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THE PRINCE'S  
**TEACHING  
INSTITUTE**

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Mathematics & Science

2010

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## CLARENCE HOUSE

It has given me the greatest pleasure and encouragement to see how my Teaching Institute has developed over the past eight years. Starting from the first pilot Summer School in 2002, it has grown into an organization which, in strategic partnership with the University of Cambridge, has had a direct impact on the teaching in over 800 state secondary schools in England; has embraced five of the most important subjects in the curriculum and, according to many who have attended my Institute's residential courses, has offered greater opportunities for teachers themselves to be heard by those responsible for deciding what should be taught in our schools. The enthusiasm I have encountered in the feedback from previous teacher delegates makes it clear that there is a hunger for well planned, subject-based training, and that is what my Summer Schools seek to deliver.

Science and Mathematics are comparatively recent additions to my Teaching Institute's programme. These closely related subjects are essential to our understanding of the world around us. Only by careful and sympathetic observation of the natural environment – the scientific principles and the numerical patterns – can we fully appreciate the laws that underpin it and so have a chance of maintaining that delicate balance, which is so crucial to the well-being of our own and future generations.

I am confident that this Residential course, like the Summer Schools that have gone before it, will offer absorbing lectures, stimulating debate and the reassuring company of like-minded colleagues. I hope that it will also inspire and enthuse you and give you plenty of lasting value that you can take back to your own schools.



*Charles*

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## Welcome

I am delighted to welcome you to this Residential, as I have done to all the ten such courses which have preceded it. Every year since the first pilot in 2002, the Prince of Wales Education Summer Schools and Residentials have provided an opportunity for teachers to stand back and reflect on the nature of their subjects and on what is most important in the teaching of them. The teachers themselves tell us that such opportunities are rare in their professional lives and all the more welcome for that.

In response to this evident demand, the Summer School programme is constantly developing. It now encompasses five subjects and more are under consideration. The programme in Science was initiated in 2007 and in Mathematics just last year.

The courses place emphasis on academic content and offer a chance to discuss subject issues in depth with academics and experts. Accordingly we have included in this year's programme a number of seminars, presentations and lectures by speakers eminent in their various fields of Science and Mathematics. We are most grateful to them for agreeing to come and delighted to have them with us.

In the workshop sessions our aim is to offer teachers a chance to discuss their work with colleagues and to explore some of the more difficult aspects of subject delivery: what parts of our subject should we be teaching and why, and what are the best ways of doing so? How can these subjects be made challenging and yet accessible to pupils of lesser ability as well as to the brighter ones?

Each year at the end of the course we have presented our findings to a panel of educationalists from a variety of backgrounds. This provides an opportunity not only for them to hear what the teachers are thinking, but also for delegates from different disciplines to listen to each other and perhaps find the reassurance of common ground. We do hope that this session will generate an active debate about aspects of education in your subject that concern you; even indeed a consensus that we can then feed through to the policy makers.

But the most powerful effect of the courses has been that teachers have gone back to their schools feeling it is within their power to change their classroom approach; to put scholarship and a delight in their subjects at the heart of their teaching. For example, one teacher writes, "This course has given me back my belief in myself and reawakened my passion for my subject. It has also taught me that I am empowered and that I can." To date, teachers in over two hundred and eighty school departments have chosen to keep this spirit alive by joining our Schools Programme and I hope you will want to find out more about it and join it too.

I look forward to meeting you all in Crewe this year. We have designed a course that I am sure you will find both stimulating and challenging and I hope you will return to your classrooms inspired to share your experiences with your pupils and your colleagues.

**Bernice McCabe**  
**Course Director** November 2010

# Course Background

The Prince of Wales's long standing concern about the teaching of English Literature and History was the original driving force behind the creation of his annual Education Summer Schools. Three years ago a programme for Science teachers was added. The Mathematics course was piloted in 2009, in conjunction with Science, and because of the close connections between these subjects, the same pairing is repeated this year.

## Subject Knowledge

Now in their ninth year, these short but intense courses have provided teachers from all over the country with (to use their words) 'life-enhancing' and 'inspirational' opportunities to discuss their subjects with professional colleagues, leading academics, and those concerned with directing national education policy. The discussions in previous Summer Schools and Residentials focused on the central importance of particular subjects: the aspects of them that could or should be taught at different levels, and the best ways for teachers to meet the challenge of doing so effectively.

Those who are actually involved in teaching have no doubt about the importance of the subject knowledge that underpins their own enthusiasm for their subjects; and this is what they want to pass on to their students. It is not always easy for them to do so. For the centrality of subject knowledge is not universally considered a priority in the drive to raise standards in schools; it has too often taken second place to a concern with teaching methodology and skills. Furthermore the desire to make subjects 'relevant' to young people has led in some schools to a focus on cross-curricular topics at the expense of acquiring the depth of knowledge needed to study such topics seriously. The new Secretary of State for Education has made it clear that he would like to see a swing of the pendulum back towards an emphasis on subject-knowledge and has publicly endorsed the principles that underpin the PTI's approach. We are therefore embarking on this course with the reassurance of a following breeze rather than having to face into the wind as so often in the past.

## Science and Mathematics

No-one who has spent any time in a classroom will undervalue the importance of knowing how to teach, as well as what should be taught. But by concentrating on the methodology of teaching and assessment we can lose sight of the simple truth that good teaching is about communicating with enthusiasm and passion what lies at the heart of our subjects. Science encompasses a wealth of world-changing discoveries and insights, to which every child is entitled to be introduced. Teachers of Science must also be able to provide – for some if not for all – the detailed and up to date knowledge of the subject on which further scientific progress essentially depends. Scientific study requires too a knowledge of Mathematics and there is growing concern among scientific bodies about the inability of even the most promising pupils to perform simple numerical manipulations in handling Science questions. Mathematics is of course an important and endlessly fascinating subject in its own right, with applications ranging from the mundane and practical to the highest levels of abstract thought. It also presents a wide range of challenge for the teacher, when some pupils struggle with simple computations and others seem to have an instinctive understanding of every new topic. But there is great satisfaction to be found in learning how to solve a problem at any level.

# Examination and Assessment

Examination and assessment are essential elements in any formal process of Education; they should also encourage good learning. But there has been a widespread and strongly-held belief amongst teachers who have attended previous Summer Schools and Residentials that there should be more incentive for teachers trying to communicate the richness of their subjects and to impart bodies of knowledge. The lack of critical thinking and problem-solving skills evident among Science pupils is cited by the Royal Society of Chemistry as adding to “the growing body of evidence that dedicated teachers are working under a system which encourages teaching to the test and which fails to meaningfully differentiate pupils’ performance”. Similarly, the 2008 Ofsted Report on Maths teaching stated: “Evidence suggests that strategies to improve test and examination performance, including ‘booster’ lessons, revision classes and extensive intervention, coupled with a heavy emphasis on ‘teaching to the test’, succeed in preparing pupils to gain the qualifications, but are not equipping them well enough mathematically for their futures.” There are more hopeful signs, however: the greater number of pupils now studying Further Mathematics at A Level, and the significant increase this year in the number of entries for three individual Science GCSEs rather than the combined Science and Additional Science papers in which a recent Ofqual report found “a collective falling short of the standards that young people and teachers have a right to expect”.

## Curricular Debate

Science and Mathematics are both core subjects, compulsory elements in the curriculum up to the end of Key Stage 4. This presents the challenge of reconciling the needs of the many and the few: ensuring that all pupils are given the basic knowledge and competence in Science and Mathematics that they will need in their future lives while at the same time stimulating the interest of the more able pupils and encouraging them to specialise in these areas which are so important for the country’s development. The policy of the previous government favoured what it perceived as the interest of the many, trying to devise syllabuses that were ‘relevant’ and ‘accessible’. But these were widely criticised for lack of rigour and as providing no sort of preparation for the higher levels of study. A thorough-going review of the curriculum, involving representatives not just of schools but also of Higher Education and Business, is shortly to be undertaken. The PTI will have an opportunity for its voice to be heard, representing the numerous state school teachers who are its adherents.

So, there are real and live issues here, and the outcomes of our discussions of them may have an influence on national policy. What then is the right balance, and how should the curriculum in Science and Mathematics be determined? In bringing teachers together to discuss such questions, these courses not only give them as individuals a renewed sense of purpose; they also demonstrate to the teachers that the future of the subjects they love lies, more than they imagine, in their own hands. Identifying the difficulties in their way is only a start. They must also identify the solutions that really will work in the classroom, and achieve what they want to achieve. That is what the Summer Schools and Residentials are for.



# The Prince's Teaching Institute

The Prince's Teaching Institute believes that all pupils, irrespective of background or ability, are entitled to a subject-based curriculum, taught with rigour and passion. It was created in 2006, and works in partnership with the University of Cambridge. It has grown out of The Prince of Wales Education Summer Schools which, every year since 2002, have provided an opportunity for teachers to come together to debate and where necessary challenge teaching approaches to their subject. Its aims are to:

- Promote the idea that subject knowledge, subject rigour and the enthusiasm for communicating them are essential requirements for effective teaching to children of all abilities
- Create an inspirational forum for teachers, enabling them to step away from the classroom and rediscover their love of subject
- Promote and provide subject-based professional development for teachers
- Encourage and inspire teachers by demonstrating good use of academic rigour and challenge in the classroom
- Create stronger links between academic departments in schools and universities
- Promote and enable a more constructive dialogue between teachers and government educational agencies
- Exercise a beneficial influence on the development of policy in the areas of curriculum development, assessment and training

The institute brings together teachers and leading academics with a view to encouraging rigorous and challenging subject teaching in all schools for children of all abilities. It demonstrates how children can be inspired, and consequently achieve higher standards, by teaching that goes beyond the constraints of exam syllabuses and by rich subject provision that incorporates extra-curricular activities. It also provides an additional pathway of communication between teachers and Higher Education and Government Agencies.



# SCIENCE

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## the aims

**The aim of the course is to explore the nature and purposes of Science teaching, specifically by:**

- Providing an opportunity for practising teachers to consider the reasons for Science being a core subject in today's world and the place of values within Science education
- Offering a forum for the debate of these issues, with eminent scientists and leading science communicators and educators presenting some challenging perspectives of their own
- Providing an opportunity for practising teachers to explore the principles of rigorous, relevant and responsible Science teaching to pupils of all abilities, through participation in workshops led by experienced teachers
- Probing critically current approaches to Science education and its assessment, and examining the extent to which young people are being equipped to understand the nature and importance of scientific thinking
- Enabling pupils to make informed judgments about the implications of scientific development, and to evaluate the impact of Science on the future well being of planet Earth and its inhabitants

## the objectives

**To provide Science teachers with the opportunity to:**

- Refresh their thinking about the role of Science in preparing both responsible citizens and specialist scientists for the future
- Share and refine their ideas for rigorous, exciting and sustainable developments in the Science programme at their schools
- Learn about some current lines of research and new applications in real world Science
- Discuss the impact of national policies and practices on the effectiveness of Science teaching and consider ways forward for improvement

# MATHEMATICS

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## the aims

**The course is intended to promote the primacy of subject knowledge, both among pupils of all abilities and among teachers. It aims to:**

- Provide an inspirational forum to agree the central role and enabling nature of Mathematics within the school curriculum
- Promote an understanding of the nature and scope of Mathematics, and of the combination of comprehension, technical expertise, logic and rigour of practising mathematicians
- Develop approaches that will equip students with the confidence to acquire and apply the mathematical knowledge and skills required in our increasingly complex and demanding society
- Discuss and focus upon the aspects of Mathematics that stretch and challenge students of all abilities
- Develop expertise and facilitate the sharing of good practice in the teaching of Mathematics

## the objectives

**The purpose of the course is that teachers should be re-inspired to teach their subject in a more rigorous, ambitious and creative way, and should influence their colleagues to do the same. Specifically the course will:**

- Promote self-confidence in teachers to present curriculum ideas in a more flexible, creative and mathematically rigorous way
- Consider applications of mathematics, such as how to construct the perfect circle and the links between Mathematics and other subjects, for example art and history
- Promote greater challenge for both teachers and students in the classroom and give students a better understanding of mathematical reasoning

# Keynote Speakers

## Richard Noble OBE

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courtesy of BLOODHOUND SS

Richard Noble OBE is an entrepreneur who specialises in developing high risk ventures. His Thrust 2 programme that brought the World Land Speed Record back to Britain in 1983 and Thrust SSC, the first ever supersonic car, are the best known.

At the end of October 1997 Richard Noble achieved the seemingly impossible. His newly designed Supersonic car broke the land speed record, with Andy Green, one of the RAF's top pilots, at the wheel. The record of 763.035 mph still stands today.

For his achievements, Richard Noble has been awarded an OBE, the RAC Diamond Jubilee Trophy, the John Cobb Memorial Trophy, the Sir Malcolm Campbell Trophy and the Sir Henry Segrave Trophy.

Richard Noble is currently Project Director of the BLOODHOUND SSC engineering adventure. He is leading a team inspiring our young engineers and scientists with an incredible rocket-powered car capable of 1,000 mph.

## Professor David Nutt

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Professor David Nutt is currently the Edmund J Safra Professor of Neuropsychopharmacology at Imperial College London.

Professor Nutt is also currently Chair of the Independent Scientific Committee on Drugs (ISCD), President of the European College of Neuropsychopharmacology (ECNP), President-elect of the British Neuroscience Association, the UK Director of the European Certificate and Masters in Affective Disorders Courses and member of the International Centre for Science in Drug Policy. He has published over 400 original research papers, a similar number of reviews and books chapters, eight government reports on drugs and 26 books.

Previously Professor Nutt has been member and Chair of the Advisory Committee on the Misuse of Drugs (ACMD – 1998-2009), President of the British Association of Psychopharmacology (BAP), member of the HEFCE/NHS Senior Lecturer Selection Panel and member of the MRC Neuroscience Board.

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*"Without doubt, I feel enthused about teaching my subject after hearing about cutting-edge research and reminding myself of the different careers my students could head towards after studying science."*

**Summer School delegate**

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TIME	SCIENCE	MATHEMATICS
0900-1030	Registration	
1030-1050	Course Welcome by Course Director	
1050-1140	<b>Keynote Address: Richard Noble OBE</b>	
1140-1220	Introductions and Break	
1220-1310	<b>Pupil Discussion</b>	
1310-1400	Lunch	
1400-1530	<b>Workshop</b> Why do we teach Science?	<b>Workshop</b> What is our purpose in teaching Mathematics? What are the key issues in Mathematics?
1530-1600	Break	
1600-1700	<b>Presentation</b> <b>Dr Paul Barker</b> <i>Self-assembling circuits – lessons from Biology to the electronic engineer. Connecting A-level topics to current research in nanotechnology</i>	<b>Presentation</b> <b>Dr David Acheson</b> <i>Mathematics, Magic and the Electric Guitar</i>
1700-1830	<b>Workshop</b> Sharing good practice	<b>Workshop</b> Sharing good practice
1830-1930	Break	
1930-2200	Reception and Dinner: After Dinner Talk by <b>Prof David Nutt</b>	

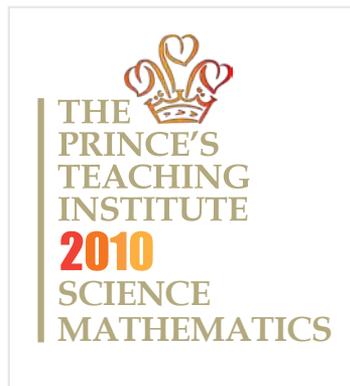


TIME	SCIENCE	TIME	MATHEMATICS
0900-1000	<p><b>Choice of Presentations</b>  <b>Dr Phil Cox</b> <i>Form and Function of the Mammalian Skull: Old Questions, New Techniques.</i></p> <p><b>Dr Jim McElwaine</b>  <i>The Dynamics of Avalanches</i></p>	0900-0930	<b>Schools Programme Presentation</b>
1000-1030	<b>Schools Programme Presentation</b>	0930-1100	<p><b>Choice of Presentations</b>  <b>Prof Celia Hoyles OBE</b>  <i>Reconciling the learner's and teacher's views of Mathematics</i></p> <p><b>Dr Vinay Kathotia</b>  <i>Mathematics as story-telling</i></p>
1030-1100	Break	1100-1130	Break
1100-1300	<p><b>Workshop</b>  Sharing development objectives</p>	1130-1300	<p><b>Workshop</b>  Making Maths engaging for all:  Can we overcome the difficulties that occur when teaching Mathematics?</p>
1300-1400	Lunch		
1400-1540	<p><b>Choice of Presentations</b>  '<i>At the Cutting Edge</i>'</p>	1400-1500	<p><b>Choice of Presentations</b>  <b>Dr Snezana Lawrence</b>  <i>How did the Egyptians do it? Ideas for the Mathematics classroom from the ancient papyri</i></p> <p><b>Tom Bree</b>  <i>Geometry – the beauty of visual Mathematics</i></p>
1540-1610	Break	1500-1530	Break
1610-1800	<p><b>Workshop</b>  What are the issues in Science education?</p>	1530-1700	<p><b>Workshop</b>  Sharing development objectives</p>
		1700-1800	<p><b>Choice of Presentations</b>  <b>Prof Imre Leader</b>  <i>Patterns of Beads</i></p> <p><b>Dr Chris Sangwin</b>  <i>How round is your circle?</i></p>
1800-1930	Break		
1930-2200	Reception and Dinner		

TIME	SCIENCE	MATHEMATICS
0900-1000	<p><b>Choice of Presentations</b>  <b>Dr Lisa Jardine-Wright</b>  <i>Keeping up with the Universe: activities in Astronomy and Physics</i></p> <p><i>The Extended Mind: recent experimental evidence.</i> <b>Dr Rupert Sheldrake</b> in conversation with <b>Ian Skelly</b></p>	<p>0900-1030  <b>NRICH workshop</b>  <b>Charlie Gilderdale</b>  <i>If you want to build higher, dig deeper</i></p>
1000-1100	<b>Workshop</b> Special Interest Groups	1030-1100 Break
1100-1130	Break	1100-1230 <b>NRICH workshop</b> <b>Charlie Gilderdale</b> <i>If you want to build higher, dig deeper</i>
1130-1230	<p><b>Presentation</b>  <b>Dr Geoff Tansley</b>  <i>Bloody Engineering</i></p>	
1230-1330	Lunch	
1330-1530	<b>Reports on key themes: Plenary Panel Discussion</b>	
1530-1545	<b>Evaluations</b>	
1545	Attendance Certificates and Depart	



# Keep in Touch



## **Schools Programme**

As you have attended this Residential, your school department is eligible to join The Prince's Teaching Institute Schools Programme.

The Schools Programme is a membership scheme that gives you the opportunity to stay in touch with teachers you have met and allows you to continue to promote the spirit of the Residential once back at school. Members share ideas and projects that enhance their department's subject provision, and meet every year to share experiences and devise further ideas.

Membership gives all members of your department access to the resources of the Staffroom area of the PTI website, discounts on Continuing Professional Development and, after a year, the opportunity to use a the PTI Mark on your school's stationery and website (above).

Membership is obtained by discussing and agreeing your departmental objectives with your teacher leader, and requires the agreement of the school's Head and Chair of Governors. For further details please talk to any member of the PTI team at the residential, or e-mail: [jane.mccallum@princes-ti.org.uk](mailto:jane.mccallum@princes-ti.org.uk)

## **Continuing Professional Development**

The Prince's Teaching Institute provides one day subject-based Continuing Professional Development courses. Combining academic lectures and teacher workshops, the courses are similar to a day of the residential, but are usually focused on a particular area of syllabus. The days are devised and led by practising teachers who have been to a Residential. The PTI office provides all logistical support and will invite speakers. Past speakers include Dr David Starkey CBE, Dr David Bainbridge and Prof Sir Gordon Conway KCMG.

Details of forthcoming events can be found at [www.princes-ti.org.uk/events](http://www.princes-ti.org.uk/events)

We welcome offers to run an event, and if you are interested, please contact:

[jane.mccallum@princes-ti.org.uk](mailto:jane.mccallum@princes-ti.org.uk)

## **Website**

The public pages of [www.princes-ti.org.uk](http://www.princes-ti.org.uk) contain details of all of our activities and events. Membership of the Schools Programme allows you to access the staffroom area of the website and its expanding library of resources. As well as the opportunity to listen again to many of the lectures from this Residential, you will be able to hear podcasts of speakers from previous PTI events, and also access presentation materials. Should your department join the PTI Schools Programme, all members of your department will gain access to these resources.

## Acknowledgements

The residential would not have been possible without the very generous sponsorship provided by Baring Private Equity Asia, Mr & Mrs K Breslauer, the Clore Duffield Foundation, Esmée Fairbairn Foundation, Mr & Mrs D Hampson, the Hintze Family Charitable Foundation, ICAP, Mr Ben Iversen, Mr Alan Kelsey, Mr Edmund Lazarus, Mr Harvey McGrath, Mr David Meller, The Mercers' Company, Dr Jonathan Milner, Mr Rupert Mitchell, NCETM, Nomura Charitable Trust, Patron Capital, Mr Ajmal Rahman, RM plc, ShareGift, the Steel Charitable Trust, Mr & Mrs R Tager, the Training and Development Agency for Schools, Mr David Tucker, Mr & Mrs J Weiss and a number of anonymous donors.

The Prince's Teaching Institute ("the PTI") was formed in 2006 to continue the work of The Prince of Wales Education Summer Schools, to expand its programme of continuing professional development for teachers and develop its support for Summer School alumni and their schools. The board of Trustees of the PTI is chaired by Harvey McGrath, Chairman of Prudential plc. The other trustees are Alan Kelsey, Dr Kate Pretty and Sir Michael Wilshaw. The PTI has two co-Directors, Christopher Pope and Bernice McCabe.

The design of the Summer School was led by Oliver Blond, Headteacher, The Henrietta Barnett School. The PTI would like to thank the following people for their support and assistance in organising the Summer School: Mr Alastair Cuthbertson, Ivybridge Community College, Dr Robert Ferguson, North London Collegiate School, Natalia Timoshina, North London Collegiate School.

The PTI would like to thank Mark Leishman, Private Secretary to TRH The Prince of Wales and The Duchess of Cornwall; Stephen Miles, Worle Community School, Martin Roberts, former Headteacher of The Cherwell School, Oxford, James Sabben-Clare, former Headmaster of Winchester College and Adrian Barlow, Institute of Continuing Education University of Cambridge, for their advice throughout the year, Robina Newman for her design work, including this brochure, and Benjamin Ealovega for the photography. All photographs in this brochure, except for biography portraits and where otherwise indicated, are © Benjamin Ealovega.

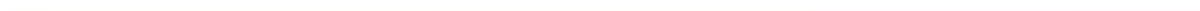
The Trustees would like to acknowledge the support and assistance received from Nadia Porter and Gill Boyne (Assistants to Bernice McCabe, North London Collegiate School). Jane McCallum, Patrick Wigg, Dhivya Srinivasan, Farhana Somani and Amisha Patel (The Prince's Teaching Institute Office), Katie Scully and Jo Gillan (HRH The Prince of Wales's Office), and the conference organisers, Jenny Wilde Associates.



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THE PRINCE'S  
TEACHING  
INSTITUTE



*"It was wonderful to be treated like a professional. I have left this course knowing why I went into teaching- a love of my subject, enthusiams, zest, and a desire to change young people's lives. This week has allowed me to rediscover all of these."*

*"Please continue with all the obvious hard work and effort that has gone into this - it is much appreciated and we have felt valued and appreciated, which is much needed in this demanding profession."*

*"A course like this is music to my ears because it feeds my passion for my subject."*

*"This has been the most useful, inspiring and enjoyable educational course I have attended."*

*"The seminars were excellent and it was very exciting to be learning in this way again. Insights into the latest scholarly research enables teaching to be at the forefront of subject development in schools."*

*"I thought that the lectures and seminars were extremely stimulating, useful and informative both in terms of subject knowledge and ideas for classroom application."*

*"I found the workshop sessions interesting and useful. The discussions were meaningful and it was good to have the opportunity to think through the purpose of education and the importance of it within a national context."*

*"It has made me appreciate the importance of having a passion for my subject. As a manager, we often lose this as we try to balance admin with teaching (which can become secondary). I will be redressing this balance. "*



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