVERSITY-PURDUE UNIVERSITY. (BLAKEMORE & CENTERS, 2005)

'Recently I bought my daughter new pyjamas, they were from the 'boys' section. They had robots on. My daughter spent about an hour before bed time pretending to be a robot and we talked about electronics and space... if all girls are exposed to is princesses, fairies, and ballet dancers then their narratives are limited and so are their life options'

CARMEL OFFORD, SCIENCEGRRRL

'One of the difficult smoke and mirrors of patriarchy is that no-one has ever not lived in it'

JUDE KELLY, ARTISTIC DIRECTOR SOUTHBANK CENTRE

We talk about 'having it all' but true sharing of responsibilities is not yet a reality. The implication that girls and women have 'never had it so good' undermines further effort for progress. The suggestion is that we should be satisfied with what we have. We believe there is no such thing as too much equality.

What maintains this imbalance of power? We argue that gender stereotypes feed the unconscious biases that permeate organisational process and individual decision making. We are pleased to see the House of Commons Science and Technology Committee (2014) highlighted unconscious bias as an undermining thread running through a woman's scientific career.

The dearth of women at the top is an ongoing battle in many sectors (Women's Business Council 2013) and involves similar barriers. The difference in STEM careers is that the gap presents itself early within formal education and continues to widen with ongoing consequences. A restricted set of subjects open doors to STEM, and these critical choices must be made early.

'A lack of diversity across the scientific community represents a large loss of potential talent to the UK. Restricted opportunity and diversity limits not only UK competitiveness and prosperity, but also vitality in the wider scientific workforce and creativity in society. Individuals from lower socio-economic backgrounds, certain ethnic minorities, women, and disabled people are all currently under-represented in education, training and employment related to science, technology, engineering, mathematics, and medicine'

ROYAL SOCIETY, DIVERSITY PROGRAMME

We also believe that challenging social norms is not a 'women's issue'. We welcome the men who want to join or work with **SCIENCEGIRL** because we believe that the next step forwards must be taken in partnership. We would like to see more non-traditional male role models; more men who truly step forwards for gender equality. True freedom of choice is the key to a truly equal world. A more equal world is better for everyone.

2.2.2 GENDER STEREOTYPES

Shelley Correll, Professor of Sociology at Stanford University [defines a stereotype](#) as a 'cognitive shortcut' that enables us to make faster decisions based on what we think we know about categories of people.

STEREOTYPE

'stɛrɪə(ɔ)ʈɪp, 'stɪərɪə(ɔ)-/

noun

A set of inaccurate, simplistic generalizations about a group of individuals which enables others to categorize members of this group and treat them routinely according to these expectations.

**'STEREOTYPE THREAT' –
THE IDEA THAT
'PERFORMANCE CAN
BE HARMED BY THE
AWARENESS THAT ONE'S
BEHAVIOUR MIGHT BE
VIEWED THROUGH THE
LENS OF STEREOTYPES'**

She argues that these assumptions lead to bias, defined as errors in decision making. In addition, as Steven Stroessner (Professor of Psychology, Columbia University) and Catherine Good (Assistant Professor of Psychology, City University of New York) discuss on their website (www.reducingstereotypethreat.org) there is a wealth of academic literature on 'Stereotype Threat' – the idea that 'performance can be harmed by the awareness that one's behaviour might be viewed through the lens of stereotypes'. As you can see from our 'Neurotrash' box, this is precisely what happens to girls when it comes to STEM subjects.

NEUROTRASH: WITH YOUR HOST PROFESSOR GINA RIPPON

There is a wealth of evidence from neuroscience that tells us not only is dividing the population into male and female halves overly simplistic, it perpetuates the idea that our brains are 'hard wired' and there's nothing we can do about it. We turned to Gina to help us take out the 'neurotrash'.

SCIENCEGRRRL: Gina, where does the stereotype about girls' brains and science come from?

It's part of a wider stereotype that women's brains do not process information in the kind of systematic way required in science – that women's lack of 'visuospatial ability' means that they can't engage with scientific careers. But there is good evidence that actually these kinds of cognitive differences don't exist anyway or, where they do, they can be altered by appropriate training and experience. But the field is littered with just the same sort of problems that have characterised pre-20th century 'research' this area - in other words, 'neurotrash'.

SCIENCEGRRRL: Why do you think gender stereotypes persist?

That's a big question, tied up with many political and historical factors, but the misuse of science has certainly contributed. Some of it is based on the misunderstanding and misrepresentation of what brain imaging studies are actually telling us, often the product of ill-informed journalism or populist writings. Sometimes it's bad science, or 'neurosexism', where scientists themselves ask the wrong questions in the wrong way and use stereotypes to explain their findings.

SCIENCEGRRRL: So we're not born with hardwired male or female brains?

Absolutely not, The idea that there is such a thing as a male or a female brain is a stereotype in itself! And I think the concept of 'hardwiring' is really bad news. It completely ignores what we know about how our brains change during our lives. These changes obviously happen during critical periods of development but also as the result of all sorts of things we do during our lives, such as taxi driving and juggling. And our brains are 'permeable' and can be affected by attitudes and self-perceptions in the world around us – a world that is full of stereotypes and unconscious bias. As Cordelia Fine has pointed out, a world full of the 'drip drip drip' of the gendered environment.

SCIENCEGRRRL: What evidence do we have that the environment can affect us in this way?

Well, negative stereotypes about girls' abilities in maths can translate into lower test scores but when examiners tell students that girls and boys are equally capable in maths, the difference in performance essentially disappears (Hill et al 2010). It works the other way, too. Michalska et al (2013) report that girls are much more likely to rate themselves as more empathic than boys, even when objective measures show no difference. Also, activating the 'women are better at verbal tasks than men' stereotype negatively affects men (Seibt & Foster 2004).

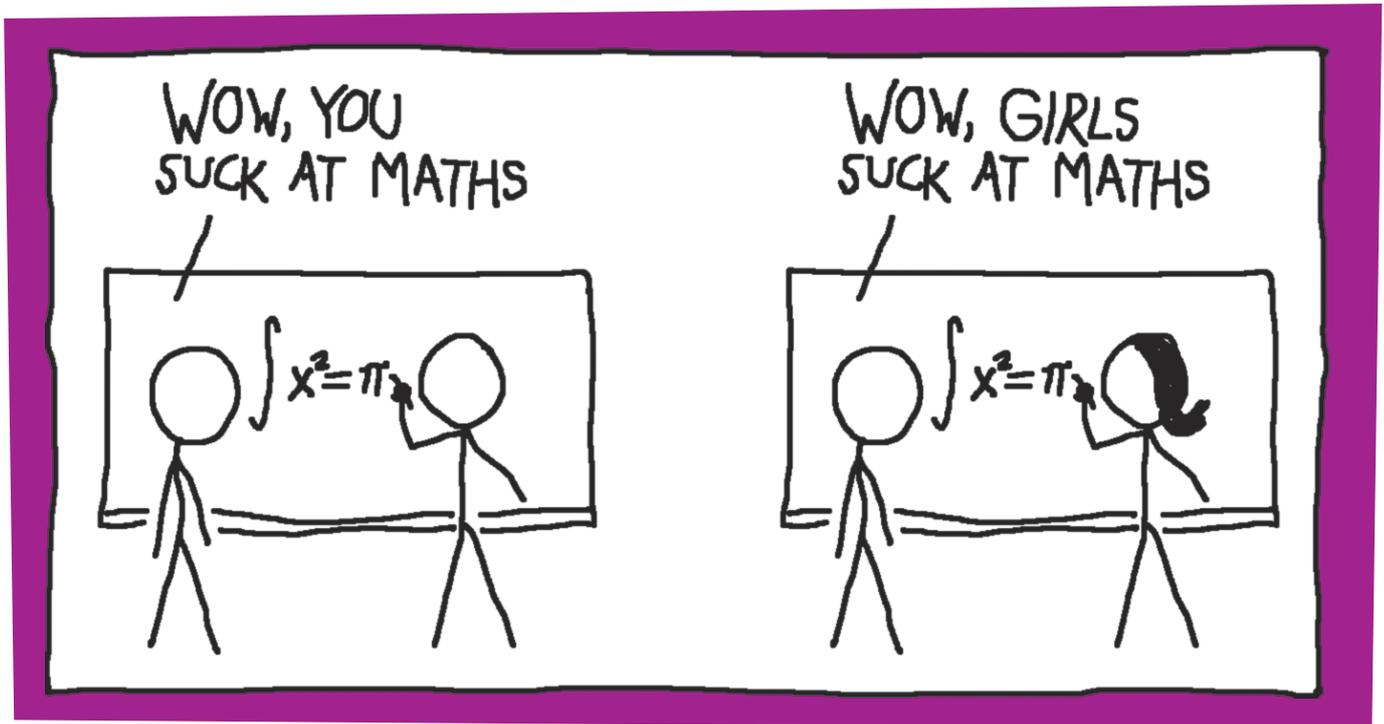
SCIENCEGRRRL: So, can we see the effects of stereotype threat in our brains?

Yes – MaryJane Wraga has done a really nice study where she took 3 groups of females and got them to do a mental rotation task while in a brain scanner. This sort of task is one of the very few where there is some evidence of very small, group level differences between females and males. The group that was told about this difference performed worst and showed different patterns of brain activation, in those areas more often associated with emotional processes. A group that was given positive messages performed best, and showed brain activation patterns consistent with visual processing and working memory.

SCIENCEGRRRL: Right, we're ready. So, how do we fight Neurotrash?

There is good research, where brain imaging can make positive contributions to the saga by informing the real story. Scientists can help everyone develop a 'nose for 'neurotrash', so we can root out the neurotrash and stamp out the neurosexism. This should be done systematically, and in collaboration with educators and social scientists to inform good practice, and to move the conversation on. You can also report it as #neurotrash on Twitter!

Gina Rippon is Professor of Cognitive Neuroimaging at Aston University. (See also Fine et al, 2010)



Adapted from www.xkcd.com/385/

When we look at the content of gender stereotypes, it is clear that our culture implicitly reinforces stereotypical male characteristics and roles as desirable and devalues stereotypically female ones. Being called 'a girl' is a pretty damning playground insult. Devaluation of such characteristics is obviously bad for girls. We argue it is also bad for boys, both in terms of personal development and allowing them to be truly free to choose their own paths. Men who choose stereotypically female paths come up against social and institutional barriers.

'I have a daughter who is 6 years old. From an early age she is presented, by a range of sources, with the dilemma 'if I'm not pretty, then what am I?' I agree with ScienceGrrl that we need to stop defining girls by their looks and focus on what they can do and the impact they can and will have on the world'

@BELINDAPARMAR, CEO OF LADY GEEK

'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)

*'WHEN I WAS AT SCHOOL
I DIDN'T REALISE THAT SCIENCE
IS SO BROAD AND FULL OF
DIFFERENT COMPONENTS OR THAT
ENGINEERING CAN BE SO DIVERSE'*

Attitudes towards women have a limiting and damaging effect on a girl's sense of having a 'right to be there'. Indeed, the recent Girls' Attitudes Survey (Girlguiding 2013) questioned 1288 girls aged 7–21 years old about a range of issues. Many of the findings in this survey (ranging from low self-esteem and body confidence to the extent of sexual harassment) are hugely upsetting. Hearing that 60% of 16–21 year olds surveyed 'have felt patronised or made to feel stupid because of their sex' is one such finding.

We do not want to paint a picture of fragile young women. This is plainly not the case, but we must see this in the context of the invisible hurdles experienced by girls. More positive messages from the Girls' Attitudes survey are that when it comes to happiness in the future, '45% spontaneously mentioned a good job or career' and 55% of girls want to be a leader in their chosen field, despite concern over lack of role models in leadership positions. We believe that this is closely linked to wider debates about how we define leadership and success, as well as workplace culture and attitudes to flexible working for both men and women.

Julie Bentley, CEO of [Girlguiding](#), told us:

'Our research has shown that 62% of 11–21 year old girls and young women think engineering and science are 'more for boys' and that a lack of female role models in STEM careers puts them off. We have found that over half of girls say they think science/engineering is too hard for them, despite the evidence, cited in 'Through Both Eyes', showing equal ability among girls and boys in these subjects. Girlguiding works to bust gender stereotypes so our members feel they can fully explore their talents and interests. I agree with the joined up approach suggested by ScienceGrrl and welcome the opportunity to discuss potential collaborations.'

JULIE BENTLEY, CEO GIRLGUIDING

2.2.3 STEM CAREERS STEREOTYPES

If that wasn't enough, there is also the STEM careers stereotype to contend with. A lack of knowledge about where STEM education can lead is a widely recognised problem that we discuss further in this report. Identifying with STEM is key to pursuing it and a narrow and limited STEM careers stereotype undermines that process. The current STEM stereotype aligns most closely with the male gender stereotype. Indeed, research by the TISME project found that most daughters and parents perceive STEM careers as masculine (Archer et al., 2013). The exceptions to this are medicine and the life sciences (HESA 2008/9), in these areas stereotypes are aligned with 'female' nurturing characteristics and less of a barrier to access despite real difficulties in subsequent career progression for women. In addition, biology is commonly seen as the 'easiest' science, playing into gender stereotypes about the intellectual capacity of girls for STEM. These careers are also more likely to be linked in wider consciousness to value-based careers decisions like wanting to 'help people' and 'change the world'. Actively challenging the STEM careers stereotype by showing the broad scope of opportunities, and challenging snobbery about non-academic routes, is needed to appeal to a broader range of personal identities – male or female. In reality, STEM careers are so diverse that overall there is no defining set of characteristics required for success.

This feeds into wider issues about diversity in the sector. Enabling individuals to choose the path that best suits their passions, skills and dreams requires a concerted effort to challenge limiting stereotypes. The 'STEM choice' for girls is undermined by 'Stereotype Collision' – the conflation of gender stereotypes and the STEM careers stereotype.

These conclusions are supported by a briefing paper from the Targeted Initiative on Science and Maths Education (TISME 2013). The paper summarises

findings from five STEM-education focused projects and finds that, unlike boys, girls often have to reconcile STEM-related career aspirations with their gender identities. In short, the former feel it is 'normal' to follow such career-paths whereas girls do not. This is echoed in a report by the Wellcome Trust (2013) which found that 'young women are more likely to be concerned about science not being a field for 'people like me' than young men are'.

ENGINEERING

ɛndʒɪˈniəriŋ/

noun

The creative and practical application of science and technology to meet societal needs.

2.3 THE HOME AND PERSONAL NETWORKS

2.3.1 SCIENCE CAPITAL

Some children benefit from engagement with STEM disciplines and careers through their families and social networks – in other words they are endowed with a significant amount of 'science capital' (Archer et al 2014). As the Aspires report (2013) explains, 'science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job)'. The evidence presented in this report shows that the more science capital a family has, the more likely a child is to express interest in science as a career and/or aspire to study science further (see also Archer et al., 2012). Science capital and high teacher/parent expectation can override some invisible barriers and empower girls to say 'YES' to STEM.

Wellcome Trust (2013) and Aspires (2013) both report that families constitute the greatest source of influence on 10 – 14 year olds' aspirations. 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 (2011). They found that only a minority of girls chose a STEM education and career path against their parents' advice.

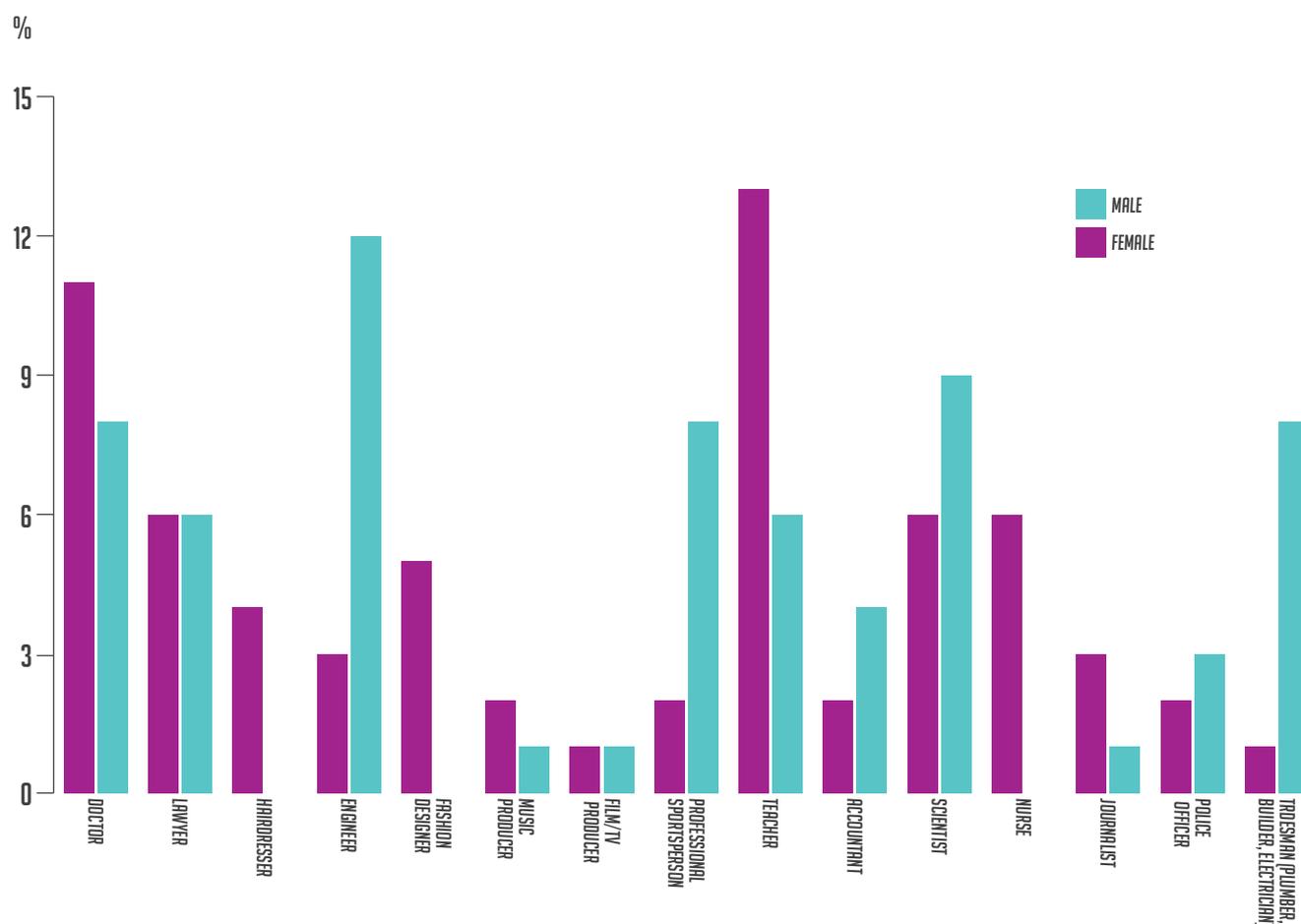
While science capital is a clear influence on early decision making, access to this capital is currently not equally available to all. We argue that broadening access to science capital through STEM networks would be widely beneficial.

2.3.2 EXPECTATIONS

The literature demonstrates that attitudes and beliefs are limiting girls in a very real sense from an early age. This applies to both learning and careers. Most people associate STEM subjects and careers with masculinity, and the arts and humanities fields with femininity (Hill et al 2010). This bias not only affects individuals' attitudes toward others but may also influence girls' and women's likelihood of cultivating their own interest in STEM areas.

Girls' thinking is strongly influenced by family and friends (Ofsted 2011), but gendered perspectives can also be reinforced by teachers and schools (House of Commons Science and Technology Committee, 2013) – and culture more generally (Ofsted 2011). 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 (Perkins Review, 2013).

SCIENCE CAPITAL REFERS TO SCIENCE-RELATED QUALIFICATIONS, UNDERSTANDING, KNOWLEDGE (ABOUT SCIENCE AND 'HOW IT WORKS'), INTEREST AND SOCIAL CONTACTS (E.G. KNOWING SOMEONE WHO WORKS IN A SCIENCE-RELATED JOB)



Response to the question 'What type of job would you most like your child to pursue when they finish their education?' (Engineers Week polling data 2013)

But as they grow older, their outlooks become more nuanced. Ofsted (2011) say that by secondary school girls believe 'all' jobs are open to them, and that they can choose any kind of job irrespective of tradition. Almost all the girls and young women who took part in the Ofsted 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, strongly championed by teachers and school leaders, was not matched by any noticeable shift away from gender-typical course or career choices. Almost all of these girls told Ofsted inspectors that they were not planning to pursue such a route for themselves. 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 relatively small. This suggests that the girls were aware of a wider societal discourse about the 'appropriate' roles for men and women, but that what they are being told does not sufficiently challenge their real-world experiences (Ofsted 2011).

Ofsted found that in 11 of the 25 secondary schools visited, 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. We believe a wider societal discourse about flexible working and work life balance (including parenting) would be a good thing, and boys should be included in such conversations.

2.4 THE CLASSROOM

2.4.1 SUBJECT CHOICES

The statistics in the introduction of this report show that even at the very beginning of their education girls can be underrepresented in some STEM disciplines. For example, fewer girls study the science Triple Award (which gives them three separate GCSEs in physics, chemistry and biology). By not studying this programme many are excluded from further progression in STEM courses and careers. A significant proportion, including girls, do not to pursue maths beyond the age of 16 thus limiting their future educational opportunities and hindering them in the workplace (Kumar et al 2013) We are pleased this is being addressed with the new '16 to 18 core maths package'. Furthermore, students can select level 2 vocational courses that do not provide pathways to other academic and/or vocational qualifications (HM Government 2011). Thus, decisions typically made in Year 9 (at age 13 or 14) can have life-changing consequences.

2.4.2 TEACHERS

Limited engagement with science further reduces girls' confidence and fuels their belief that STEM subjects are difficult. Murphy and Whitelegg (2006) find that girls' access to physics is limited within the normal curriculum provision at Key Stages 3 and 4. They also suggest that on the basis of older UK and international research it may be true that boys receive more teacher attention than girls in science classes (although teachers are not aware of this), that teachers hold lower expectations for girls in these subjects and that boys are more likely to dominate class interactions.

This leads to female students' increased sense of inadequacy in the subject and the growing belief that physics is difficult and not 'for someone like me'. Wolf (HM Government 2010) points out that the UCAS tariff point score puts pressure on students to maximise their grades, possibly at the expense of studying the most relevant subject to their future educational and career aspirations, especially if it is perceived to be more difficult. A lack of self-confidence translated into a fear of failure all contributes to girls and women being more cautious in their choices. Also, ambitious young women may be deterred from choosing STEM because they do not see how such subjects will help them get a career they want.

The science learning experience is highly influential. The Wellcome Trust (2013) report that of the various things that young people say encouraged or discouraged them when learning science, the quality of the teacher is the most commonly mentioned. The Council for Science and Technology (2013) claims that:

'The cornerstones of a school experience that will engender an early interest in mathematics and science is clear: access to well-informed, enthusiastic teaching staff, to inspiring practical work, to enrichment and 'informal science' activities, and a curriculum that is geared to nurturing a sense of wonder and excitement in these subjects, rather than serving the needs of the assessment system too narrowly.'

Indeed, a growing body of evidence shows that variation in teaching quality has a major impact on outcomes and that, all other things being equal, the difference between having an 'excellent' and a 'bad' teacher is equivalent to one GCSE grade (Kumar et al 2013). TISME research (2013) shows that good teaching can increase engagement, achievement and/or participation in science and mathematics. They define good teaching as approaches that enable students to engage with the subject in meaningful ways. For example, active student-centred learning approaches, based on discussion, are found to be particularly engaging and evidence correlates with higher learning gains – particularly in mathematics classes (TISME 2013).

'I DIDN'T DO A LEVEL OR DEGREE LEVEL SCIENCE AND MATHS - TEACHERS SAY THEY ARE VERY DIFFICULT, SO IT MAKES YOU THINK YOU CAN'T DO IT'

THE DIFFERENCE BETWEEN HAVING AN 'EXCELLENT' AND A 'BAD' TEACHER IS EQUIVALENT TO ONE GCSE GRADE

2.4.3 EARLY YEARS

Education has the potential to challenge gendered beliefs that children may have acquired from either family and friends, or society more generally. The Council for Science and Technology (2013) state that 'Children's most formative experiences in determining their engagement with STEM start at Primary School'. Primary schools could therefore play a key role in engaging girls in STEM subjects, helping to overcome a range of challenges that are identified in relation to academic progression in STEM at level 2 and 3. But there is an 'acute shortage of science and mathematics specialists in primary schools': only 3% and 2% of qualified primary teachers have an initial degree in science and mathematics respectively (Royal Society 2010). The Council for Science and Technology conclude: 'Responsibilities inevitably fall on the shoulders of generalists, who often do not have the expertise and confidence to make up for this shortfall'. This is important as 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).

2.4.4 CURRICULUM

Furthermore, viewed through a gender lens, the curriculum could be central to changing the information students receive about the role of women in STEM. As it stands, whilst there are some efforts to recognise female historical figures, the curriculum is overwhelmingly male. This further reinforces subconscious girls' beliefs that STEM is 'not for me'.

Research relating to physics analysed by Murphy and Whitelegg (2006) shows that gender influences subject choice, and that this is related to relevance in daily life, learning goals, future study and career aspirations (see also Wellcome Trust 2013 and Aspires 2013). Girls are less likely to think that the physical sciences have personal relevance, in contrast to their views of biology. Murphy and Whitelegg summarise the situation thus: 'what students consider personally relevant affects their perceptions of their areas of competency... [and] what they choose to, or feel able to, engage with in learning and assessment situations. The evidence indicates that what boys, more than girls, pay attention to and engage with is generally valued and judged relevant in physics'.

The idea that girls and boys intrinsically need different things from STEM is mistaken. We believe that evidence relating to 'relevance' reflects the identity conflict between being a girl and being a STEM student. The Institute of Physics Report 'It's Different for Girls' points to the marked increase in attainment by girls in a single sex education setting. Why? We believe that single sex schools actively create a context within which it is normal and desirable for girls to study physics, both in terms of their expectations of students and provisions of opportunities and real choice. We also believe that another reason is girls' active self-concept in this setting is one of a student, not of a 'girl' with all the stereotypes that entails. It is a mistake to keep drawing gender lines where the answer is better teaching for all.

Relevance is strongly shaped by culture and society and the construction of femininity. We argue that instead of changing the STEM curriculum 'for girls' we should be looking at promoting both more flexible attitudes towards gender identity and more realistic representations of what STEM careers actually entail, and how creative they can be. The 'STEM-stereotype' is an active and counterproductive problem. We believe that 'making the world a better place' is a value-based career choice that appeals to boys and girls. By not embedding the creative potential and real world value of STEM careers into teaching we are missing an entire demographic – not just girls.

**IT IS A MISTAKE TO KEEP
DRAWING GENDER LINES
WHERE THE ANSWER IS
BETTER TEACHING FOR ALL**

**BY NOT EMBEDDING THE
CREATIVE POTENTIAL
AND REAL WORLD VALUE
OF STEM CAREERS INTO
TEACHING WE ARE MISSING
AN ENTIRE DEMOGRAPHIC –
NOT JUST GIRLS**

**AS A SOCIETY WE
DO NOT EMBRACE
FAILURE AS A VITAL
STEP FOR INNOVATION
AND LEARNING**

We'd like to end this section with a note on failure. As a society we do not embrace failure as a vital step for innovation and learning. That girls are less confident is a challenge in its own right that reflects cultural messages. Yet, in such a world, what is a lack of confidence if not a fear of failure? We see this carried through into adult life as 'Imposter Syndrome'. Athene Donald (Professor of Physics, Cambridge University) describes this as 'the feeling that you don't belong, that you are only where you are through some clerical or other error and that one day, probably soon, you will be FOUND OUT.' She notes that women are more likely to own up to feeling like an 'imposter', but she goes on to say that: 'my belief is that the phenomenon is ubiquitous, across ages, genders and disciplines'. Our society is one that is afraid to embrace failure and vulnerability and so 'Imposter Syndrome' seems inevitable to some degree, after all – no one is perfect. A more creative and flexible attitude to failure is not only a better reflection of life in a STEM field and the skills that are needed there, it also gives the confidence to try in the first place, to exceed your own expectations – and the chance to build resilience.

2.5 THE WORKPLACE

2.5.1 CAREERS ADVICE

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 (TISME 2013). However, STEM careers (excluding medicine) are not popular aspirations among 10–14 year olds, and 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' (TISME 2013).

This is probably because students do not recognise the relevance of STEM subjects to a wide range of employment opportunities (see for example. Automotive Council UK 2013, Murphy and Whitelegg 2006 and Wellcome Trust 2013), and have very limited knowledge and understanding of how their choices influence their future career, progression and earning opportunities (Ofsted 2011). The majority of young people obtain information about possible careers from their family (67 per cent); almost half gain information from teachers and almost as many use information from career advisors at school (Wellcome Trust 2013). It is now recognised by 87% of teachers that providing careers guidance is part of their role – eight out of ten would base that guidance on their own knowledge and experience and around a fifth of them think a career in engineering is undesirable. On a more positive note, it is encouraging to learn that nine out of ten STEM teachers are aware of curriculum enhancement and enrichment activities (Kumar et al 2013) – however only 46% got involved in them, suggesting that they are not extending their own knowledge about STEM careers, or increasing the engagement of their young people with real-world STEM experiences.

2.5.2 WORK EXPERIENCE

Work experience and work placements could be used to challenge gender stereotypes, but this is not generally happening. The Wellcome Trust (2013) report that of the 61% of young people who have done work experience, 28% say this was in a STEM field, and – unsurprisingly – fewer young women than young men have done STEM work experience.

Ofsted inspectors who visited secondary schools found that work experience was not used effectively to challenge vocational stereotypes (Ofsted 2011). They report that not enough of the young women spoken to had first-hand experience of, and insights into, less traditional areas of work. Of the 1,725

**'WHAT I WOULD HAVE LIKED
TO KNOW WHEN I WAS 15 WAS
WHAT DOES A PHYSICIST DO?'**

EMPLOYERS AND SCHOOLS NEED TO KNOW HOW TO DEVELOP RELATIONSHIPS WITH EACH OTHER AND WHAT EACH OTHER WANT OR CAN OFFER. THEY ALSO NEED PRACTICAL STRATEGIES FOR ENGAGEMENT AND PHYSICAL ACCESS IN MORE RURAL AREAS

examples of work placements for young women, only 164 represented non-stereotypical experiences. Almost all were stereotypically female, for example in education, hair and beauty establishments, offices, retail and health care.

The Ofsted report (2011) finds that most of the schools had not explicitly encouraged girls to choose something different, but that most would support a student's wish, if possible. Exceptionally, in one case a young woman felt deterred by her school. She enjoyed working with motor cycles and cars and had found her own placement in a garage. However, she thought that her school considered that this was not acceptable; she believed this was because school staff held stereotypical views about the kind of placement that was suitable. She reluctantly undertook a placement in a nursery, but later studied motor vehicle maintenance at college.

In all but three of the schools visited, the young women were required to identify their own placements. As a result, much of this pattern was dependent on the young women's family background and resources. Some of the girls spoken to said, 'It's not what you know, it's who you know.' In one rural location, work experience had been reduced to one week as it was difficult to find placements. Therefore, the young women felt lucky to get a placement, irrespective of whether it matched their interests.

Many of the young women in Year 11 interviewed by Ofsted felt that, on reflection, they should have been more adventurous in their choices. These reflections were subsequently helpful to those in Year 10, and this demonstrates the impact that older students can have when they share their experiences and are challenged to appraise them.

In addition there are broader barriers to schools and employers working together regardless of gender issues, as identified by the Education and Employers Task Force (EETF) (2010): Communication, Awareness, Expertise and Geography. Employers and schools need to know how to develop relationships with each other and what each other want or can offer. They also need practical strategies for engagement and physical access in more rural areas.

2.5.3 PERCEPTIONS OF STEM

Many STEM sector organisations believe that inaccurate perceptions of STEM careers contribute to low progression to higher education and higher apprenticeships by women. Students and their families may be making judgments about future careers based on misperceptions; for example that engineering is dirty work (House of Commons Science and Technology Committee, 2013) – and unsuitable for women. Aspires (2013) research found that most 11– 14 year olds receive little, if any, careers education, and generic careers advice does not seem to influence students decisions to study STEM courses (Aspires 2013 and Holman and Finegold 2010).

This undoubtedly affects views and take up of alternative routes into STEM careers. Young people and their parents have a 'hazy' understanding about apprenticeships and this knowledge is informed by stereotypes. The House of Commons Science and Technology Committee (2013) believe that 'there is a cultural misperception that plagues vocational education, namely that it is for less bright students'. Furthermore the Education and Employers Taskforce and Price Waterhouse Coopers (2012) find that 'there is a default view that apprentices are stereotypically male, and are narrow in terms of the vocational or occupational choices available'. They also found that large majorities of teenagers surveyed like the idea of jobs which have structured training and want to know more. In the new era of increased tuition fees for higher education, growing numbers of young people are interested in going straight into the workforce from school or college. But a key concern among potential female apprentices is that non-traditional workplaces will be unfriendly towards them (The Education and Employers Taskforce and Price Waterhouse Coopers, 2012).

THERE IS A CULTURAL MISPERCEPTION THAT PLAGUES VOCATIONAL EDUCATION, NAMELY THAT IT IS FOR LESS BRIGHT STUDENTS

A KEY CONCERN AMONG POTENTIAL FEMALE APPRENTICES IS THAT NON-TRADITIONAL WORKPLACES WILL BE UNFRIENDLY TOWARDS THEM

**OF STUDENTS AGED
14-16 YEARS OLD,
46% HAD RECEIVED
NO INFORMATION ABOUT
APPRENTICESHIPS.
THE SURVEY RESULTS
ALSO SUGGEST A TREND
TOWARDS STEERING
GIRLS AWAY FROM
TECHNICAL ROUTES IN
FAVOUR OF UNIVERSITY**

2.5.4 APPRENTICESHIPS

Teachers are potentially an influential source of information about apprenticeships, but they often do not have the knowledge to direct prospective pupils towards such routes. In a survey of secondary school teachers 52% were 'not at all confident' about advising young people on apprenticeships (The Education and Employers Taskforce and Price Waterhouse Coopers (2012). YouGov (2011) found that teachers underestimate the extent to which parents, young people and employers value apprenticeships as a realistic alternative to academic study. This suggests that teachers will be less likely to promote apprenticeships compared to other education options, such as A-levels, which in turn means they are even less likely to encourage girls to pursue 'doubly non-traditional' routes – i.e. vocational pathways in STEM disciplines. Furthermore, The Council for Science and Technology (2013) argue that there has been a proliferation of qualifications available to young people between the ages of 16 and 19, and this has created a real lack of clarity for students, obscuring pathways into higher education and the workplace.

Professor Alison Wolf in her review of vocational education for the Department for Education (HM Government 2011) argues for good quality apprenticeships and vocational training that provide real access to further education and/or employment. She argues that high quality apprenticeships offer young people a demanding programme of work and study with excellent career prospects. Such programmes are popular and over-subscribed. The Government broadly accepted these recommendations, saying in a 2013 progress report that 'our system has no business tracking and steering [students] into programmes which are effectively dead ends' (HM Government 2013). However, a survey of 1080 secondary students undertaken by GradCracker 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. The survey results also suggest a trend towards steering girls away from technical routes in favour of university.

2.6 CONCLUSIONS

The reasons behind a student's choice to pursue STEM studies are well-understood. At the beginning of this section we proposed 3 key questions – 'Is it for people like me?' 'Do I feel confident?' 'Can I see the possibilities and pathways?' These questions are effectively asked by students when making decisions about their future. The literature shows pervasive gender stereotypes in all environments which are perpetuated through the STEM career stereotype. These contribute to girls being less likely to answer 'YES' than boys. These stereotypes must be robustly challenged in all quarters if we are ever to make real progress towards gender equality in STEM. In addition, opening up STEM career stereotypes will make STEM appealing to a more diverse range of identities.

3.0 SOLUTIONS

3.1. INTRODUCTION

As we stated at the beginning of this report, the lack of women in STEM and of young women pursuing a STEM education is widely recognised as a waste of talent. Addressing this challenge has been described as 'business critical' and an imperative for economic development.

**OPENING UP STEM
CAREER STEREOTYPES
WILL MAKE STEM
APPEALING TO A
MORE DIVERSE
RANGE OF IDENTITIES**

'By equalising the labour force participation rates of men and women, the UK could further increase GDP per capita growth by 0.5 percentage points per year, with potential gains of 10% of GDP by 2030'

WOMEN'S BUSINESS COUNCIL, 2013

The challenges section has used a mental gender lens to unveil the challenges facing young women entering STEM. In the solutions section we begin to bring in a physical gender lens to investigate the real life practical solutions that are being implemented on the ground. We review the solutions in the context of the four environments discussed in the challenges section: wider society; the home and personal networks; the classroom and the potential workplace. We draw out recommendations within these environments that will empower girls to answer 'YES' to our questions.

3.2 WIDER SOCIETY

3.2.1 GENDER STEREOTYPES

In recent years the so called 'fourth wave' activists and organisations have been making great strides in bringing feminism back up the social and political agenda. Groups like the [Everyday Sexism Project](#), [No More Page Three](#), the [Women of the World festival](#) (WOW) and the [women on bank notes](#) campaign have all contributed to widening understanding of our social inequalities. This is the wider context within which we can begin to address the inequalities in STEM.

One of the ways in which these inequalities can be seen is in the representation of women in the media. We must cast a wider net for positive female role models. We were dismayed to find a careers article about F1 (Formula One) in BBC Top Gear magazine that began 'so you're a schoolboy' and proceeded to show a graphic of an all-male engineering team. The only females depicted were in media/hospitality roles – and wearing short skirts. We arranged to speak with Charlie Turner, the editor, and reached an understanding about the importance of female role models – for the girls themselves but also for fathers of daughters who are likely readers of the magazine – and reached an agreement to continue a careers thread on F1 that included male and female success stories from the recently launched Silverstone University Technical College.

We call on TV and other media to use the gender lens when casting new characters in widely viewed programmes, commissioning new series that challenge gender stereotypes, and to both train and use female experts.

In addition to shaping the media, educating children about advertising is equally important. [Media Smart](#) is a non-profit organisation specialising in media education for primary school children. In a 2007 evaluation of the value of their education packs for children, 99.5% of teachers agreed with the statement that 'children are easily influenced by advertisers' and 79.8% felt that media education was necessary to 'prevent children being exploited by advertisers'. The Government Equalities Office partnered with Media Smart to launch an educational pack specifically to focus on the prevalence of low self-esteem and low body confidence perpetuated by doctored media images. As we highlighted in the challenges section, young women today are under huge pressure to conform to idealised notions of physical perfection.

The Government accepted the findings of the 'Letting Children Be Children' report (Bailey 2011), which considered that 'we are all living in an increasingly sexual and sexualised culture, although it is far from clear how we arrived at this point' and that 'sexualised and gender-stereotyped clothing, products and services for children are the biggest areas of concern for parents and many non-commercial organisations'. Through a call for evidence from nearly 1000 parents, it was clear that:

WE CALL ON TV AND OTHER MEDIA TO USE THE GENDER LENS WHEN CASTING NEW CHARACTERS IN WIDELY VIEWED PROGRAMMES, COMMISSIONING NEW SERIES THAT CHALLENGE GENDER STEREOTYPES AND TRAINING AND USING FEMALE EXPERTS

WE ARE ALL LIVING IN AN INCREASINGLY SEXUAL AND SEXUALISED CULTURE, ALTHOUGH IT IS FAR FROM CLEAR HOW WE ARRIVED AT THIS POINT

'Parents are happy to take responsibility for their children's upbringing, but they expect and want businesses and others to support them and to deal fairly and responsibly with children.'

WE BELIEVE THAT MUCH OF THE EVIDENCE AND WILL IS IN PLACE AND THAT WITH STRONGER LEADERSHIP, REAL CHANGES IN PRACTICE ARE WITHIN REACH

Bailey called on the British Retail Consortium (BRC) to develop 'a retail code of good practice on retailing to children'. A Government progress report on this recommendation (Bailey 2013) revealed that BRC member take up of such guidelines stood at 51% of the children's clothing market. We are pleased to see that the progress report also points to interest in developing such good practice for toys and games, specifically referencing gender stereotyping.

Parent-led campaign '[Let Toys Be Toys](#)' believes that 'both boys and girls benefit from a range of play experiences and should not be restricted by gendered marketing'. Of the 14 retailers contacted by the campaign, seven have removed gendered signage and five are 'in the process' of making changes. A broader '[Let Toys Be Toys](#)' 2012–13 survey also shows a promising trend – a 60% reduction in gendered signage in one year.

We believe that much of the evidence and will is in place and that with stronger leadership, real changes in practice are within reach.

1.

RECOMMENDATION LEADERSHIP ON GENDER EQUALITY

1.1 We believe there is a case for strong leadership in translating the large amount of academic literature on gender (see 1.2) into public policy. This could build on Government Equality Office policies that are already in place, such as 'Think, Act, Report' (gender equality in the workplace) and 'Body Confidence'. We suggest that the evidence shows these factors affect children's identities and choices – and that there is a real gap in 'duty of care' towards children.

We recommend a Government-led roundtable with cross-party support for retailers and manufacturers of children's toys, clothing, books and media in partnership with academics, professional bodies including Institute of Physics, Media Smart, GirlGuiding, EveryDaySexism, ScienceGrrl & other grassroots groups like Let Toys Be Toys.

The outcome should be an agreement of core marketing and media principles regarding a 'duty of care' towards children. We recommend working towards a pledge that includes the business case for diversity and opportunity as supported by the current [Royal Society diversity programme](#) and [Women's Business Council](#).

Owner: Number 10 Policy Unit

Partners: BIS, Government Equalities Office, BRC,

1.2 To support this, we recommend the formation and funding of a Gender Science Taskforce with the explicit aim of synthesising the wealth of academic feminism, neuroscience, social psychology, educational and sociological data for integration into teacher training, public dissemination and to develop equality, diversity and inclusion training. This could be supported by a [Sense About Science](#) – Ask for Evidence campaign on gender science. We call on Government to use such resources to develop consistent inclusion guidelines across Departments and RCUK to ensure that gender equality becomes embedded into research questions through explicit requirements in funding processes.

Owners: Government Equalities Office

Partners: Royal Society, Wellcome Trust, Institute of Physics, Science Council, Royal Academy of Engineering, ScienceGrrl, Academics, Sense About Science, National STEM Centre, RCUK, Equality Challenge Unit

3.2.2 STEM STEREOTYPES

There are a growing number of organisations helping to address the narrow view of the engineering profession. For example companies like [Practical Action](#) and [Engineers Without Borders](#) work with schools to show the societal impacts of engineering in developing countries. They draw tangible links between engineering solutions and peoples' lives. These types of activities and messaging are an essential part of breaking open the STEM stereotype.

Showcasing the diversity of STEM careers is also part of breaking this stereotype. The [SCIENCEGRRRL](#) calendar (available on the [Future Morph website](#)) deliberately presented scientists and engineers from a wide range of disciplines and applications to show that science really can be 'for everyone'. As the Aspires (2013) report concludes, most people have a relatively narrow view of where science can lead. The Aspires report calls for a move from talking about the 'science pipeline' to a 'science springboard' which, it argues, will serve to 'emphasise its wide value within modern life and to convey how science qualifications can be valuable for propelling an individual to numerous careers and destinations.'

The discussion workshop '[Science it's a People Thing](#)' was devised collaboratively by the Institute of Physics, WISE and Intel. It offers girls the opportunity to openly discuss the myths and facts about girls and women in STEM careers in a safe and nurturing environment. This opportunity reportedly had a significant impact on the young women attending, with one girl claiming that she was keen to spread the work to her personal network: 'I will tell my friends and family about the facts that I have learned and hopefully inspire others as I have been inspired today' (participant aged 13).

We support Perkins' (2013) recommendation that the engineering community should 'agree effective core messages about engineering and cooperate to disseminate these messages to young people.' A broad-based report into diversity in STEM (CaSE, 2014 forthcoming) supports our proposition that breaking the STEM stereotype will benefit the sector as a whole and also makes recommendations along these lines.

**THE ASPIRES REPORT
CALLS FOR A MOVE
FROM TALKING ABOUT THE
'SCIENCE PIPELINE' TO A
'SCIENCE SPRINGBOARD'**

2.

RECOMMENDATION REBRANDING STEM

2.1 We would like to see a campaign that is focused on breaking down the STEM stereotype. We believe that current plans for a National campaign to attract women into STEM should use this approach.

Owner: Number 10 policy unit, BIS, DfE

3.3 THE HOME AND PERSONAL NETWORKS

3.3.1 ROLE MODELS, MENTORS AND SPONSORS

It is clear that science capital is key to raising awareness of routes and career options by bringing students into contact with role models, mentors and sponsors and also because they have engaged and supportive schools, teachers and families. The reverse is also true – a lack of knowledge about the potential 'springboard' effect of STEM amongst families may also contribute to deterring girls from taking this route.

'Empowering girls without consideration for their situation at home can often result in conflict. Families often react to what they do not understand or to something they see as unnecessary or not for their daughter. We invited the parents of our mentees to meet us in a local restaurant and explained to them exactly how we were helping their daughters and why. They had an opportunity to meet some mentors and ask us questions, and since we have only had positive responses from the parents of our girls'

CHARLY YOUNG, CO-FOUNDER, THE GIRLS NETWORK

'I would be keen to discuss how Future First could partner directly with organisations like STEMNET – we would welcome the opportunity to link STEM Ambassadors with their old schools'

ALEX SHAPLAND-HOWES, MANAGING DIRECTOR, FUTURE FIRST

Ofsted (2011) reports that mentoring was also a strong feature in several colleges and had a very important impact in helping some young women to overcome barriers to achievement. Hughes (2011) recommends that all secondary schools and colleges should develop networks of former students who are willing to be contacted by current students. Organisations like [Future First](#) actively arrange for former students to come back and work with current pupils to raise aspirations and help the students make decisions about their future careers, as well as help them make the most out of their remaining time at school.

We spoke to Kirsten Bodley (CEO, [STEMNET](#)) who told us she is keen to develop such relationships and build on those already in place with the [Social Mobility Foundation](#). Engaging with girls' families and expanding on networks to build science capital for those who don't already have it will be central to progress.

3.3.2 NETWORKS

There are an increasing number of local groups working specifically to target girls in STEM. [SCIENCEGRRRL](#) chapters bring together local women with an interest or career in STEM. Our approach is to channel their passion through local networks and bring female role models to the forefront. Better coordinated local opportunities would help time-pressed volunteers make a real impact.

Another way of highlighting female role models is by increasing their online presence, which was one of our goals with the [SCIENCEGRRRL](#) 2013 calendar. We wanted to showcase real women, as real people. Not all scientists are the same, but not all women are the same either and we feel that increasing the diversity of visual images as well as telling girls about these women is as important when it comes to finding 'someone like me'.

*'MY FATHER WAS AN ENGINEER
SO I SAW WHAT IT WAS ABOUT
FROM YOUNG AGE'*

Other groups and campaigns seek to provide safe spaces for girls. [Stemettes](#) aim to inspire the next generation of women into STEM fields via a series of panel events, hackathons, exhibitions, and mentoring schemes to showcase female role models.

Stemettes are also an excellent example of tapping into specialist knowledge of enhancement and enrichment delivery and their hackathons can be linked to the British Science Association's [CREST Awards](#) scheme. Other groups like [Little Miss Geek](#) and Girl Guiding also use girl-only events as a vital way of challenging these doubts and exploring failure in a safe space.

We believe that initiatives targeted at girls are currently necessary. Indeed, when [SCIENCEGRRRL](#) funded a team of girls and boys to take part in [International Space School](#) at King's College London we found that the girls were visibly less confident speaking about their experiences in front of the boys. We hope that as we break down stereotypes and move towards true equality both genders will be fully catered for by an integrated STEM sector.

'I think the ScienceGrrl calendar is very unique. Each month the calendar shows different women in the science world achieving amazing accomplishments. This calendar is very encouraging to young women like me, showing them all of the scientific career opportunities that are available to them. The calendar promotes women who aren't the stereotypical female scientists and in the descriptions the calendar shows women who have hobbies as well as amazing academic achievements such as running and music. In my opinion this calendar is great; it serves its purpose as I feel encouraged to get involved in the world of science'

HOLLY, @PHYSICSGIRLIES

'In just 8 months, we've inspired 300 girls and have exposed them to women working in the field. We've also seen a 22% increase in those wanting to work in Science, 5% in Technology and 4% in Engineering. Importantly, there was an 18% increase in those who knew of women working in technology and overall 12% increase in those who knew of women working in STEM. Out of 10, our public events get an average of 8.7 and all girls would recommend them to a friend. We even had one girl who wanted to switch her degree subject (from History) after attending our hack!'

ANNE-MARIE IMAFIDON, STEMETTE, HEAD & FOUNDER,

GIRLGUIDING

Girl Guide Leader, Dr Jill Johnson put on her ScienceGrrl member badge and organised a science camp for her Guide Unit, the 8th Hanwell Guides. Sixteen girls, aged 11–15 years old, spent a weekend at a base in South West London learning about each Patrol's mascot scientist – Ada Lovelace, Jane Goodall and Marie Curie – and getting hands-on with maths, engineering and science. The activities ranged from dissecting strawberries, to finding out what happens when you add dry ice to washing up liquid, to the Science Olympics – which awarded points for practical skill and creativity. The camp was supported by a crew of mostly female scientists from Imperial College London.

'I really enjoy experiments. Science is enjoyable but sometimes mind-boggling!'

One of the Guides volunteered that the opportunity to talk to scientists was 'the best bit' of the camp and Jill tells us that 'many of the girls who participated have said they will consider a career in science in future'.

'There's been quite a bit of interest in the event from other Guide groups, so it'll go forward again.'

We think that more girls should be given the opportunity to meet role models in an environment they are happy and comfortable in. For example, empowering STEMNET with the resources to enable strategic extension of support to include the places girls already are is a chance to reach out to those who do not currently identify with STEM as something 'for me'.

'OUR SCIENCE BUILDING IS CALLED THE 'ROSALIND FRANKLIN BUILDING', I DIDN'T KNOW WHO SHE WAS... I WAS IMPRESSED!'

3.

RECOMMENDATION ROLE MODELS

3.1 The Government Equality Office '[Parent Pack](#)' initiative targeted at raising girls' confidence and their families' expectations could include non-stereotypical careers and showcase female role models as case studies. This could include use of images from the ScienceGrrl 2013 calendar, for example.

Owner: Government Equalities Office

Partner: ScienceGrrl

3.2 We recommend creative STEM Ambassador partnerships, which would require a shift from STEMNET's formal remit of only working with schools. Partnering with groups like Girl Guiding would allow STEM Ambassadors to reach girls where they already are, in an extracurricular environment that is a safe space for girls. We recommend building on existing sponsorship and support of Girl Guiding badges (as National Grid and Rolls Royce already do) so that they are aligned with diversity objectives in the STEM sector. We also support partnerships with the UK Association of Science and Discovery Centres.

3.3 We recommend that STEMNET contract holders explicitly discuss the importance of female role models with partner schools. STEMNET should also take advantage of the networks developed by the [Women in Science and Engineering](#) (WISE) campaign, [Women's Engineering Society](#) (WES), ScienceGrrl and others.

Owner: BIS, STEMNET

Partners: Girl Guiding, UK Association of Science and Discovery Centres, and female networks such as those named above.

BEING PULLED UP THROUGH THE SYSTEM BY BEING GIVEN OPPORTUNITIES THAT MIGHT NOT HAVE OTHERWISE COME YOUR WAY REALLY IS THE BENEFIT OF SCIENCE CAPITAL

There is also a need to make role models accessible as mentors – and to move past that into sponsorship. Literature from the business sector suggests that ‘women are being mentored to death’ (Carter & Silva, 2010) as they progress whilst men go ahead and grab opportunities because they have sponsors. Being pulled up through the system by being given opportunities that might not have otherwise come your way really is the benefit of science capital. So whilst increasing ‘exposure’ to STEM professionals is no doubt a good thing, we need to work towards a system of role models and mentors who are empowered to become sponsors who offer genuine opportunities.

We believe that STEM networks could also engage better with teachers by providing improved access to information, offering real world applications of the science they teach and future job opportunities for their students. Networks like the [Stimulating Physics Network](#) provide direct support to teachers through resources, events and ‘teaching and learning coaches’. They have a national network of coordinators (themselves experienced teachers) who provide training to physics teachers and point them to opportunities for enriching the physics curriculum. This type of teacher support is essential in ensuring that they are able to make the most of opportunities available to them. This network is also gender aware and informed by the outcomes of the Institute of Physics’ [Girls in Physics Programme](#). The Perkins Review (2013) supports this engagement with teachers by calling for professional engineers to provide continuing professional development to help inspire their students.

4. RECOMMENDATION STEM MENTORING AND SPONSORSHIP

STEM Ambassadors and other volunteers should be aware of ways in which they may develop their activities through existing networks such as [The Girls’ Network](#), FutureFirst and [CASinclude](#) to increase the diversity of ambassadors, including more women, undertaking this role.

4.1 We recommend that STEMNET develops its partnerships with existing schemes and builds on the links these organisations have made with schools. Mentors could become sponsors by becoming easy points of contact for work experience. This would be especially powerful by expanding STEMNET in terms of Government funding and support and backing from the private sector.

4.2 We recommend STEM Ambassador ‘Buddy Schemes’ for teachers, where support can take the form of social networks, resources for Virtual Learning Environments and up to date experience of an academic or industry setting through contact with a range of local Ambassadors. We understand this already occurs in some capacity, but argue for a clearer framework and mission that also promotes this work and communicates its value to schools. Many teachers will not have experienced STEM workplaces, and teacher partnerships with STEM Ambassadors is a route to get this information to students that has legacy. Engagement of greater diversity of role models could be facilitated by using alternative communication channels e.g. Skype, Google Hangout.

4.3 We recommend STEM employers lead strongly on unifying attitudes towards enhancement and enrichment work – to be underpinned by key principles of transferable skills (communication, networking, teamwork) that are currently undervalued. We recommend such skills should be more highly valued at promotion and logged at appraisal to help assess true community impact. Policies about enhancement and enrichment time commitments should be discussed at inductions so those who are motivated feel supported in such activities. STEM Ambassadors are eligible volunteers as defined by the Police Act 1997 (criminal records) Regulations 2002 and as such the disclosure check is carried out free of charge. Currently, this means that the volunteer cannot benefit directly from their work and cannot use it as accredited CPD. We believe this situation should be reviewed so that enhancement

WHEN MY SCIENCE TEACHER SAID THERE WAS NO POINT TRYING FOR A HIGHER GRADE, I WANTED TO GIVE UP. I MEAN, IF A TEACHER SAYS YOU’RE NOT GOOD ENOUGH, THEY MUST KNOW. THEY’RE A TEACHER

and enrichment activities may be linked to career progression but that so disclosure checks remain free of charge. We also recommend investment in more Public Engagement positions and dual activity roles in line with the priorities of the RCUK Concordat on Engaging the Public with Research.

Owner: STEMNET, BIS

Partners: The Girls' Network, Social Mobility Foundation, FutureFirst, ScienceGrrl, Inspiring the Future, STEM Employers, RCUK, schools, CASinclude

3.4 THE CLASSROOM:

3.4.1 TEACHER EDUCATION AND TRAINING

IN THEIR 'CLOSING DOORS' REPORT THE INSTITUTE OF PHYSICS (2013) CLEARLY SHOW THAT GENDER STEREOTYPING IS A PROBLEM IN SCHOOLS – FOR BOYS AS WELL AS GIRLS

Teacher–student relationships contribute significantly to levels of engagement in the classroom, especially for girls 'where girls' self-concept is less positive relative to boys' (Murphy and Whitelegg 2006).

As Keziah, 14 years old, told us 'when my science teacher said there was no point trying for a higher grade, I wanted to give up. I mean, if a teacher says you're not good enough, they must know - they're a teacher.' Raising expectations means girls are more likely to answer 'YES' to the question 'do I feel confident?'

There is some evidence that single sex teaching and learning impacts positively on girls' participation and achievement in STEM subjects. Part of the explanation is that in single sex teaching girls primarily identify as 'students' rather than 'girls'. However, other factors are significant too: in particular having a relevant curriculum taught by teachers who have high expectations of girls (Murphy and Whitelegg 2006). We must address structural inequalities so that this is true for every school.

In their 'Closing Doors' report the Institute of Physics (2013) clearly show that gender stereotyping is a problem in schools – for boys as well as girls. They argue that schools and school governors have a duty of care to reflect upon their own statistics around gender participation and put in place whole school measures to counter gender stereotyping.

The above points to the importance of teacher education and training (Murphy and Whitelegg 2006, and also Council for Science and Technology 2013). There are insufficient specialist STEM teachers (HM Government 2012), so this requires both additional approaches to recruitment (Council for Science and Technology 2013), and improving the quality of training for generalist teachers. Training for teachers should include awareness of the differential engagement of male and female students in STEM disciplines and the potential impact teachers can have on this, together with practical strategies for making the curriculum relevant and for teaching in more student-centred ways.

Teacher training could also include case studies about promoting subjects to girls. Ofsted (2011) found that one school had been effective in challenging stereotypes and 'hard selling' mathematics to young women, resulting in equal numbers of male and female students starting the subject in Year 12. In the previous three years the same course has been male dominated. Also, in a school specialising in applied learning with a female headteacher with enthusiasm for technology, 94% of girls studied design technology at Key Stage 4 and an unusually high proportion continued studying technology at A-level. Five progressed to study for engineering degrees (Ofsted 2011).

The Institute of Physics (2012) recommends that gender equity and access to all subjects should be actively addressed in all schools, and that gender targets be introduced (for A-level physics). These would require gender stereotyping by teachers and pupils to be actively challenged both in and out of lessons and across all subjects.

IN A SCHOOL SPECIALISING IN APPLIED LEARNING WITH A FEMALE HEADTEACHER WITH ENTHUSIASM FOR TECHNOLOGY, 94% OF GIRLS STUDIED DESIGN TECHNOLOGY AT KEY STAGE 4

5. RECOMMENDATION BRINGING THE GENDER LENS TO TEACHING

5.1 We recommend equality and diversity training (building on the gender science awareness materials recommended earlier) be mandatory for teacher training to challenge unconscious bias for trainee teachers, New Qualified Teachers (NQT) and in-service training for experience teachers. We are aware that The Girls' Network and TeachFirst are exploring positions in schools with a specific responsibility for gender equality as part of a whole school ethos, we would like to see this explored further.

5.2 We support the Institute of Physics (2013) recommendation that gender equity should be part of the Ofsted inspection criteria, so that a school cannot be judged outstanding if there are clear participation issues that are not actively being addressed.

Owner: DfE, schools, Ofsted, National STEM Centre,

Partners: Gender Science Taskforce members from recommendation 1, Gender Education Alliance, TeachFirst, National Science Learning Centre, The Girls' Network

3.4.2 PRIMARY EDUCATION

Some organisations and initiatives are focused on enhancement and enrichment activities in primary schools. For example, National Grid's '[School Power](#)' resource is an interactive website and education resources focused around energy, forces and materials and is focused on 4–11 year olds. The British Science Association's [CREST Star](#) scheme is focused on 5–11 year olds and enables them to solve STEM problems through practical investigation. [Primary Engineer](#) have developed a set of activities that can be delivered in primary schools. They offer training to teachers to enable them to deliver these projects in their classroom. They also hold cross-school challenge days that enable students to come together to showcase and celebrate their projects.

However, these initiatives are generally underfunded and do not have the scope to have a significant national impact. Many funding sources for enhancement and enrichment activities are focused at the 11–16 age group and this does not adequately support primary school STEM education that is already struggling to inspire young children in STEM (as discussed in the challenges section). We argue that this is a particularly pressing issue and a significant gap in current provision.

The Wellcome Trust are supporting primary schools in gaining access to specialist science teachers. They have worked with the National Science Learning Centre to develop a [CPD programme](#) for primary science coordinators who wish to strengthen their science teaching expertise. This has been designed to develop the confidence, subject knowledge, teaching expertise and subject leadership skills of participating teachers. We support this scheme and call for further investment in the recruitment of specialist teachers.

PRIMARY SCHOOLS

Kate Bellingham trained as an engineer before working in television, she is Education Ambassador for [BLOODHOUND STC](#) and President of [Young Engineers](#). She told us that:

'Primary schools often lack STEM support. Even though STEM ambassadors are available to support primary schools, there is a limit to how much time they have. Those who are not working, or part time, and perhaps not yet registered as STEM Ambassadors, may have a lot to offer. In particular, there is a lack of female STEM role models for primary schools children (both boys and girls). While they may have predominantly female teachers, few of these will have STEM qualifications or experience.'

*'I NEED TIME SET ASIDE TO LEARN
HOW TO DELIVER STEM CAREERS
ADVICE AND ENRICHMENT'*

Many parents/carers help out in school in primary school with reading, however anecdotal evidence suggests they are rarely encouraged to help in their area of expertise. By offering STEM support, linking into the STEM Ambassador network they could help address this need – and build useful skills for returning to STEM employment themselves, if they so choose to.'

6. RECOMMENDATION PRIMARY SCHOOL SCIENCE

6.1 We recommend proactive, rather than responsive, STEM Ambassador teacher support to primary schools (so that every school has access to specialist knowledge and links to resources) and a drive by STEMNET to recruit stay-at-home parents with STEM skills as Ambassadors. This will require more resources for STEMNET.

6.2 We support recommendations of others to incentivise recruitment of specialist science teachers.

6.3 We recommend increased funding streams for Primary Science enhancement & enrichment from all stakeholders.

Owners: BIS, STEMNET

Partners: Funders, Primary School enhancement and enrichment specialists (e.g. CREST Star, National Grid Primary Power, Primary Engineer), Tomorrow's Engineers, British Science Association, STEM employers

3.4.3 CURRICULUM

The literature shows that girls are not fully engaged by the curriculum contents and pedagogy frequently used in STEM subjects (e.g. Murphy and Whitelegg 2006). There is discussion about teaching topics that are relevant to female students' interests and wider real world issues.

Murphy and Whitelegg (2006) call for a more active student-centred approach that includes investigative lab work, group and class discussions, problem-solving and project-based activities where students are the decision makers. There is emerging evidence that these strategies impact positively on the achievement levels of girls as a group relative to boys and that there are no negative impact on boys' overall achievement. In addition, it is clear that embedding such skills is valuable to employers.

'All our research with industry has stated that pupils are not leaving with the right skills. Moving science back in a skills direction instead of the direction it is going towards in terms of curriculum 2014 is a priority'

NIMISH LAD, HEAD OF SCIENCE WOOTTON UPPER SCHOOL

These recommendations require a move away from models of teaching that transfer knowledge to more active learning approaches where teachers facilitate and guide, and has implications for pedagogy and assessment in classrooms. Such an approach also requires a re-evaluation of the curriculum. This could build on specialist resources already provided by the sector, for example the Royal Society's ['Invigorate'](#) website and also their [Partnership Grants scheme](#) that bring STEM professionals into the classroom for novel

and collaborative projects. The Institute of Physics (2013) supports this by recommending that curriculum developers should reflect on the curriculum content and the types of assessment to ensure meaningful access to all.

For example, showing how maths relates to the workplace and the British Interplanetary Society's new [Space A-level](#) initiative are examples of increasing relevance. Wolf (HM Government 2010), Hodgen and Marks (2013) and Aspires (2013) argue for alternative, vocationally relevant courses to be available, or for maths learning to take place in the workplace, something that has been taken on board by Government with the new [core maths qualification](#) and '[Tech Bacc](#)' performance measure. Another way of reinforcing the relevance of STEM is to capitalise on the potential enhancement and enrichment opportunities offered in the local STEM ecosystem. For example, integrating with schemes like CREST that have been shown to enhance employability skills, offer real world experience of STEM and achieve a gender balance is one point of synergy:

'We offer suggestions on how our CREST coordinators could encourage the schools in their area to work with more girls. There are no quick wins, but bringing it up in conversation is certainly the first step. I don't think there's a need to tailor content for girls, beyond making sure the relevance to wider society is explicit throughout.'

KATHERINE MATHIESON, BRITISH SCIENCE ASSOCIATION

We agree with this approach – active awareness of the gender issue, working locally to implement change, but talking about relevance for all. We must stop talking about 'teaching topics that are relevant to female students' interests' which implies that girls are somehow 'other'. We must move towards an integrated approach that recognises the weight of cultural messages and accepts that girls and boys are currently poles apart when it comes to answering the question 'is it for people like me?' Changing the curriculum to appeal to stereotypically female interests is patronising and will only reinforce the gender divide over time. We don't need to make the STEM curriculum pink to widen its range.

WE MUST STOP TALKING ABOUT 'TEACHING TOPICS THAT ARE RELEVANT TO FEMALE STUDENTS' INTERESTS' WHICH IMPLIES THAT GIRLS ARE SOMEHOW 'OTHER'

CREST AWARDS

The [British Science Association's](#) well-respected CREST Awards are a fantastic example of project-based learning (CREST 2009–11). The CREST ethos is to encourage independent thought together with creative and practical approaches to learning and also provides students with real world experience of STEM. The evidence all shows this is key to engaging students. Importantly CREST also reliably delivers equal participation of boys and girls – even in physics-based projects.

'It's not dumbed down, like the lessons. You're given the challenge and you've got to find the solution to it'

It's not just STEM skills and aspirations. There is strong evidence that participation in the CREST Awards 'introduce and enhance wider employability skills' such as self-management, problem solving, communication and business understanding.

In our conversations with stakeholders, it is clear that expanding the reach of CREST would be valuable, but that this would require a review of the delivery model and an increase in breadth to bring in engineering and maths projects. We believe this last point would be best achieved with industry backing for the CREST Awards.

'The danger is that Science can seem too distant and abstract. It takes on status and social value when students see that STEM is integral to the likes of Coca-Cola, Apple, L'Oréal, Tesco. If local companies can take a direct interest in students' CREST projects, so much the better.'

CREST is endorsed by UCAS for inclusion in a student's personal statement and is an accredited contribution to the Extended Project Qualification by Edexcel and we feel this recognition should be expanded to indicate the value of practical STEM experience.

With support from the sector – for example a commitment to delivery by STEM Ambassadors and the support of Engineering UK to help connect CREST with employers as a valuable template product – we feel that CREST could be scaled so that its benefits were more widely felt.

'This survey suggests that participation in CREST has impacted positively on the attitudes and plans of around half of the students involved... amongst those whose attitudes have not changed is a significant proportion of students who had already decided for Science. There are virtually no negatives.'

7.

RECOMMENDATION: BRINGING THE GENDER LENS INTO THE CURRICULUM

7.1 We recommend that the Department for Education (DfE) commission a diversity review of STEM curriculum at Primary and Secondary levels. This should review the topics covered, pedagogy and assessment issues, and consideration of the inclusion of women and non-stereotypical STEM careers in the curriculum.

Owner: DfE

Partners: Gender Science Taskforce members (see 1.2), Gender Education Alliance

3.5 THE POTENTIAL WORKPLACE

3.5.1 EXTENDING THE CURRICULUM IN PARTNERSHIP

The Aspires (2013) report suggests an alternative approach to career education: to integrate STEM careers awareness into mainstream science and mathematics teaching over the 10 – 14 age period, as in other high-performing economies (OECD 2010). An embedded approach would be beneficial as the evidence from a range of sources (including Aspires 2013) indicates that if students can see the relevance of their learning, and it is connected to future employment, they are more likely to engage with a subject. However science teachers do not feel able to keep up to date with relevant careers education information (Kumar et al 2013). It would therefore be necessary to provide additional support to subject teachers to facilitate the integration of STEM careers awareness into mainstream teaching. This can be achieved through STEM professionals engaging in the classroom. There are various examples where this is currently happening, although female role models are not always well-integrated into mainstream approaches.

Many of the mainstream interventions centre on the idea of providing exposure to STEM subjects, professionals and employment opportunities, or enrichment activities. Straw et al (2011) define a STEM enhancement and enrichment activity as providing schools with opportunities to deliver more relevant content in an exciting and challenging way. For example, the Royal Society runs an [Associate Schools and Colleges scheme](#) that brings together a 'network of enthusiastic teachers who share their experience' and are supported with specialist resources.

Extending the curriculum through engagement with STEM professionals creates a way of providing girls with exposure to STEM, generating science capital, can broaden career pathways for young women and challenge occupational stereotypes if it is actively embedded into practice (Ofsted 2011).

SCIENCE TEACHERS DO NOT FEEL ABLE TO KEEP UP TO DATE WITH RELEVANT CAREERS EDUCATION INFORMATION IT WOULD THEREFORE BE NECESSARY TO PROVIDE ADDITIONAL SUPPORT TO SUBJECT TEACHERS TO FACILITATE THE INTEGRATION OF STEM CAREERS AWARENESS INTO MAINSTREAM TEACHING

For example, the [Royal Academy of Engineering](#) launched the [London Engineering Project](#) (LEP) with the aim of improving cultural and gender diversity in engineering through partnerships with existing stakeholders. Through a comprehensive DRIVE process for assessing diversity measures in projects before their inclusion and providing diversity training, most LEP activities had a 'minimum 50% participation by girls' (WISE 2009). DRIVE's core diversity principles, embedded from the beginning of the design process is an effective way of using the gender lens in enhancement and enrichment activities and has been used by Tomorrow's Engineers and the British Science Association:

'Our CREST Star scheme was at its developmental stage and the principles of the DRIVE process have remain embedded in the resources produced as part of the scheme.'

ADRIAN FENTON, BRITISH SCIENCE ASSOCIATION

Employers who took part in an Ofsted survey (2011) felt that confidence was the key to progression to non-stereotypical routes for young women. They specify the need to extend practice in preparing for job interviews and in developing young women's presentational skills. Some of the ways employers saw the potential for expanding links to tackle occupational stereotypes were by providing work experience in a wider range of roles to extend choice and by promoting role models and case studies from the local area where young women had moved beyond stereotypical routes.

This report also notes that 'for better or worse' role models shape the views of young women's career choices. For example, 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 and could lead to further opportunities for sponsorship, such as a work experience or careers guidance.

However, although meeting people from business has a positive impact on girls' aspirations this approach has not been developed systematically in most of the schools visited:

'In particular, the positive influence of role models was not planned sufficiently to improve girls' and young women's knowledge and understanding of the place of women in society, or used specifically to challenge gender stereotypes through careers education'

(OFSTED, 2011)

Education and Employers' Taskforce (EETF)

EETF (2010) makes a series of detailed recommendations for establishing a national service to facilitate the engagement of businesses with schools. This includes a single national 'entry point' service for employers to provide them with advice and guidance for engaging with schools, and creating a brokerage service, which is now [Inspiring the Future](#). This is a free service across England with volunteers from all sectors and professions going into state secondary schools and colleges to talk about their work.

Inspiring the Future told us that 'just over 3,800 women have signed up to the programme; over 750 of these women attended events in schools, talking to young men and women about their careers from July 2012–June 2013. Of these female volunteers, 295 work in IT/computing; 293 work in engineering; 116 work in other scientific sectors; 425 work in financial services, and 250 are in the legal profession or in legal services and 70 have specified they would like to discuss the use of maths in the workplace.'

EETF has launched a new campaign called [Inspiring Women](#). Its Director, Nick Chambers, says the aim of this campaign 'is to bring about a culture change where girls, whatever school they attend, have the chance to meet women doing a wide range of jobs and gain first-hand insights into the world of work.'

**'FOR BETTER OR WORSE'
ROLE MODELS SHAPE THE
VIEWS OF YOUNG WOMEN'S
CAREER CHOICES**

**'I HAD THE OPPORTUNITY TO
SPEAK WITH LECTURERS AND
LINKS TO INDUSTRY BEFORE
GOING TO UNIVERSITY -
IT WAS REALLY USEFUL'**

'PLEASE DON'T SEND ME A 500 PAGE RESOURCE PACK, I NEED SOMETHING THAT FITS IN EASILY WITH WHAT I'M ALREADY DOING - SOMETHING THAT DOVETAILS WITH THE CURRICULUM'

EETF argue that coordinated messaging and actions are necessary to ensure that young people at secondary and primary schools are given inspirational role models and engaging careers information to inform choices. EETF suggest that to encourage all businesses (especially small and medium sized ones), to engage with schools the Government should simplify 'red tape' to reduce the associated administrative and financial barriers to this. Furthermore, EETF encourages employers to treat working with schools as they would any other business activity – as crucial to their success. We support their recommendation that an award or quality mark for volunteering and community engagement to provide careers advice and engagement in schools and colleges be introduced.

EETF also suggest the creation of a portal for sharing resources between schools and employers, and training teachers to engage with employers. They also stress the importance of quality evaluation and that school accountability should not be limited to examination results but should include other economic and social outcomes for young people in the longer term.

We believe that Inspiring the Future and Inspiring Women, and their sister programme [Speakers for Schools](#), have huge potential to support activity within the STEM sector, and that encouraging volunteers to talk more generally about their STEM skills will help highlight the breadth of opportunities that studying STEM brings.

STEMNET

STEMNET's vision is to 'increase young people's choices and chances in STEM' through a Government funded STEM Ambassador programme comprising 27,000 volunteers (40% of whom are female) from business and industry that give their time to inspire young people in STEM, managing an advisory network for secondary schools regarding delivery of enhancement and enrichment activities and coordinating the [STEM Clubs Programme](#). In 2013 the STEMNET Evaluation found that 90% of UK secondary schools had engaged a STEM Ambassador at least once a year, up from 82% in 2011. Contact with STEM Ambassadors is hugely beneficial, with increased engagement, knowledge and understanding about STEM and STEM careers being reported by the majority of teachers and students. It is clear that for teachers this impact is due to enhanced real world relevance of STEM and increased confidence and enthusiasm for teaching these subjects (Straw et al 2011). Between April 2013 and March 2014 STEM Ambassadors recorded 21,000 activities, of which nearly 6000 were workshops/challenges, 1200 supporting STEM Clubs and nearly 4000 careers talks. STEMNET records of all activity and engagement indicate that 60% of UK state-maintained secondary schools access STEM Ambassadors on three or more occasions each year. However, in 2011 only 41% of pupils had sustained interaction with STEM Ambassadors and the majority had seen an Ambassador give a talk, rather than interacted with them through an enhancement and enrichment activity.

Extracurricular STEM clubs are hugely effective at engaging students and are an opportunity for students to better engage with STEM Ambassadors and industry representatives. Evaluations suggest that more ongoing and sustained contact with STEM Ambassadors could lead to even greater impacts for pupils (Straw et al 2011).

Some STEMNET clubs target girls specifically, and most have good representation of girls: the evaluation found that 35% of questionnaires were returned by girls. Although STEMNET does not track participation by gender, we feel this is likely to be representative of the gender split in STEM Clubs. It is striking to note however that none of the STEMNET's formal objectives relate specifically to girls, or mention a gender-aware perspective. We would like to see this change, and are encouraged by the recent inclusion of female STEM Ambassadors in the 'Real Life Maths' resource on the STEMNET website.

CONTACT WITH STEM AMBASSADORS IS HUGE BENEFICIAL, WITH INCREASED ENGAGEMENT, KNOWLEDGE AND UNDERSTANDING ABOUT STEM AND STEM CAREERS BEING REPORTED BY THE MAJORITY OF TEACHERS AND STUDENTS

EVALUATIONS SUGGEST THAT MORE ONGOING AND SUSTAINED CONTACT WITH STEM AMBASSADORS COULD LEAD TO EVEN GREATER IMPACTS FOR PUPILS

We also feel that investing in STEMNET would benefit the whole sector, and encourage independent Employer Ambassador schemes to connect with local STEMNET contract holders to share resources, links and experience. Developing the STEM Ambassador scheme in this way could also take better advantage of specialised knowledge and enable more focused training for enhancement and enrichment activity delivery. We believe that streamlining expertise in this way is the key to more sustained, and sustainable, support for schools.

'We have had great results with specialist STEM Ambassadors for both Tomorrow's Engineers and Big Bang programmes. Helping STEM Ambassadors gain skills to deliver our activities is most definitely needed'

SARAH DEVONPORT, ENGINEERING UK

CLUBS

Clubs that engage students' interest in STEM outside the classroom have been proven time and time again to offer a chance to gain knowledge, practical skills, improve confidence, learn where STEM can lead, and to have fun.

'Pupils who attend STEM Clubs are more willing to stretch themselves and ask more probing questions' (Science teacher, Case study 4).

'49% of pupils who have had contact with a STEM Ambassador and 61% of STEM Club members want a job that involves STEM, compared to 37% of all pupils'

There is huge scope to grow and develop these clubs and we feel strongly that building on the potential for links with STEM Ambassadors and Employers is the key to scaling. For example, an evaluation of the 2007–09 After School Science & Engineering Club initiative (DCSF, 2008) notes that 'less than 10% of clubs had visited a business' and visiting a workplace accounted for 28% of STEM Club activities. Also, only 22% of teachers had involved STEM Ambassadors in their STEM Clubs. It's clear from published evaluations and our conversations that funding, the burden on teachers' time and availability of resources are the main barriers to expanding STEM Clubs.

Funding is a particular issue at primary level because most support is being directed towards the 11–14 age group. ScienceGrrl funded a Brixton-based primary school science club for girls because we feel that building identity at these ages is key to feeling that STEM is 'for people like me'. STEMNET has developed a set of videos to support STEM Club leaders in establishing and running engaging Clubs for their pupils.

'The girls really understand that doing science is about investigating and asking questions. What does it look like? How does it feel? What's happening? Why? How do we know? They now all agree that science is fun and have had the chance to meet a physicist, a microbiologist specialising in malaria, a bat ecologist, an engineer, an astrophysicist and TV producer. 'I didn't know this was science!' has been a common exclamation.'

BETH RICE, PEACH STEM CLUB FOR GIRLS 6–10 YEARS OLD

We feel that one way of addressing the other barriers is to streamline activities into those proven to work and that both teachers and STEM Ambassadors could be trained to deliver. This could build on the [Powerful Practical](#) resource developed by STEMNET, available on the National STEM Centre website. For example, in 2011 only 20% of STEM Clubs delivered

CREST Awards – this is an ideal opportunity for expansion. Another way is to empower STEM Ambassadors to support teachers with resources as discussed in recommendation 4.2.

Another area for development is the current focus on science at the expense of engineering and maths. Partnerships with [Tomorrow's Engineers](#), Young Engineers and Primary Engineer seem worth developing. In addition, with support from BIS and [EngineeringUK](#) local employers could be encouraged to directly fund with STEM clubs and integrate their expertise into projects, such as the Jaguar Land Rover [CREST maths challenge](#). This could be done in a creative way that encourages information sharing between schools through partnerships with the [Big Bang Near Me](#). Industry involvement would also expose students to technical routes, which would help widen participation.

'You can see exhibitions about engineering, you can be told about it, you can look at pictures, watch videos and read books, but until you've had a go for yourself you haven't experienced the thrill of it! At first I was interested. Now I'm addicted'

'By doing [an engineering club] we took the engineering course, the diploma, which was really good, because it really, like, inspired us to do engineering because we all enjoyed it' (Straw et al, 2011)

Tomorrow's Engineers

EngineeringUK and the Royal Academy of Engineering offer a careers programme called Tomorrow's Engineers (Engineering UK 2013). It is delivered by a broad partnership between STEMNET, business and industry, the engineering profession, activity delivery organisations and schools. The long-term aim is to reach every state-funded secondary school in the UK in order to raise awareness of engineering, inform about career opportunities and encourage young people to make the subject choices that keep routes into engineering careers open.

They have developed gender-aware careers information and resources to be used as part of the programme, and a communications strategy designed to ensure that the wider population understand that studying science and mathematics subjects at school, college and university can open up a whole range of exciting and rewarding career opportunities in the real world. Tomorrow's Engineers worked with 37,941 students of which 18,591 were girls in 2012/3 and '36% of girls who took part in a Tomorrow's Engineers activity felt that a career in engineering was desirable, compared to 23% in our all UK survey. Compared to 59% and 57% for boys'.

The Big Bang Fair

The largest single intervention aiming to 'improve young people's and adults' perceptions of STEM' is the [Big Bang Fair](#). Led by EngineeringUK, this is intended to be a collaborative partnership between British Science Association, the Science Council, the Royal Academy of Engineering and Young Engineers, and is supported by BIS and industry.

There is no doubt that The Big Bang Fair has positive effects on all those who visit it, in terms of enjoyment and awareness of careers (EngineeringUK, 2012). This was especially true for girls, whose preconceptions were challenged by the event. We are excited by the development towards Regional Fairs because we feel they could play a valuable role in developing local connections with employers, schools and science centres. As Penny Fiddler (CEO, UK Association of Science and Discovery Centres) told us, such venues are ideal physical hubs for partnerships:

'Each year, 10 million women and girls choose to go to science centres across the UK to get involved in science (192,000 each week). 1 million of these are school girls participating in curriculum-linked inspirational science'

WE ARE EXCITED BY THE DEVELOPMENT TOWARDS REGIONAL FAIRS BECAUSE WE FEEL THEY COULD PLAY A VALUABLE ROLE IN DEVELOPING LOCAL CONNECTIONS WITH EMPLOYERS, SCHOOLS AND SCIENCE CENTRES

and engineering workshops. All science centres work hard to ensure their exhibitions and science programmes are equally appealing to girls as boys, and many have specific programmes to inspire more girls. Indeed over half of the scientists that visitors meet when they visit with families and schools are female, acting as role models every day.'

We understand that the Big Bang UK Fair is important to unify the brand, but we worry that Universities and smaller employers are being priced out – and that this may become a barrier to engagement with Regional events. We would like to see an open debate on the UK Fair, in terms of cost, impact and inclusivity. It would also be interesting to explore partnerships with TeenTech, who collaborate with Universities, industry and Education Business Partnerships to run events that inspire and inform young people about opportunities in STEM.

BIG BANG @ SCHOOL

As part of their drive to engage schools with STEM employers on a local level, Engineering UK have creatively expanded their Regional Big Bang Fairs into local events '@' schools through the development of a toolkit. Sarah Devonport who leads the initiative told us that 'a pilot scheme is currently in process and has already proved to be popular with both schools and colleges. It's helping break down some of the barriers to schools getting involved in the Fairs, such as geography and cost'. One of the schools that participated in the pilot is Redmoor Academy led by Head of STEM, Jo Cox:

'Our first Big Bang @ School has been a great experience. We've developed good relationships with local organisations as well as neighbouring schools. We're passionate about STEM at Redmoor Academy and hosting a Big Bang has been an excellent way to enthuse our pupils about the possibilities that STEM opens up to them.'

Faisal Khan also ran a successful Big Bang @ The Market Bosworth High School. He also feels the event offers mutual benefits because 'companies receive firm – and marketable – links with the local community of potential employees.'

It's not just the toolkit that makes The Big Bang @ an exciting development, it's the opportunity for a wide range of stakeholders to collaborate and work towards a shared mission and the valuable support that this brings to schools:

'We were able to tap into their expertise as well as their resources and contacts, which made life so much easier than starting from scratch.'

In total, the Big Bang @ Redmoor Academy was a collaboration between 11 local employers (including Campbell Scientific, Triumph Motors, Severn Trent, Bletchley park, Caterpillar, National Grid UK and Recognition Express Coventry) and 7 organisations from the STEM sector (STEMNET, Young Engineers, British Science Association, STEM ambassadors, IOP and Greenpower Education Trust) working together to support 12 local schools, including nurturing mentoring relationships between primary and secondary schools. Sarah Devonport joked that 'in the end, the Big Bang Near Me team probably did the least!'

We feel that building up the local STEM ecosystem within a national framework such as this would offer the flexibility to meet local needs, and could also help kick-start the strong relationships that really make things happen.

However, despite the hive of activity (including the grassroots initiatives mentioned in the 'home and personal networks' section) the sector is not integrated into the formal delivery of STEM education or well-coordinated amongst itself. We believe this is a wasted opportunity and invite further consideration regarding how to unify the STEM sector in Recommendation 10.

8. RECOMMENDATION

SUPPORT PROJECT BASED, CREATIVE & REAL WORLD LEARNING

8.1 We recommend that DfE review the decision to cut their funding of the CREST awards and argue for increased backing from other sources. The scheme is one that has been shown to engage students, provide employability skills, engage industry, is UCAS-accredited and achieves a gender balance. This is especially important in hard to reach schools where students have lower science capital. We recommend consideration of matched funding from STEM Employers to expand the scheme to enable more CREST partnerships with charities and employers that are in line with employer interests and needs. We also recommend that stakeholders consider how the CREST delivery model could be updated to something more sustainable.

8.2 We recommend that Tomorrow's Engineers work together with CREST and STEM employers representatives to develop and strengthen the engineering CREST project portfolio.

8.3 We recommend that collaboration between local STEMNET contract holders and The Big Bang Near Me scheme is formalised, including data sharing. This could capitalise upon the networks of both partners to encourage industry to channel activity through STEMNET, developing relationships at a local level, to facilitate delivery of the programmes we know are effective.

8.4 We recommend further investment in STEMNET and a review of activities in the next funding round to help deliver these programmes.

8.5 We imagine that in practice, these recommendations will require a joint mission to be drawn up between all owners. This should include a pledge to open data and progress meetings at BIS. The partners should also arrange opportunities for their teams to meet and share expertise, perhaps in a conference style setting. In the longer term, this could help drive a collaborative funding model.

'STEMNET works with many partners to support STEM enhancement in schools. We are always keen to share knowledge and examples of good practice, which STEMNET sees during its work with all secondary schools in the UK, to ensure schools are supported and benefit in inspiring young people in STEM.'

STEMNET

'We would welcome the opportunity to share our data and knowledge with Government and Partners'

ENGINEERINGUK

'We are keen to share our learning with collaborators. There is a need for Government support to enable the key providers of STEM enhancement and enrichment activities to share data that will help them make their provision for schools more timely, more tailored and ultimately, more effective.'

BRITISH SCIENCE ASSOCIATION

Owner: BIS, BSA, Engineering UK, STEMNET

Partner: STEM Employers, DfE

3.5.2 THE POTENTIAL WORKPLACE

Work-related learning

Much of the literature is underpinned by a belief that effective careers education requires a partnership with employers. This has perhaps been most comprehensively demonstrated in research from the Education and Employers Task Force (EETF 2010), who show that the overwhelming majority of young people and employers would value a more active role.

**EFFECTIVE CAREERS
EDUCATION REQUIRES
A PARTNERSHIP
WITH EMPLOYERS**

Work placements and related activities provide an opportunity for students to gain valuable work experience (UKCES 2012), to learn about different careers in an applied way and challenge gender stereotypes. Ofsted (2011) also found that impact of interventions was more effective in an on-going arrangement rather than a one-off activity. In agreement with EETF findings, this suggests the 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). To facilitate work experience, Wolf (HM Government 2010) recommends the government consider reimbursing employers for providing work placement opportunities and that schools and colleges should be encouraged to prioritise longer internships for older students.

THIS SUGGESTS THE 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

There are examples of industry led schemes that target girls and young women specifically. For example, as part of their business partnership scheme, Jaguar Land Rover runs '[Young Women in the Know](#)', a five day course that gives young women in Year 11 or above the opportunity to meet female role models onsite. The company has also recently launched 'Girls in the Know'. Rolls Royce has a similar residential programme for 14–15 year old girls called '[Outward Bound](#)'. Atkins have published a careers research study highlighting talented female engineers (Atkins, 2013). Other examples of employer engagement are the [BAE Systems Schools Roadshow](#) and also the [National Grid Careers Lab pilot](#), the results of which are due in Summer 2014. A partnership between EADS Astrium, UK Space Agency, the Ogden Trust and Leicester University offers boys and girls the chance to meet space scientists and potential employers at [Space School UK](#). Of course, universities themselves have solid engagement programmes: for example, the Imperial College London '[Reach Out Lab](#)'; the University of Nottingham's [Science Outreach Programme](#); and [Discover STEM](#) run by the University of Sheffield. The Research Councils UK [Concordat for Engaging the Public with Research](#) sets out some principles of engagement and also points to student engagement as a priority. RCUK also funded [Research Catalysts](#) to embed engagement into HEIs as a valued activity. We believe the public and private sector should be supporting each other when it comes to the future of young people.

STEM COLLEGES

[Algenuity](#) are a company that build foundational technologies to support, catalyse, and propel the emerging algal biotech industry. They are based in Stewartby, located near Kimberley STEM college. The BTEC Level 3 applied science group visited the company labs and completed activities linked to the curriculum. Subsequently, a worker from Algenuity showed the students their results via a live Skype call. The success of this activity was down to its relevance to the curriculum and also having activity taking place both on a laboratory site and in school via a live Skype call. However, a member of staff at the school told us that reliance is totally on the networking skills of these people within the school, and their pre-existing links with industry.

Companies such as Jaguar Land Rover put a call out for their employees to become school governors. We recommend that such practice be encouraged to help strengthen relationships between schools and industry.

'[See Inside Manufacturing](#)' is a partnership between BIS and industry that aims to 'shake up old fashioned views of manufacturing.' It has the support of companies like McLaren Group, BAE Systems, Airbus, Nestle UK and Ford among many others. GKN Aerospace provided us with three female case studies. The case studies offered an insight into the proactive approach taken by GKN Aerospace regarding women in manufacturing, with one student detailing a tour by a senior woman and another student saying:

WE BELIEVE THE PUBLIC AND PRIVATE SECTOR SHOULD BE SUPPORTING EACH OTHER WHEN IT COMES TO THE FUTURE OF YOUNG PEOPLE

WE WOULD BE INTERESTED TO SEE A GENDER BREAKDOWN OF SEE INSIDE MANUFACTURING'S SUCCESSES ACROSS ALL PARTICIPATING COMPANIES

'It is a great thing to know that women can get into that line of work on merit and not be discriminated against... overall, the day grabbed my interest and made me think about what the options are for the future'

We would be interested to see a gender breakdown of See Inside Manufacturing's successes across all participating companies. Seeing role models in action and having the chance to experience the workplace are in line with all the evidence base regarding 'what works' for breaking down both gender and STEM stereotypes.

We are pleased to note that in a letter to The Times, Peter Luff, MP and representatives from WS Atkins, National Grid, Jaguar Land Rover, Airbus Group UK, GKN and Babcock International, BAE Systems called for unity of action. We feel that this mission is best achieved through developing collaborative frameworks rather than through a single institution.

Technical routes

Vocational qualifications have the potential to combine education with exposure to STEM professions. The Wolf report (HM Government 2010) makes sensible and challenging proposals to improve vocational education, but there is little in the report specifically addressing gendered participation and stereotypes. The industry members of the Automotive Council expect to take on more than 7,600 apprentices and 1,700 graduates over the next five years, and the Automotive Council UK (2013) is working together to improve the quality and quantity of apprentices, graduates and postgraduates in the automotive industry (Automotive Council UK 2013). The problem of the underrepresentation of girls and young women is recognised, but the gender lens is not being used effectively to address the lack of female apprentices.

In order to promote apprenticeships EETF (Education and Employers Taskforce and Price Waterhouse Coopers 2012) recommend that the employer strategy should raise awareness of apprenticeship routes. This includes giving careers talks in schools, and following this up with work experience or job shadowing to give a realistic insight into what the prospective apprentice can expect. They also propose supporting apprentices to be successful in their applications through transparency and practical support such as mock interviews, which is unsurprisingly similar to good practice in careers advice more generally. Research by the EETF has shown that to be truly effective, employer contacts with young people have to be situated within a coherent programme of careers support where professional advice and access to up-to-date materials supplement first-hand insights into the working world. We argue that it also has to be informed by the gender lens.

University Technical Colleges (UTCs) represent a more formal approach to embedding employer knowledge into learning. These colleges were first launched in 2009 and 'focus on providing technical education that meets the needs of modern employers' (DfE, 2012). UTCs are supported by the Baker Dearing Educational Trust and are sponsored by local universities and employers. There are some concerns that uptake is slower than expansion of the scheme, with capacity ranging from 30% (Central Bedfordshire UTC) to 76% (Aston University Engineering Academy) according to the Hansard records of the answer to a Parliamentary Question directed to the Secretary of State for Education in November 2013.

In addition, young women are, unsurprisingly, underrepresented. For example, we were told that Bristol Technology and Engineering Academy is '7% female for this academic year, and approximately 10% for next'. Similarly, JCB Academy recognises the need to drive up their female intake, aiming to increase it from 12% 'to around 25% over the next 5 years'. We spoke to Neil Patterson, Principal of [Silverstone UTC](#) who told us that next year's Engineering female applications were around 5% in Year 10 and 11% in Year 12. He stressed to us the importance of challenging perceptions:

RESEARCH BY THE EETF HAS SHOWN THAT TO BE TRULY EFFECTIVE, EMPLOYER CONTACTS WITH YOUNG PEOPLE HAVE TO BE SITUATED WITHIN A COHERENT PROGRAMME OF CAREERS SUPPORT WHERE PROFESSIONAL ADVICE AND ACCESS TO UP-TO-DATE MATERIALS SUPPLEMENT FIRST-HAND INSIGHTS INTO THE WORKING WORLD. WE ARGUE THAT IT ALSO HAS TO BE INFORMED BY THE GENDER LENS

'We discriminate without even knowing it. One young woman I spoke to, who was doing her year in industry, told me that one of the things that was a concern for her when choosing engineering was that she might not be strong enough to carry out some physical activities in an engineering workshop, and that if that happened, she would have considered herself a failure.'

'We use tools so to make the job easier, and if the tool doesn't work for everyone, we are discriminating. We should question the tool, not the ability of the person using it. We would jump to make a new tool for someone with a disability – but not to cater for the full range of physical strength in humankind.'

NEIL PATTERSON, PRINCIPAL SILVERSTONE UNIVERSITY TECHNICAL COLLEGE

WE ARE PLEASED TO HEAR THAT WISE AND THE ROYAL ACADEMY OF ENGINEERING ARE DUE TO LAUNCH A BOOKLET ADVISING UTCs ON HOW TO RECRUIT YOUNG WOMEN

Jo Lopes, Head of Technical Excellence at Jaguar Land Rover supported this view. He told us that one of the key reasons the 6th form at Warwick UTC was full, with 18% female applications, is that there had been a coordinated and concerted effort to get employees out into schools, to show the students what engineering was really about and the advantages of a technical route. We are pleased to hear that WISE and the Royal Academy of Engineering are due to launch a [booklet advising UTCs](#) on how to recruit young women.

9.

RECOMMENDATION

STEM RESOURCES: TECHNICAL ROUTES

9.1 We recommend raising awareness of CPD modules that allow teachers to explore technical routes. Such CPD modules should be signposted through the DfE careers framework we have proposed in recommendation 11.

9.2 Both Professor John Perkins and Professor Alison Wolf have called for streamlining of technical routes into STEM, which we support.

9.3 In the longer term, we recommend that knowledge of all routes into STEM be integrated into teacher training. It will be particularly important to consider the stereotypes that prevent girls entering these routes in such training.

Owner: BIS, National STEM Centre, National Science Learning Centre

10.

RECOMMENDATION

UNIFYING THE STEM ECOSYSTEM

10.1 We recommend a more rigorous investment in developing an understanding of good practice for enhancement and enrichment activities and programmes. We suggest that the RCUK Concordat for Engaging the Public with Research and the UK [Science and Society Charter](#) could be developed into a series of core principles for engaging young people. We recommend seeking public and private sector signatories to such a document. Core principles of engagement might include that an activity should have real world relevance, develop employability skills and bring young people into contact with STEM professionals.

10.2 There is a need to measure the effectiveness of enhancement and enrichment activities through agreed and common metrics. These impact assessments should include a pledge for open data so that opportunities for learning can be maximised across the sector and can be fed into the development of best practice guidance for enhancement and enrichment (as in 10.1). This evidence base will also enable scaling of initiatives that work by providing clear impact metrics to investors.

10.3 We call upon the Government to take leadership in uniting STEM employers across the public and private sectors. Government should encourage and incentivise collaboration using its procurement and funding processes, and with policy incentives and kite marks.

Owners: DfE, BIS, RCUK
Partners: STEM sector

THIS REVIEW FINDS LITTLE EVIDENCE RELATING TO THE WAYS IN WHICH CAREERS EDUCATION IS BEING USED TO MAKE STEM SUBJECTS AND CAREERS MORE ACCESSIBLE TO GIRLS, OR CHALLENGING GENDER STEREOTYPES

WE FEEL THAT THIS MOVE THAT WILL CAUSE LESS WELL-EQUIPPED SCHOOLS AND THEIR STUDENTS TO SUFFER, UNLESS ON-THE-GROUND SUPPORT AND CLEAR ADVICE IS PROVIDED THROUGH THE TRANSITION PERIOD

3.5.3 CAREERS GUIDANCE

Access to reliable information can transform the way in which young people make decisions (The Education and Employers Taskforce and Price Waterhouse Coopers 2012). However, this review finds little evidence relating to the ways in which careers education is being used to make STEM subjects and careers more accessible to girls, or challenging gender stereotypes. There is widespread agreement that currently careers advice and guidance is not achieving as much as it could or should (Hughes 2011, Ofsted 2011 & 2013, House of Commons Science and Technology Committee 2013). An example is the careers working group set up by EngineeringUK, which consists of professional engineering institutions and major employers collaborating to create clear, simple, and unified messages that are gender-aware.

We believe that the new duty on schools to provide independent careers education is ill-advised. This is supported by Ofsted's 2013 report, 'Going in the right direction?' which says that only 12 out of the 60 schools they visited provided a 'wide breadth' of careers advice. Further they confirm that 'the DfE's guidance does not prescribe clearly enough the way that schools should provide students with independent and impartial guidance'. There is not sufficient local infrastructure to support good careers education and good work-related learning. We feel that this move that will cause less well-equipped schools and their students to suffer, unless on-the-ground support and clear advice is provided through the transition period.

Hughes (2011) recommends that the government should guarantee face-to-face careers advice for all young people in schools, and that there should be stronger requirements on schools to provide detailed information about careers and academic and vocational pathways. Hughes also says that primary schools should arrange for 10 and 11 year olds to attend careers events where parents, family members and others come in to talk to pupils about their jobs and work, and to give pupils the opportunity to ask questions about how to obtain and qualify for them.

Other recommendations are that the Government should direct the new [National Careers Service](#) to ensure that appropriate advice is given to young people on the following: STEM subject choice at school and its possible consequences for future study and careers; the choices available within STEM subjects at HE level and beyond, and the advantages of pursuing a STEM degree; and relevant careers advice that highlights the jobs available to STEM graduates both within STEM and in other industries (HM Government 2012). Neither Hughes (2011) nor HM Government (2012) address the issue of relevant careers education for girls.

Ofsted's (2011) recommendations focus more explicitly on careers education for girls. Although they call for more information about non-stereotypical roles for women, it is worrying that provision about information on careers and parenthood is specifically directed at girls.

Two reports (Ofsted 2011 and House of Commons Education Committee 2013) comment on the lack of careers destination information schools have about students, both to evaluate outcomes and inform school practices. This however would only benefit girls if the indicators included a gender dimension and the subsequent improvements incorporated an approach with sufficient gender-awareness to make STEM subjects and careers relevant to girls and women, and to challenge gender stereotypes.

This leads us to point out a striking representation of the disjointedness we are referring to: specialised careers websites for STEM already exist. These include, for example [GradCracker](#), [GoCracker](#), and [whereSTEMcantakeyou.com](#). Other sites are aimed directly at young women e.g. [EveCracker](#) and some have deliberately developed their content in a gender aware manner, for example the Science Council's [Future Morph](#) website for 11–19 year olds. Over the last year the site has averaged over 5,500 visits per month including a total of 1,600 unique views for the online version of the [SCIENCEGRRRL](#) calendar.

'It would take significant extra resources for a STEM specific careers website to achieve the kind of audience reach that generic careers websites attract, therefore, we should be disseminating our messages through the generic sites and other intermediaries. The focus groups we have conducted and informal feedback has shown that teachers and students find the site useful once they use it but we have struggled to raise awareness of the site'

**NICOLA HANNAM, DIRECTOR OF POLICY AND DEVELOPMENT
AT THE SCIENCE COUNCIL**

'A culture change in careers provision for young people and adults is needed. Business, careers professionals and schools should work together to ensure increased access to high quality work experience and job shadowing. As part of this, employers should commit to ensuring their graduates, trainees and apprentices visit schools regularly to act as role models and deliver more accessible, first-hand insights about the range of career opportunities available'

WOMEN'S BUSINESS COUNCIL REPORT, 2013

11. RECOMMENDATION LEADERSHIP ON CAREERS ADVICE

11.1 We feel careers information should be channeled through the routes people are already using. This involves developing an understanding of where teachers access information. We recommend that such websites (e.g. National Careers Service) make better use of the wealth of specialist knowledge by linking directly to such sites as Future Morph and whereSTEMcantakeyou.com. It is important that sites convey joined up messaging.

Owner: DfE

11.2 It is clear that there are not currently the resources in the STEM sector to fully devolve responsibility of careers advice to schools. We recommend that DfE leads on a clear framework for STEM careers advice that unifies messages across the sector to be embedded into teaching with real world examples. We recommend that these messages should centre around: the earning potential increased by STEM; the marketability of STEM skills; that STEM skills and careers are not just knowledge based, they encompass creativity and contribute to societal impact; and the diverse opportunities provided by STEM. Lastly, STEM is for everyone: technical and academic routes must be given parity.

11.3 In parallel, we recommend that BIS builds on the excellent research done by the Education and Employers Taskforce and leads on a clear framework for work-related learning that capitalises on relationships built through educational enrichment frameworks, for example through offering on-site training as part of a CREST project aligned with business aims. We agree with EETF that there should be a move away from the traditional two week placement and towards long-term, project driven partnerships that can be supplemented with Skype advice sessions with professionals.

This advice should draw attention to unconscious biases and the statistics relating to girls and wider diversity issues in STEM. We recommend this framework be delivered to schools as a single 'STEM careers framework' through DfE.

Owner: DfE

Partners: BIS, Gender Science Taskforce (see 1.2)

WE BELIEVE THAT IT IS THIS TREATMENT OF 'GIRLS' AS A SEPARATE ISSUE IS A FUNDAMENTAL ROADBLOCK TO PROGRESS TOWARDS GENDER EQUALITY IN STEM, DESPITE WIDESPREAD AWARENESS AND EFFORT

CURRENT SOLUTIONS FALL FAR SHORT OF CLAIMING A RESPONSIBILITY FOR ADDRESSING THE SOCIAL MESSAGING AND PARENTAL EXPECTATIONS THAT INFLUENCE CHOICES FROM AN EARLY AGE AND THAT PERMEATE THE CLASSROOM, WORKPLACE AND HOME ENVIRONMENTS

3.6 CONCLUSION

Reviewing the solutions that have been proposed or implemented, we find many initiatives that aim to tackle 'the problem of girls in STEM'. We also find a seemingly parallel and predominantly gender-blind literature discussing how to improve the take up and delivery of STEM education and careers. The separation between 'girls' on the one hand and mainstream interventions on the other, is deeply worrying. We believe that it is this treatment of 'girls' as a separate issue is a fundamental roadblock to progress towards gender equality in STEM, despite widespread awareness and effort.

We argue that progress requires integration on two levels. Firstly, it is clear that the needs and realities of girls and young women are not consistently embedded into messaging from the STEM sector. We find that the majority of current interventions focus on the classroom and the potential workplace, ignoring the wider societal contexts that shape girls' identities. Current solutions fall far short of claiming a responsibility for addressing the social messaging and parental expectations that influence choices from an early age and that permeate the classroom, workplace and home environments. This is the major challenge, and awareness of the gender lens means looking at our society through both eyes. Only when we make invisible barriers visible can we truly start to dismantle them.

*WE SEE THE INGREDIENTS
OF A GREAT TEAM
WHO ARE CURRENTLY
NOT PLAYING TO EACH
OTHER'S STRENGTHS*

Secondly, we argue that there is a lack of cohesion between the stakeholders attempting to address this problem. We have encountered a cacophony of initiatives and organisations, often seeming to be trying to achieve everything alone without taking advantage of tremendous potential for synergy. We think it's time for organisations to re-evaluate such opportunities. However, we suggest that there is currently little incentive for these partnerships to take root. We suggest that they will go where the money is – and strongly argue for a move away from 'capturing the landscape' and towards Government and Industry leadership on backing the frameworks and proven initiatives that are already fighting for air.

SCIENCEGRRRL are new to this sector and our experience on the ground is that, with the best will in the world, progress is not easy. We have met some fantastically committed and passionate people during the course of writing this report. We see the ingredients of a great team who are currently not playing to each other's strengths – we believe this is partly due to a lack of trust and collaborative funding. We also think an open conversation about strengths, weaknesses and mindsets would be hugely beneficial, and probably a welcome relief to many.

There are huge positives to take from our review of the current landscape. One of the most exciting is the scope for synergy. We believe there is much goodwill and passion driving the initiatives that we have detailed here. It is clear that female underrepresentation in STEM is beginning to be taken seriously at the highest levels, and that all stakeholders recognise that the UK is not capitalising on the full extent of our talent and potential. It's now time for action.

STEM is for everyone, and messaging from the sector must represent that. This means having the courage to go back to the drawing board with full awareness of our preconceptions and biases. The solution isn't about bolting on the needs of 'other' groups on top of a stereotypical view of STEM. It is about valuing those needs in the spirit of true equality to give everyone a place at the table.

Our recommendations call for better leadership, partnership, resources and communication in all of the environments that influence whether any student will choose to pursue STEM. Diversity should be at the heart of good practice. This issue is not just part of feminist discourse, it's not really even just about STEM; it is part of a wider discourse on inclusion. This is everyone's issue, and we must now work together to take meaningful action.

SIR PETER LUFF MP: A CALL TO ACTION

We have been talking about the underrepresentation of women in science, technology, engineering and maths – STEM – for decades. This authoritative report is a call to stop talking and start doing. It deserves to be acted on because it is written by genuine experts – young women who are making their careers in the STEM subjects.

STEM skills shortages are the single greatest constraint on the growth of many businesses. I saw this as Chair of the Business, Innovation and Skills Committee and I saw it even more vividly as Minister for Defence Equipment. Indeed, these shortages threaten not just our prosperity but also our security.

We need urgently to develop policies that will bring more young people, boys and girls, into STEM disciplines. And if we could increase the female participation rate in STEM careers we would make a huge contribution to addressing this problem.

'Through Both Eyes' explains just how bad the situation is when it comes to the proportion of girls in STEM subjects and careers and sets out a radical but intensely practical agenda to do something about it.

I challenged **SCIENCEGRRRL** to make suggestions for change, some of which can be made quickly. They have asked young women scientists and engineers what they think, they have spoken to companies about their experience, they have reviewed the many existing reports on this issue, and they have come up with a programme of ideas for change.

Now we must work to make sure the report's recommendations are implemented.

And we are grateful – the **SCIENCEGRRRL**s and me – to our sponsors for their willing backing of this valuable piece of work.

In the 1990s, during the construction of the Konkan railway in India, a notice was pinned to a hut reading, 'I am an Engineer; I serve mankind, by making dreams come true.'

That is what those who work in the STEM disciplines do. They make our dreams come true. And it is in all our interests that girls are at last allowed to play their full part in turning those dreams into reality.

Sir Peter Luff, MP for Mid Worcestershire
Chair, Business, Innovation and Skills Committee, 2005–2010
Minister for Defence Equipment, Support and Technology, 2010–2012

***IN THE 1990S, DURING
THE CONSTRUCTION OF
THE KONKAN RAILWAY
IN INDIA, A NOTICE
WAS PINNED TO A
HUT READING, 'I AM
AN ENGINEER; I SERVE
MANKIND, BY MAKING
DREAMS COME TRUE'***

REFERENCES

- Aspires (2013) *What shapes children's science and career aspirations age 10–13?* Interim Research Summary. London: King's College London
- Atkins (2013) *Britain's got talented female engineers*
- Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B. & Wong, B. (2012) *Science Aspirations and family habitus: How families shape children's engagement and identification with science*. *American Educational Research Journal*, 49(5), 881–908
- Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B. & Wong, B. (2013) *Not Girly, not sexy, not glamorous: Primary school girls' and parents' constructions of science aspirations*. *Pedagogy, Culture & Society*, 21 (1), 171–194
- Archer, L., Dewitt, J. & Willis, B. (2014) *Adolescent boys' science aspirations: Masculinity, capital and power*. *Journal of Research in Science Teaching*, 51 (1), 1–30
- Athene Donald's Blog (2012) *What Am I Doing Here?* Occam's Typewriter
- Automotive Council UK (2013) *Driving Success – A strategy for growth and sustainability in the UK Automotive Sector*. London: Automotive Council UK
- Bailey, R. (2011) *Letting Children be Children – Review of the commercialisation and sexualisation of childhood, looking to assess how children are being pressured to grow up too quickly*. London: Department for Education
- Bailey, R (2013) *Letting Children be Children: Progress Report – Report of Progress on the Recommendations of the Independent Review of the Commercialisation and Sexualisation of Childhood*. London: Department for Education
- Blakemore & Centres (2005) *Characteristics of boys' and girls' toys*. *Sex Roles*, Vol. 53, Nos. 9/10
- CaSE (2014, forthcoming) *CaSE Diversity Report*. Campaign for Science and Engineering (CaSE)
- Carter & Silva (2010) *Mentoring: necessary but insufficient for advancement*. Catalyst
- Council for Science and Technology (2013) *STEM Education – Text of a letter to the Prime Minister*. London: CST.
- CREST Expansion Scheme (2009–2011) *An independent evaluation prepared for the CREST team*
- DfCSF (2008) *After-school Science and Engineering Clubs Evaluation*. Sheffield: DfCSF
- Department for Education (2012) *Boost for vocational education as 14 new business-backed schools open*. Press release
- Education and Employers Task Force (2010) *Helping Young People Succeed: How employers can support careers education*. London: Deloitte
- Education and Employers Taskforce and Price Waterhouse Coopers (2012) *Closing the Gap: How Employers Can Change the Way Young People See Apprenticeships*. London: Price Waterhouse Coopers
- EngineeringUK (2012) *Executive summary of research evaluating The Big Bang Fair 2012*. EngineeringUK
- EngineeringUK (2013) *Tomorrow's Engineers – 2012/2013*, EngineeringUK
- Engineers Week polling data (2013) *Attitudes to engineering: Before and after engineering week 2013*
- Fine, C., Jordan-Young, R., Kaiser, A. & Rippon, G. (2010) *Plasticity, plasticity, plasticity...and the rigid problem of sex*. *Trends in Cognitive Sciences*, Vol 17. Issue 11, 550–551
- Girlguiding (2013) *What girls say about... equality for girls*. Girls Attitudes survey. London: Girlguiding
- GradCracker (2013) *Crackin' Times*. Issue 01, September 2013
- Grant, L, Baltitude, K. & Daly, A. (2010) *Girls into Physics: Action Research. A practical guide to developing and embedding good classroom practice*. Institute of Physics
- Hansard (2013) 18 November, Column 750W
- Higher Education Statistics Agency (HESA) Table 10: *Qualifications obtained by students on HE courses at HEIs in the UK by sex, subject area and level of qualification obtained 2008/09 to 2012/13*
- Hill, C., Corbett, C. & St. Rose, A (2010) *Why So Few? Women in Science, Technology, Engineering, and Mathematics*. Washington: AAUW
- HM Government (2011) *Review of Vocational Education: The Wolf Report*. London: Department for Education
- HM Government (2012) *Government Response to the House of Lords Select Committee on Science and Technology Report: Higher Education in Science, Technology, Engineering and Mathematics (STEM) Subjects*. London: HM Government
- HM Government (2013) *Progress April 2013: Wolf Report Recommendations*. London: Department for Education
- Hodgen, J & Marks, R (2013) *The Employment Equation: Why our young people need more maths for today's jobs*. London: King's College
- Holman, J. & Finegold, P. (2010) *STEM Careers Review*. London: Gatsby Charitable Foundation
- House of Commons Education Committee (2013) *Careers guidance for young people: The impact of the new duty on schools. Volume 1*. London: The Stationary Office Limited
- House of Commons Science and Technology Committee (2014) *Women in scientific careers*. London: The Stationary Office Limited
- House of Commons Science and Technology Committee (2013) *Educating Tomorrow's Engineers: the impact of Government reforms on 14–19 education*. London: The Stationary Office Limited
- Hughes, S. (2011) *Report to the Prime Minister and Deputy Prime Minister from the Advocate for Access to Education (The Hughes Report)*. London: Cabinet Office
- Institute of Physics (2012) *It's Different for Girls: The influence of schools – An exploration of data from the National Pupil Database looking at progression to A-level physics in 2011 from different types of school at Key Stage 4*. London: Institute of Physics
- Institute of Physics (2013) *Closing Doors. Exploring gender and subject choice in schools*. London: Institute for Physics
- Kennedy, H. (2005) *Eve was framed. Women and British Justice*. Vintage
- Kumar, A., Randershon, N. & Kiwana, L. (2013) *The state of engineering*. Engineering UK
- Let Toys Be Toys (2013) *Let Toys Be Toys. Survey and retailers report*. Let Toys Be Toys
- Michalska, K. J., Kinzler, K. D., & Decety, J. (2013) *Age-related sex differences in explicit measures of empathy do not predict brain responses across childhood and adolescence*. *Developmental cognitive neuroscience*, 3, 22–32
- Murphy, P. & Whitelegg, E. (2006) *Girls in the Physics Classroom – a review of the research of the participation of girls in physics*. London: Institute of Physics
- OECD (2010) *Learning for Jobs*. Paris: OECD
- Ofsted – Office for Standards in Education, Children's Services and Skills (2011) *Girls' Career Aspirations*. Manchester: OFSTED
- Ofsted (2013) *Going in the Right Direction? Careers guidance in schools from September 2012*. Manchester: OFSTED

Perkins Review (2013) *Review of engineering skills by Professor John Perkins for the Department of Business, Innovation and Skills*

Royal Society (2010) *'State of the nation' report on 5–14 science and mathematics education*. London: Royal Society

Seibt, B. & Förster, J. (2004) *Stereotype threat and performance: how self-stereotypes influence processing by inducing regulatory foci*. *Journal of personality and social psychology*, 87(1), 38

Straw, S. Hart, R. & Harland, J. (2011) *An evaluation of the impact of STEMNET's services on pupils and teachers*. Slough: NFER

The Targeted Initiative on Science and Mathematics Education (TISME) (2013) *'What influences participation in science and mathematics?' A briefing paper from the Targeted Initiative on Science and Mathematics Education* (TISME). London: ESRC

The Times, Letters 'Engineering and the UK's Future', 6th January 2014

TopGear Magazine (2013) December

UK Commission for Employment and Skills (UKCES) (2012) *The Youth Employment Challenge*. Rotherham: UKCES

UNESCO (2006) *Gender in Education Network in Asia. A toolkit for promoting gender equality in education*

Wellcome Trust, (2008) *Science as a Key Component of the Primary Curriculum: A rationale with policy implications, in Perspectives in Education*. Wellcome Trust

Wellcome Trust (2013) *Wellcome Trust Monitor Wave 2. Tracking public views on science, biomedical research and science education*. London: Wellcome Trust

WISE (2009) *UK Resource Centre for Women in SET Submission to the Panel for Fair Access to the Professions*. WISE

WISE (2012) *Women in Science, Technology, Engineering and Mathematics: from Classroom to Boardroom*. WISE

Women's Business Council (2013) *Maximising women's contribution to future economic growth*. Women's Business Council

Wraga, M., Helt, M. Jacobs, E. & Sullivan, K. (2007) *Neural basis of stereotype-induced shifts in women's mental rotation performance*. *Social cognitive and affective neuroscience* 2(1):12–9

YouGov (2011) *EDGE Annual Programme of Stakeholder Research: Business in Schools*. London: YouGov

AUTHORSHIP

DR ANNA ZECHARIA DR ELLIE COSGRAVE PROFESSOR LIZ THOMAS DR ROB JONES

correspondence to anna@sciencegrrl.co.uk @Science_Grrl www.sciencegrrl.co.uk

With thanks to all those who have spoken to us about their experiences during the course of this project. We would also like to thank Sir Peter Luff MP for this opportunity and his continued support, guidance and enthusiasm. Many thanks to Cosima Dinkel for translating our messages and identity into the design of this report.

Our views are our own, but we are grateful to our sponsors for their kind support and backing of **SCIENCEGRRL**.

SPONSORS

ARUP

BAE SYSTEMS
INSPIRED WORK

AIRBUS
GROUP

 **GKN PLC**

 **JAGUAR**

 **LAND ROVER**

nationalgrid

'STUDENTS NEED TO BE GIVEN THE OPPORTUNITY TO EXPLORE SCIENCE CREATIVELY, WITHOUT FEAR OF FAILURE, AND WITH SOME AUTONOMY'

'I'VE HAD TO PROVE MYSELF AS AN EQUAL TO THE MALE ENGINEERS. HAVING DONE SO HAS GAINED ME MORE RESPECT, WHICH HAS HELPED IN MY CAREER AND ENABLED ME TO MENTOR THE YOUNGER GIRLS WHO ARE COMING THROUGH THE CAREER PATH'

'THE SCIENCE CURRICULUM TEACHES FACTS RATHER THAN THE SCIENTIFIC PROCESS - THIS IS A PROBLEM'

'I THINK HAVING A CLEARER IDEA OF THE VASTNESS AND DIVERSITY OF THINGS THAT ARE UNDER THE ENGINEERING UMBRELLA BEFORE AND DURING UNDERGRADUATE COURSE AND HAVING MORE INDUSTRIAL EXPERIENCE WOULD HAVE HELPED ME'