



# Report on the 2016 Autumn Residential for teachers of Mathematics and Science

Held at Crewe Hall, Cheshire

12<sup>th</sup> - 14<sup>th</sup> November 2016



## Executive summary

This course was attended by 80 subject leaders in Mathematics and Science from schools across the country. They raised issues across four areas, and a panel of educationalists then responded. Below is a summary of the conclusions from the conference:

### **1. How can we better inspire pupils in Mathematics and Science?**

Pupils are inspired in Maths and Science when they can see the practical applications of their subjects in the world beyond school, and can see their own futures as part of this world. They are highly influenced by passionate and inspiring teachers who challenge them to think independently. This residential course has helped teachers to feel empowered to treat students as individuals, keep up-to-date with the latest developments and bring more enriching, practical activities into the classroom. A panel of educationalists provided advice for teachers to increase their effectiveness in linking classroom study to the wider world, and this is detailed in the report.

### **2. Seeing challenges as opportunities in the teaching of Maths and Science**

Delegates and panellists proposed a range of solutions to the issues currently faced by Maths and Science teachers. Placing equal value on alternative pathways for less academic students, giving time in the curriculum for creativity and mastery, increasing professional development opportunities, defending creative subjects and joining the Chartered College of Teaching were all proposed as ways to move forward and improve education for all.

### **3. Recruiting and retaining high-quality Maths and Science teachers**

Despite concerns about inconsistencies in the quality of initial teacher training, delegates were confident that by taking steps to improve conditions for existing teachers they could improve the retention of valuable colleagues. Suggestions for doing so included making quality time to collaborate with colleagues, investing properly in NQTs and giving Science teachers proper technical support.

### **4. Recommended resources for teachers of Mathematics and Science**

Panellists suggested ways to keep up with the latest resources, as well as advising on a range of recommended resources for teaching and careers advice. These are detailed in the report.

## Course report

This report brings together points made during discussions in three elements of this residential: the pupil panel that began the course, reports made by subject leaders following teachers' discussions and a panel who responded to these reports.

- **The pupil panel**

The programme began with a panel of pupils with particular passions for Mathematics and Science, and who were studying for their GCSEs or A Levels in one or more STEM-related subject. They spoke about what inspired them in these subjects. The pupils were drawn from two comprehensive schools in the local area.

- **Reports by subject leaders**

Throughout the course, participating heads of department discussed their subjects, the importance of teaching them and the issues they felt were currently affecting them professionally.

- **Panel responses**

The panel responded to the issues raised by teachers. The panel members were:

- Sue Pope - Association of Teachers of Mathematics (ATM)
- Shaun Reason - Chief Executive, Association of Science Educators (ASE)
- Brenda Yearsley - School and Education Development Manager, Siemens

The report is presented according to the following themes that emerged during the residential:

1. How can we better inspire pupils in Mathematics and Science?
2. Seeing challenges as opportunities in the teaching of Maths and Science
3. Recruiting and retaining high-quality Maths and Science teachers
4. Recommended resources for teachers of Mathematics and Science

The report concludes with a selection of quotes from delegates.

## 1. How can we better inspire pupils in Mathematics and Science?

This section examines three questions:

- 1) What inspires pupils in Maths and Science?
- 2) How has this residential course better equipped teachers to inspire their pupils?
- 3) How can teachers be more effective in linking classroom study to the wider world and STEM careers?

- 1) What inspires pupils in Maths and Science?

The pupil panel were clear that students are inspired in Maths and Science when:

- **They can link their subjects to the world beyond school**  
Enthusiastic pupils see mathematics as the language of the universe, and love learning about new scientific discoveries. Their interest is sparked when they are introduced to science that has not yet been covered in the curriculum, and they are excited by science in the news. They see the potential for science to change the world for the better, and are confident that they can become a part of this change in their future careers.
- **They see their subjects in action**  
When practical elements are introduced into Maths lessons, learning becomes more engaging. Pupils remembered their teachers introducing scenarios, such as holiday budgeting or following step-by-step instructions to build something tangible. They also found it useful to learn real financial life-skills. Pupils appreciated the links between Maths and Science, but felt that their Science teachers had been better at making the connections than their Maths teachers.  
In Science, pupils found practical experiments especially memorable, and one said that seeing the scale of the universe visually represented inspired them by showing how much was left to learn.
- **They experience success**  
Doing well in their exams encourages pupils to take these subjects further.
- **They are challenged and given freedom to think independently**  
Pupils are enthused when their potential is spotted and teachers offer extra depth and challenge. They prefer being given guidance to receiving answers they do not understand. They feel lifted up by the opportunity to tackle A Level questions at GCSE and appreciate these sorts of gradual steps that can help them prepare for the next level of study.
- **Girls are encouraged and see female role models**  
Teachers need to ensure that they reach out to girls to establish their confidence in STEM subjects, as they are battling against stereotypes that can be a deterrent. Highlighting female role models can help with this.
- **Teachers are passionate about their subjects and experts in teaching them**  
Students reciprocate teachers' enthusiasm and learn well when high-quality feedback and great questioning skills lead them to achieve more than they thought possible.

2) How has this residential course better equipped teachers to inspire their pupils?

Teachers attending the residential felt that they were now better prepared to inspire their pupils by:

- **Being inspired in their subjects**  
Delegates had the opportunity to challenge and inform their own understanding of their subjects, from the known to the unknown. They were reminded of the importance of sharing their passion to develop the enthusiasm of their students.
- **Remembering the importance of 'doing' and linking to the real world**  
Teachers saw first-hand that the fundamental principle underpinning good quality Maths and Science education is all about the 'doing', and they discovered a myriad of enriching activities and resources to make their subjects more practical and applicable.
- **Recognising the need to treat students as individuals**  
Hearing students reflect on how vital their teachers had been to their subject choice and their future careers emphasised to delegates the need for them to challenge every student and individualise learning.
- **Feeling empowered to see challenges as opportunities**  
Through guided group discussions with colleagues, conversations that were initially dominated by daily issues quickly became solution-focused opportunities for delegates to share good practice, common experiences and ways of moving forward.

3) How can teachers be more effective in linking classroom study to the wider world and preparing students for STEM careers?

The following advice for teachers was provided by the concluding panel:

- **Develop students as whole individuals, not exam factories**  
Employers value those who have developed a passion, who have experience of teamwork and who have had interesting, practical experiences in STEM.
- **Stay up-to-date with the latest developments**  
Join a subject association or sign up for a free newsletter to see what they have to offer. This is one of the best ways to get fresh ideas. Set yourself up as the expert and committed professional you are by applying for chartered teacher status or a Master's degree.
- **Foster numerous links with other subject departments**  
Help students to better see the connections between subjects and to see science and maths in different contexts. This will help them to become more articulate about the science or maths they have used, how and why. One avenue to explore is the combination of Science and Drama, which can be very effective in supporting and interesting lower ability students.
- **Set challenges**  
Entering local and national competitions and setting problems to be solved are good ways to engage learners.
- **See practicals as real learning opportunities**  
Science practicals do not need to end with students getting the 'right' answer. See these situations as teaching opportunities and help students to solve 'why'.

- **Many engineers are missing the ‘M’ in STEM**

Ensure that the work covered in the classroom is contextualised in terms of its wider applicability and linked to practical mathematical skills where possible.

- **Use positive messages to promote engineering as a career for women**

Only 4% of engineering apprentices are girls. Tell them about the great salary and opportunities it provides, and dispel myths that engineering involves being dirty and standing out in the cold.

## 2. Seeing challenges as opportunities in the teaching of Maths and Science

Delegates and panellists discussed the current challenges faced by teachers, and proposed the following ways forward to improve education for all:

- **Recognise that one size does not fit all; value technical and vocational pathways**

Teachers need to increase the science capital for all, preparing the keen and enthusiastic for technical degrees whilst developing scientific and mathematical literacy for the unengaged and disaffected. With the need to fill technical roles in industry increasing, pathways such as apprenticeships should be considered as equally valid as academic ones, and the curriculum should reflect these additional opportunities.

- **Give time and space in the curriculum to encourage creativity and mastery**

For pupils to become fluent in mathematics, they need the chance to apply deep knowledge in different contexts. Ensure that even in a crowded and demanding syllabus, pupils are given the time to develop mastery, to be creative and to be inspired.

- **Increase professional development opportunities**

Teachers need to connect with their subjects and with one another in order to inspire pupils. Ensure that teaching staff have these opportunities, within and outside school.

- **Defend creative subjects**

Up to a third of schools will no longer offer Music within the curriculum, and that is a real concern for the future of STEM as creative skills are vital for progress in science and engineering.

- **Join the Chartered College of Teaching**

Raising the status of the profession and valuing teachers as both pedagogical and subject experts could help with:

- **Making curricular change stable and profession-led**

Make curriculum change more predictable, for example through ten-year review cycles that give time to embed teaching practice and gather evidence so that changes are not damaging to pupils.

- **Increasing trust in teachers**

Raising the status of teachers as professionals, who are trusted to deliver the curriculum and conduct fair assessments, could help to reduce accountability measures.

## 3. Recruiting and retaining high-quality Maths and Science teachers

With the recruitment and retention of teachers such a pertinent issue, delegates at this conference identified the following issues when employing and retaining high-quality staff:

- **Accountability and responsibility for teacher training has been devolved to schools**  
Initial teacher training is now therefore of varying quality and level, and due to teacher shortages, there is a pressure to pass all trainees. ITT can now be conducted in conjunction with universities or can be focused on a single school, providing different kinds and levels of experience.
- **Retention, pay progression and pay portability are inconsistent across schools**  
The introduction of academies has raised concerns that schools can 'hold people back' as a cost saving measure or, in some cases, offer higher pay than their local counterparts in order to attract the best teachers.

#### **What steps can subject leaders take to ensure the retention of high-quality subject teachers?**

The panel proposed the following solutions for retaining Maths and Science teachers:

- **Make quality time to collaborate with colleagues and DO maths and science together**  
Thinking collaboratively about how to teach topics, planning lessons together and then, crucially, reflecting on those lessons together helps teachers to not only improve their practice but also to feel that their ideas are valued by the team. A lot of inset days are spent doing admin rather than concentrating on what teaching is about and encouraging a love of teaching.
- **Raise your profile among governors**  
One role of governors is to ensure that the school is following a robust and correct curriculum. Talk to governors and senior leadership about any concerns over teacher retention, and the importance of having time to plan lessons together with colleagues.
- **Invest in your NQTs**  
New teachers are not always well looked after. They are continually observed and put under pressure to be immediately perfect. They are hired on temporary contracts and let go when they do not live up to expectations. Recognise what an important resource Maths and Science teachers are and invest in developing them to ensure they fulfil their potential.
- **Provide proper support**  
Changes to the curriculum mean that there is a generation of Science teachers who have never done practicals in the way they will have to teach them. Technicians are often more qualified in terms of their science background than teachers. Give new Science teachers plenty of technical support, which will help them gain confidence and conduct effective practicals.

#### **4. Recommended resources for teachers of Mathematics and Science**

The panel provided these tips for keeping up-to-date with the best teaching resources

- Read the front and back sections of the national curriculum to gain guidance in terms of what content to focus on.
- Joining a membership organisation, like the Association for Science Education (ASE), can help to generate links with other schools and promote the sharing of equipment and resources. In some areas, ASE has been encouraging technicians to facilitate equipment

sharing between schools, so that they can meet the challenge of teaching new core practicals at GCSE and practical endorsements at A Level in a time of falling budgets.

### The panel recommended the following resources for teaching Mathematics and Science

- ***The Language of Mathematics in Science*** (available free online)  
This booklet, produced by the Association for Science Education and the Nuffield Foundation is designed to enable teachers to achieve a common understanding of the important terms and techniques related to the use of mathematics in the secondary Science curriculum.
- ***Engaging Mathematics for all Learners***  
A fantastic resource for cross-curricular case studies.
- **Siemens teaching resources**  
These are all curriculum-mapped and available online: [www.siemens.co.uk/education](http://www.siemens.co.uk/education)

### The panel recommended the following careers resources:

- Stem Careers: [www.wherestemcantakeyou.co.uk](http://www.wherestemcantakeyou.co.uk)
- Maths Careers: [www.mathscareers.org.uk](http://www.mathscareers.org.uk)
- Future Morph: [www.futuremorph.org](http://www.futuremorph.org)

## 5. Selection of delegate quotes

*"This course has **encouraged me to be brave** and not to focus so much on grades"*

*"A reminder of the wider impact we as teachers can have on the wider community and society, helping create future analysts, engineers, doctors, and how this has a **direct impact on our economy**"*

*"I have been given a lot of time to reflect on why teaching maths is important. It has been helpful and refreshing to be **reminded that it is a worthwhile profession to be in** and that I do an important job"*

*"It has made me **reflect on the "bigger picture"** rather than focusing on simply the fine detail of new curriculum and the day to day elements of the job"*

*"It has helped me to understand **how I can affect the love my students have for my subject**"*

*"A chance to meet with other heads of Science, which is almost impossible in my usual role. It has **boosted my own confidence in my ability to lead a department** because the same challenges that I am facing with implementing the new GCSE and A level curricula are facing the other colleagues in my position around the country"*

*"**A chance to reconnect with my inner scientist** and to discuss my subject with other like-minded people at a deeper level. Also, being treated as a professional and being made to feel valued for what I do"*

*"It has **reminded me of why I came into teaching** and allowed me to think clearly about how I can improve things in my own school"*