



## REPORT ON THE 2013 CREWE RESIDENTIAL

### FOR TEACHERS OF MATHEMATICS AND SCIENCE

16<sup>TH</sup> - 18<sup>TH</sup> NOVEMBER 2013

HELD AT CREWE HALL, CHESHIRE

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# PRESENTATIONS BY SUBJECT LEADERS

MONDAY 18<sup>TH</sup> NOVEMBER

Brief presentations were made on the final day of the Residential by Subject Leaders from Mathematics and Science, summarising the outcomes of the teachers' group discussions. The main points they made consisted of reflections on the value of the PTI Residential and issues currently facing the teaching of Mathematics and Science.

## The value of the PTI Residential

The pupil panel demonstrated the importance of enthusiastic and knowledgeable teachers inspiring pupils to engage with the challenges of Mathematics and Science through questions and concepts that go beyond and deeper than the curriculum.

The value of the lectures was in:

- Demonstrations of the wonder and awe of the two subjects.
- Re-igniting the joy of Mathematics in teachers and challenging the traditional "geeky" perception of mathematicians.
- Reminding us that *"everybody has an innate ability to do Maths, and that each individual simply needs to find their own way of doing it"*.
- Updating teachers' scientific knowledge of current issues and research in ever developing fields: an essential process for ensuring the rigor of effective teaching.

The workshops allowed teachers:

- Time to talk with the speakers who attended the group workshops; this illuminated discussions, raised aspirations and re-invigorated teachers to set ambitious yet achievable objectives.
- Time to reflect on why they teach their subject, together with the chance to openly discuss and share ideas with other professionals in a purely positive environment.
- The opportunity to share good practice with colleagues who are inspired to organise a variety of subject enrichment activities to ensure the widest opportunities possible to engage students above and beyond the school curriculum.

Other benefits of the Residential were:

- Valuable time to think creatively and discuss work with other teachers from a wide variety of schools and with a broad cross section of abilities across the country.
- An appreciation of shared concerns and common values combined with the opportunity to speak, face to face, to other delegates about key issues, resulting in an array of satisfying solutions offered from others within their diverse groups.

## Key issues in the teaching of Mathematics and Science

### Mathematics

#### Curriculum

- Delegates repeated the call made at the last two Residentials for a period of stability in order to embed the constant stream of changes to which teachers and pupils have been subjected.
- The creation of a teacher-led College of Teaching would remove policymaking from the fluctuations of party politics and enable teachers to concentrate on their main task of inspiring another generation of young mathematicians.

#### Assessment

- The pressure for headline figures – e.g. the requirement for pupils to make three levels of progress in the five years to the end of KS4 regardless of what level they had reached by the end of KS2 – makes it difficult for teachers to regard the delivery of a rich and rewarding learning experience as their main concern.

#### Primary Schools

- The inconsistency between a level 4 at KS2 and the same level at KS3 highlights the problem of Mathematics teaching in many primary schools: there simply are not enough specialist subject teachers at primary level. This needs to be given greater priority in teacher training.

#### Collaboration

- PTI Residentials amply demonstrate the value of teachers being able to get together and exchange ideas about the delivery of their subject; yet for teachers in many schools there is no allocation of time or resources to make such collaboration possible. The problem is particularly acute in schools that are in Special Measures, where the restrictions on teachers are greatest and yet they would have the most to gain from discussion with others.

### Science

#### Curriculum

- Although there is now more rigour in the academic content of the curriculum, it lacks the coherent context needed to enable more young people to understand how mankind's development and even survival on the planet depend on the applications of Science.
- With BTEC also becoming more academically demanding, and thus less accessible to some pupils, there is a need for a credible vocational alternative to the traditional academic GCSEs in Science.
- Curriculum design pressures in some schools have resulted in the requirement to teach Triple Award Science in the time previously allocated to Double Award Science.

## Assessment

- The introduction of a new National Curriculum in Science and the move towards more academies and free schools have encouraged greater freedom in the way the curriculum is delivered. However the uncertainty about the future form of GCSEs means a lack of clear direction.
- The removal of SATs at the end of KS2 has resulted in primary schools generally spending less time laying down sound foundations of scientific knowledge, with correspondingly greater pressures on teachers at the next stage.
- Because of school targets, teaching still tends to be assessment-driven, with less flexibility to take risks and more emphasis on training pupils to pass exams (e.g. in controlled assessment), rather than developing in them a proper understanding of the nature of scientific enquiry.
- The move from modular to linear examinations increases the demands on teachers and pupils.

# PLENARY PANEL DISCUSSION IN RESPONSE TO SUBJECT PRESENTATIONS

MONDAY 18<sup>TH</sup> NOVEMBER

## Panel members:

<b>Christopher Pope</b>	Co-Director, The Prince's Teaching Institute (Chair)
<b>Pauline Hoyle</b>	Associate Director, Myscience
<b>Matthew Harrison</b>	Director of Engineering and Education, Royal Academy of Engineering
<b>John Stephens</b>	Director, National College for Teaching and Leadership
<b>Charlie Stripp</b>	Chief Executive, Mathematics in Education and Industry
<b>Richard Russell</b>	Head of Science, King Edward VI Five Ways School
<b>Nigel Gorman</b>	Head of Mathematics, St Nicholas Catholic High School

## Summary of the main points raised:

The proceedings opened with presentations by Subject Leaders in Mathematics and Science, summarising from the group discussions during the Residential what had been of particular value in the course and what the current issues were in the various subjects.

This was followed by a plenary discussion with a panel made up of Christopher Pope (Chair), Pauline Hoyle, Matthew Harrison, John Stephens and Charlie Stripp, together with Subject Leaders from the two subjects: Richard Russell (Science) and Nigel Gorman (Mathematics).

The main areas of discussion were:

1. Curriculum
2. Assessment

## **Curriculum**

### ***a. What do you think all the recent changes in Mathematics and Science – in curriculum, assessment and the inspection framework – are meant to achieve?***

The changes were perceived to be aiming:

- To ensure that the workforce is internationally competitive in a high-tech economy.
- To make up the ground we have lost to other countries who have raised their standards while ours have remained static.
- To provide more meaningful and genuinely useful courses, in response to e.g. Alison Wolf who suggests in her Report that we are falling behind because we are not teaching the right things; we must at the same time do more to build up the professionalism of teachers.

**b. Will these changes achieve what is intended?**

- Administrative changes are comparatively unimportant beside collaborative and enthusiastic endeavour by teachers.
- Teachers feel a tension between the need to meet exam specifications and doing what they want to do for their pupils. Part of this is due to repeated changes in curricular focus; a new College of Teaching might give more continuity and stability to educational policy.
- There is new material at certain Key Stages in the new National Curriculum (NC), but it is up to the teachers to determine how they interpret and deliver it.
- Mathematics (and Science) teaching has a dual function: to help people prepare for work and life, and to encourage further specialised study. These aims would be easier to achieve if there were a new set of qualifications for the life/work aspect, with outcomes that gave people what they wanted to know, not just an exam result.
- The revised NC does have coherent aims and offers new opportunities, but more central resources, more collaboration and other forms of support for teachers are needed if it is to be delivered effectively. There is a major role for subject associations such as the National STEM Centre and for organizations such as the PTI.

**c. The official aims of the revised NC state that it is “just one element in the education of every child. There is time and space in the school day and in each week, term and year, to range beyond the NC specifications”. Is this really achievable?**

- There is an expectation of enrichment, which is best met by collaboration and the sharing of ideas within a professional structure, such as that which the PTI offers.
- The ending of modular exams provides more teaching time in the year, but there is also more content in the revised NC and this puts pressure on time.
- Another major issue is the supply of specialist teachers, particularly at primary level, to ensure sound foundations in the early years of teaching and to stimulate a spirit of enquiry post-16.

**d. More is going to be expected of primary schools in terms of the Mathematics and Science they teach. Will this make the process of transition to secondary education better? What else is needed to make this happen?**

- There are courses available to help primary school teachers, both individually and collaboratively.
- Links between primary and secondary schools need to be strengthened; these should be cross-phase and properly reciprocal, not all top-down.
- The PTI Schools Programme has fostered various projects undertaken in this area of Transition, e.g.
  - Termly joint meetings to ensure curricular continuity.
  - Agreement about a uniform approach to scientific investigation.
  - The senior school lending apparatus so that younger pupils are familiar with it when they arrive.
- An investigation is underway to establish the best model of Maths or Science teaching in Primary Schools, in terms of not just subject content but also subject leadership.

**e. *There is an urgent need for more trained engineers and technicians in this country. What do you think is the best way of achieving this?***

- It requires an effective partnership between schools and employers, with schools providing the context and guidance and employers making it clear what qualities are needed. Local Enterprise Partnerships offer discussions about available opportunities, often with small businesses which may be more willing to take risks with employing and training young people.
- The availability of alternative pathways to the traditional academic qualifications is a key factor. At the moment 43% of school leavers go to University (where access to Engineering degrees is comparatively easy), 7% get apprenticeships (for which there is strong competition, which is likely to get stronger as aspiring parents see that apprenticeships offer better career prospects than some degrees), and the remaining 50% are 'invisible' but must surely contain some untapped potential which is more likely to be brought out by courses other than academic GCSEs.
- The University Training Colleges (UTC) are designed to offer alternative vocational pathways, but with the CBI now saying that attributes such as team-work and a positive attitude are as important as literacy and numeracy, it is difficult to know how much of the Mathematics and Science taught in UTCs is actually useful in the work context.

## Assessment

**a. Teachers would love to see in place modes of assessment that made a better job of measuring understanding rather than just memory. Is this achievable and, if so, how?**

- It is possible, but we may not have the right structures in place, with competing Exam Boards, some of which understand better than others how to assess the ability to analyse and synthesize, to link evidence and generally to act scientifically.
- We need a closer definition of 'skills' and 'understanding'. Skills are not a lower order attribute, inferior to knowledge, but the result of experience and application and are extremely valuable. Understanding is the product of deep thought and knowledge – it is untidy, and difficult to assess. Teachers are best placed to exercise professional judgement in assessing these attributes and a higher degree of trust should be placed in them to do so.
- There have been good Mathematics examinations (e.g. KS3 SATs) and the current pilot in dual Mathematics: *Methods and Applications* looks promising, suggesting that it is possible to assess problem-solving ability. The revised NC aims and assessment objectives for GCSE point us in the right direction. By contrast the A level modular exams in Maths were predictable because the examined content was cut up into such small chunks, while the scaffolding put up around the problem-solving questions for the sake of making them accessible diminished their effectiveness as indicators of mathematical ability.
- Teaching for understanding deserves assessment for understanding, even if there might be an initial dip in results.
- Teachers are constantly exercising judgement about how to improve their pupils' progress. They become good and experienced in this sort of assessment for learning. A school's accountability, however, relies largely on single terminal exams which may well give a much less accurate assessment of an individual pupil's level of understanding. The system does not sufficiently recognize teachers' professional judgement.
- Teachers are somewhat to blame for the present situation because of their readiness to use their expertise in jumping over hurdles. However A level modules were very predictable and Controlled Assessments encouraged over-preparation.
- Having a single exam board is not in itself a solution; competition breeds innovation and monopolies don't work. The problem lies not with the structure so much as with the examinations that are currently being set.



**Finally, the panel were asked what thoughts and impressions they would take away from this Residential:**

- The passion of the teachers and their sense of responsibility.
- Ministers don't often get the chance to have this sort of interaction with teachers; the word needs to get back to them.
- There is an appetite for change, but more needs to be done to accomplish it, including more self-determination for teachers.
- Teaching is a privilege; sharing it with other like-minded people is even more of one.

# PUPIL PANEL DISCUSSION

SATURDAY 16<sup>TH</sup> NOVEMBER

The course opened with a panel made up of pupils who were all studying a combination of Mathematics and Science subjects. The pupils were sixth form students drawn from a mix of selective and non-selective state schools. By chance, rather than design, five of the panellists were female.

Summary of the main points made by panellists in response to questions put to them:

## The attractions of studying Mathematics and Science

### Mathematics

- The logical nature of the subject
- The enjoyment of problem-solving and the confidence-building effect of finding correct answers
- The support for other subjects
- The desire to follow interests inherited from parents
- Enhanced prospects of employment

### Science

- Satisfying curiosity about things, how they are made up and how they work
- Opportunities to understand better our constantly changing world
- The sense of constant progression in the subject, with ever deepening understanding
- The interrelatedness of the three sciences

Mathematics and Science are considered difficult subjects because they require knowledge to give answers that are, by and large, either right or wrong, rather than expressions of feeling or opinion. This is off-putting for some pupils but an attraction for others.

## Aspects of good teaching and learning in Mathematics and Science

- Different pupils learn in different ways and have different levels of natural curiosity and commitment to these subjects. This presents a number of challenges to the teacher and suggests that a variety of teaching styles and methods is likely to be more effective than a uniform approach.
- Close interaction with pupils may be the best way to engage initial interest, but once they are committed they should be able to progress from note-taking to self-education.
- A challenging approach is likely to stimulate more interest than one based on concern for accessibility.

- Unwilling pupils may have their attention caught by an unexpected or unconventional approach; focus on exam specifications may also be a spur and give them confidence, but exclusive concentration on this may have the undesirable effect of making them feel they are nothing more than “*a figure on a spreadsheet*”.
- Teachers need to keep their knowledge up to date so that they can answer questions about recent research, and must be willing to go beyond the specified syllabus; to tell pupils that they don't need to know any more is patronising, demoralising and disempowering.
- Learning Physics without a knowledge of Mathematics is difficult and when Physics text books do not address the workings of the underlying mathematics, the teacher should if possible try to explain it more fully.
- Parents, even those without specialist knowledge, can help by responding positively to their children's enthusiasm.
- A teacher who is clearly enthusiastic about teaching is likely to have pupils who are enthusiastic about learning.

## SELECTION OF QUOTES FROM DELEGATE EVALUATIONS

*“After completing this course I will be asking my colleagues why we teach Maths and use this as a tool to move away from exam focused teaching towards a more holistic approach to learning.”*

*“We are keen to develop links between Maths and other subjects and this weekend has enlightened me on a range of real life projects across a range of subject areas. The students will see Maths as a far more accessible and relevant subject if they can see its wide range of connections in other subject areas too.”*

*“Excellent opportunity to take a step back and remember why I teach Science and how to do it successfully with surprisingly little mention of what OFSTED wants to see.”*

*“I feel reinvigorated about the importance of subject knowledge and will challenge all staff to attend subject knowledge based INSET in the next two years.”*

*“Listening to lectures has really made me look at how I can make my teaching more relevant to students and how they ‘see’ Science in their own lives.”*

*“The topics chosen were excellent triggers for discussion, sharing good practice and knowledge. Very useful to work and speak with peers in terms of managing a Maths department.”*

*“The topics were all really relevant... It was a really valuable experience talking about all issues and realising that it doesn't matter what type of school you are in, we all have the same underlying issues and pressures.”*

*“This course over the 3 days has made me reflect on almost every aspect of teaching and running a department.”*

*“I am in a stronger position to bring in up to date and cutting edge ideas into my teaching.”*

*“Encouraged me to look into more ways to engage/educate pupils in Science outside of the curriculum.”*

*“[The final plenary session] made me feel like a member of a real profession.”*

*“Science has been put in context again, and the bigger picture of why we teach has been enlightened. It is not about endless marking, report writing and admin, it is about science.”*

*“I found the topics under discussion pertinent, interesting and it was motivating and inspiring to hear a range of viewpoints and solutions.”*

*“It is very easy, especially in the current climate, to get embedded in the minutiae and forget what is the essence of what we do. This course has readdressed the balance.”*

*“I have made a wealth of friends and contacts and take back to school with me a multitude of fresh ideas and feel rejuvenated in my passion for my subject.”*