

Teacher training and development to inspire STEM education The Global Challenge

A joint Education World Forum fringe event by the Royal Society and the British Council.

Many countries worldwide are experiencing a shortage in STEM skilled graduates. One important way to address this is to better equip teachers to educate, engage and inspire their students in STEM subjects. Many initiatives for improving STEM engagement already exist worldwide.

The British Council and the Royal Society convened an expert panel to informally discuss some examples of the work being done internationally to address this STEM skills shortage. This report, and the supporting information, aim to share some of the initiatives that exist worldwide that may help others address this problem.

Chair

Professor Dame Julia Higgins

Panel

David Jasmin Director, La main à la pâte, France

Gill Collinson Head of the National STEM Centre, UK

Joe Brock Coordinator of the IoP Physics for Development Programme, Africa

Tim Slingsby Advisor Public Engagement in Science, British Council, UK

Harrie Eijkelhof Emeritus Professor, The Freudenthal Institute, University of Utrecht. Director of Eijkelhof Science Education Advice, Netherlands

Shaun Reason Chief Executive of the Association for Science Education (ASE), UK

Charlie Stripp Director, National Centre for Excellent in the Teaching of Mathematics (NCETM), UK

This report summarises the meeting by condensing the discussion into three emergent themes.

- **Attracting inspirational STEM teachers**
Inspiring students to pursue STEM subjects
- **Practical science**
Bringing research skills to the classroom
- **Diversity and role models**
Promoting STEM participation and encouraging ethnic minorities and girls into science

For many of the initiatives mentioned, a link to the materials and resources is available in the supporting document. The examples presented are purely reflective of countries from which delegates were present.

Background

Science and mathematics are essential skills for global citizens. They provide the foundations of economic prosperity and are vital in allowing people to understand this increasingly technological world and make informed choices about their future.

As stated by Gill Collinson, speaking as Head of the National STEM centre, the business case for increasing STEM participation is large. Securing a plentiful supply of future STEM graduates is vital to fill international business needs. A Confederation of British Industry survey in 2014¹, found that 39% of businesses need more people with STEM skills and have problems recruiting, and 53% anticipate problems within the next 5 years. The situation globally is similar, with many of the delegates participating in this discussion reporting a shortage of STEM graduates within their own countries.

In addition to this, many countries noted a shortage, if not chronic shortage, of STEM teachers. There appears to be global difficulty in attracting and retaining bright and inspiring teachers with STEM specialist knowledge. Within the UK, there is a long recognised shortage of maths and physics teachers and these professions remain on the government's occupation shortage lists. Based on comments from our audience, the shortage of STEM teachers in some African countries runs into the tens of thousands. In addition, in Tanzania, poor pay (and a perception of poor pay) appears to lead to a lack of aspiration among young people to want to pursue a career in teaching. This is undoubtedly true in many other countries also.

Inspirational science teachers are the cornerstone for inspiring increased STEM subject participation among students. At the opening of this meeting, the Royal Society's Foreign Secretary and chemist, Professor Sir Martyn Poliakoff asked audience members to raise a hand if they were inspired to pursue science careers by great school teachers. An overwhelming majority attributed their choice of a science career to their teachers and more formal surveys have shown the same.²

Attracting inspirational STEM teachers Teacher Professional Development

Clearly high quality STEM teachers are vital to inspire students to pursue STEM subjects beyond compulsory education. Delegates from many countries noted a shortage of well qualified, specialist STEM teachers. To address this, the Zimbabwean government is targeting specific universities, with a strong STEM subject reputation, to attract skilled STEM subject graduates into teaching. Omani delegates noted similar initiatives.

An additional theme echoed by the international delegates was the professionalisation of teachers. If teachers feel valued and empowered then consequently teacher retention is likely to improve. In a country such as the UK where the shortage is not as pronounced as some African countries, encouraging good teachers to remain in the profession would certainly have merit, with some delegates suggesting that improving retention might mostly solve the problem here. It was suggested that science teachers should be encouraged to see themselves as members of the science community, and vice versa that the science community should view science teachers as valuable members of their own profession. Initiatives such as conducting research projects within classrooms can be valuable, as they not only inspire students to pursue science subjects, but also allow teachers to engage more fully with the wider science community.

The Netherlands have science community focused initiatives to attract good science graduates into teaching. The Dutch government provides bursaries for STEM teachers to complete PhDs, with the result that teaching is not 'instead of' a research career. In a similar vein, bursaries are also provided for post-doctoral researchers to conduct their research on school premises, literally bringing research science into the classrooms and further connecting these two communities.

NCETM presented the UK's 'Maths Hub' model, where maths specialist teachers help to train and share good practice with other teachers in their network; essentially teachers inspiring teachers. Whilst relatively new (this particular scheme began in the UK in November), this should help build greater teacher empowerment, as well as engagement with the wider STEM community.

1. CBI Education and Skills survey 2014 <http://www.cbi.org.uk/media/2807987/gateway-to-growth.pdf>

2. Wellcome Trust Monitor. An independent nationwide survey of 460 young people. Six in ten young people stated that it was having a good science teacher which inspired them to study science at university. <http://www.wellcome.ac.uk/News/Media-office/Press-releases/2013/WTP052643.htm>

The time pressures facing teachers in the UK was also discussed. One solution is to give teachers extra free periods to plan practical sessions and keep up with scientific research in their own field; concepts which could be applied internationally if resources allow. The need for a stronger career structure for teachers to attract and motivate bright graduates, and the potential for a UK College of Teaching to provide this structure, were also considered.

Practical science

Bringing research skills to the classroom

Closing the gap between research and the classroom is thought to have great benefits for inspiring future STEM uptake among students. Practical research within classrooms allows students to be scientists whilst at school and partake in school-based research programmes alongside their teachers. La main à la pâte noted that part of its work involves encouraging engagement in citizen science research projects, which can be either community based or nationwide. One UK delegate mentioned that students at their school had become official collaborators on a CERN research project. Where students become scientists at school, they will no longer feel science is beyond them and are more likely to pursue it further. Great improvements in physics uptake were noted in schools with strong practical physics research programmes.

Practical science can have many benefits. The Institute of Physics demonstrated their effective use of a simple practical kit, which can be used to teach complex science concepts without the need for complex equipment. This is an important proviso in less developed countries.

Many participants noted the importance of engaging students in STEM subjects at primary level. At this age students are naturally curious and explorative. This inquisitive nature can be built upon to create the foundations of interest in science and maths. A UCL project called 'Think Universe' was discussed, which aims to connect scientific and mathematical concepts to inspire maths and physics interest in 10 and 11 year old students.

An integrated approach to science and mathematics was mentioned in a variety of other contexts. Cross-curricular teaching occurred in a number of participating countries. South African representatives mentioned that due to the change in language between primary and

secondary education mathematics has been integrated into their secondary literacy programme. The science curriculum in the Netherlands has a new interdisciplinary approach due to a new curriculum subject, Nature, Life and Technology. This is a new subject (since 2007) and integrates subject knowledge from biology, chemistry, earth science, mathematics and physics. It was noted that an interdisciplinary approach can have multiple benefits because, as well as complementing theoretical learning, cross-curricular teaching requires teachers to collaborate and understand aspects of one another's specialisms, creating a more joined up approach and greater participation in continuous professional development.

Diversity and role models

Promoting STEM participation and encouraging more ethnic minorities and girls into science

A student's decision to pursue a career in science or mathematics is not only influenced by their school experience, but also their own perceptions. These perceptions often come from family influence or existing, wider cultural attitudes towards STEM subjects. The theme of diversity was a common thread throughout the event. Many challenges are shared; countries appear to have the same cultural stereotypes and male dominance attached to science (particularly physics) and maths subjects. For example, the National STEM Centre noted a large discrepancy between boys and girls taking A-Level science and maths in the UK, where 79% of A-Level science entrants and 72% of A-Level maths entrants are male. Other countries, including the Netherlands and Oman, noted a similar imbalance.

Ethnic diversity within the scientific workforce was highlighted as a potential barrier with regards to these role models. Many students see scientists as white, middle-aged, middle-class and male and therefore find it difficult to perceive a career in science for themselves.

It seems that many countries have initiatives in place to address these imbalances. Many of the initiatives referred to the need for role models and the British Council outlined international programmes that identify, train and mentor dynamic, young researchers to provide interactive STEM workshops in classrooms, with the understanding that students will better relate to early-career researchers.

South African delegates mentioned the promotion of STEM subjects among the black population, as black South Africans were traditionally discouraged from pursuing science and maths subjects. The need for ethnic role models was re-iterated by a teacher from White City, London, who noted that her students find it hard to relate to the traditional scientist stereotype. Ethnic STEM role models are required to convince students that STEM subjects are not beyond them. A series of videos have been produced by the Royal Society, in collaboration with the British Library, to promote ethnic diversity in science and address this issue (see accompanying supporting resources document).

In some countries it appears that there are engrained perceptions that STEM subjects are difficult. NCETM noted that there is certainly a prevalent attitude in the UK that holds mathematics as a difficult subject. The importance of eradicating these perceptions and building a positive relationship with maths and science at a primary level was highlighted. This includes family learning initiatives to make parents feel more confident about STEM subjects. It was suggested that careers advice could also, in part, help to remedy negative perceptions of science.

Closing remarks

In his closing speech Sir Martyn Poliakoff mentioned that scientists, regardless of whether or not they fit the traditional stereotype, can work to engage young people and make themselves and their research seem more accessible. He also noted the importance and simplicity of perception and of working to change this where necessary. The first step is challenging and changing these existing cultural perceptions and, with the right initiatives, stereotypes can be altered in one generation.