

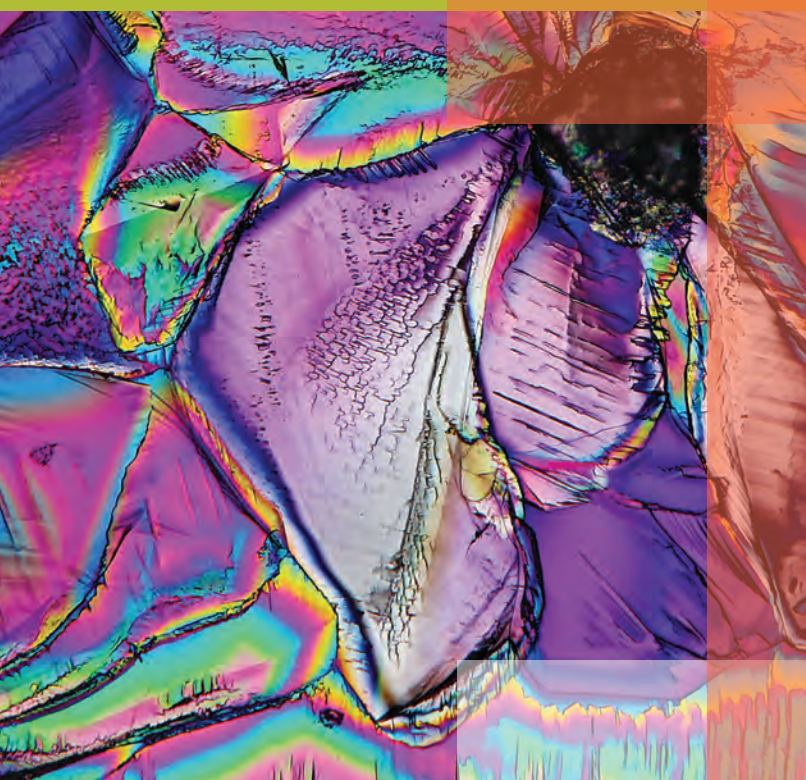


THE PRINCE'S
TEACHING
INSTITUTE

Mathematics and Science

Autumn Residential

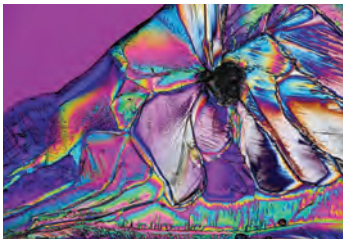
November 2016, Crewe Hall, Cheshire





BRIDGE TO INFINITY Photographer Alex Class

A long exposure on a bridge draws the eye to the distance, the stars of the Milky Way, and the infinity of space.



CITRIC ACID CRYSTALS Photographer Karl Gaff

With the appearance of a fractured stained glass window, this image reveals an electromagnetic interference pattern on the interface of crystalline citric acid ($C_6H_8O_7$) under polarized light. The black conglomeration, middle right, is a seed crystal around which the crystalline grains grow. The colour gradients are a result of a variation in crystal thickness, refracting light by varying degrees.



LADYBIRD WITH RAINDROPS Photographer Mostafa Ghroz

A ladybird with a burden of raindrops. Ladybirds are small beetles belonging to the family Coccinellidae, a name derived from the Latin word *coccineus*, meaning "scarlet". The name "ladybird" originated in Britain, where the insect became known as the Lady beetle or "Our Lady's bird", because in early paintings Our Lady, the mother of Jesus, was often depicted wearing a red cloak.



Welcome from the Course Director

I am delighted to welcome you to this Prince's Teaching Institute Autumn Residential. Every year since the first pilot in 2002, these courses have provided an opportunity for teachers to stand back and reflect on the nature of their subjects, on what is most important in the teaching of them, and how they can improve their teaching so as to inspire the next generation of schoolchildren. The teachers themselves tell us that such opportunities are rare in their professional lives and all the more welcome for that.

The PTI courses traditionally place an emphasis on academic content and we have, as usual, included in this year's programme a number of seminars, presentations and lectures by speakers eminent in their various fields to enable you to discuss subject issues in depth with academics and experts.

In the workshop sessions our aim is to offer you a chance to discuss your work with colleagues and to explore some of the more difficult aspects of subject delivery: what parts of our subjects should we be teaching and why, and what are the best ways of doing so? To ensure that these discussions do not remain just at the theoretical level but lead to effective action in the classroom, we shall be introducing you to the PTI Schools Programme which is designed to ensure that your departmental planning is centred on inspiration and enrichment.

At the end of every residential 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 policymakers.

The most powerful effect of the PTI courses to date 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"*.

I look forward to meeting you all in Cheshire 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.

A handwritten signature in black ink that reads "Bernice McCabe".

Bernice McCabe
November 2016



Course background

Since the first Prince of Wales Education Summer School in 2002 these residential courses have aimed to inspire, invigorate and empower teachers. They have used this time away from school to explore their subjects with professional colleagues, leading academics and those concerned with directing national education policy. Discussions have focused on the educational importance of every subject represented, 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.

These courses provide an introduction to the PTI Schools Programme, a community of subject leaders that encourages more challenging departmental objectives that enrich the learning of all pupils.

Knowledge and skills

One of the abiding tensions in education is that between the teaching of knowledge and the teaching of skills. Employers tend to stress the importance of acquiring skills and competences, while academics are more interested in the transmission of knowledge. There is of course a balance to be struck, and the two should be complementary. The exact balancing point is likely to vary according to particular circumstances and conditions.

The PTI sees the importance of subject knowledge as fundamental. Skills cannot be taught in a vacuum and without knowledge there can be no understanding of the concepts which are the building blocks of mental development. We are part of a cultural continuum; each generation has to build upon what has been learnt, achieved and handed down by previous generations.

This view of education is reflected in the framework of the national curriculum. Its principal aim is stated thus: *"The national curriculum provides pupils with an introduction to the core knowledge that they need to be educated citizens. It introduces pupils to the best that has been thought and said, and helps engender an appreciation of human creativity and achievement."*

Examination and assessment

Examination and assessment are essential elements in any formal process of education, and they should also encourage good learning. But there has been a widespread and strongly held belief amongst teachers who have attended previous PTI courses that there should be more incentive for teachers trying to develop in their pupils a full appreciation of the richness of their subject, and a closer correlation between the aspirational value of that subject and the way it is examined. Teachers should never feel they have to inhibit their teaching because of testing requirements, but there is little doubt that the combination of league tables and Ofsted has tended to encourage teaching to the test and the choice of subjects that are perceived as easier. While this may have been aimed at improving test results, it will have had a distorting effect on the education of some children, leaving them unprepared for higher education and employment.

Mathematics and Science

Mathematics has applications ranging from the everyday and practical to the highest levels of abstract thought. To prepare students for further study, teachers will benefit from having the time, space and expertise to teach for mastery and deep understanding at every level.

Science encompasses a wealth of world-changing discoveries and insights, to which every child is entitled to be introduced. Teachers of Science must be able to provide the detailed and up-to-date knowledge of the subject on which further scientific progress essentially depends, and they must continue to ensure that pupils benefit from seeing science in action, within and beyond the school laboratory.

In a challenging recruitment environment, support for teachers to develop their own understanding and passion for their subjects can be a means of both attracting more high-quality specialists into the profession and retaining the best practitioners. And whether it is a matter of giving learners a better understanding of the complex concepts involved in Mathematics and Science or attracting more pupils, particularly girls, to study them, good teaching is surely the key: teaching that stimulates the interest, excites and inspires.

With curricular reforms come challenges, but also opportunities to teach creatively and to ensure that pupils experience the full breadth of what our subjects have to offer. Delegates attending this Residential will all have their own ideas about how to achieve this, and the PTI is happy to provide the opportunity for them to learn from each other.



The aims of the PTI

The Prince's Teaching Institute believes that all pupils, whatever their background or ability, are entitled to be taught by passionate and knowledgeable teachers. We re-connect teachers with their specialist subject, creating an inspirational forum with leading academics to encourage more rigorous and challenging subject teaching in schools. We demonstrate how children can be inspired, and achieve higher standards, by teaching that goes beyond the constraints of exam syllabuses and by rich subject provision that incorporates extra-curricular activities. We also provide an additional pathway of communication between teachers, higher education and government agencies.

Our aims are to:

- Encourage and inspire teachers by demonstrating good use of academic rigour and challenge in the classroom
- 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
- Promote and provide subject-based continuing professional development for teachers
- Create stronger links between academic departments in schools, and between schools and universities

The PTI was created in 2006, and works in partnership with the University of Cambridge. It grew out of The Prince of Wales Education Summer Schools which, every year since 2002, have provided opportunities for teachers to come together to debate, and where necessary challenge, teaching approaches to their subject.

The aims of the course

- To provide an inspirational forum for leading teachers to discuss the importance and central role of Mathematics and Natural Sciences in the school curriculum
- To promote an understanding of the nature and scope of Mathematics and the Sciences, and of the combination of comprehension, technical and practical expertise and logical reasoning necessary for the successful pursuit of these disciplines
- To facilitate the sharing of good practice in teaching these subjects at secondary level, to make learning them a stimulating, challenging and engaging experience for students of all abilities
- To consider approaches that will stretch and challenge students and give them the confidence to apply the knowledge and skills required in our increasingly complex and demanding society
- To encourage leading teachers to reflect on both curricular and extra-curricular Mathematics and Science provision in their schools, planning for focused developments to improve engagement and raise standards of achievement

The objectives of the course

Mathematics

- To promote self-confidence in teachers to present curriculum ideas in a more flexible, creative and mathematically rigorous way
- To share and refine ideas for challenging, exciting and sustainable developments in the Mathematics programme at their schools
- To consider applications of Mathematics, such as engineering and architecture, and to look at the links between Mathematics and other subjects, for example Biology and History
- To promote greater challenge for both teachers and students in the classroom and give students a better understanding of mathematical reasoning



Science

- To share best practice and engage in supportive, constructive discussion with colleagues about the work of their department
- To plan for developing some innovative curricular and extra-curricular activities with ideas that work, ready to take straight back to school
- To experience some exciting examples of current developments in the Sciences, through speaker presentations and collaborative workshops which can be used to bring Science teaching to life
- To reflect on the key role of the wider 'STEM agenda' (Science, Technology, Engineering and Mathematics) in effective provision for the future
- To free the spirit of enquiry to build the confidence of teachers and students alike in the value of an ambitious Science programme in schools

TIME	MATHEMATICS	SCIENCE
0900-1000	Registration	
1000-1025	Course welcome Bernice McCabe, Course Director	
1025-1120	Keynote address <i>What does it mean to 'do mathematics'?</i> Lynne McClure	Keynote address <i>Space - so what?</i> Anu Ojha OBE
1120-1140	Refreshment break	
1140-1245	Pupil panel <i>A passion for Mathematics and Science: Students' perspectives</i>	
1245-1345	Lunch	
1345-1515	Teacher-led workshop <i>Why do we teach Mathematics and what are the issues in Mathematics education?</i>	Teacher-led workshop <i>Why do we teach Science?</i>
1515-1530	Refreshment break	
1530-1630	Lecture <i>Finding moonshine: A mathematician's journey through symmetry</i> Professor Marcus du Sautoy OBE	Choice of lecture <i>The world of particles: Recent discoveries and open questions</i> Professor Cristina Lazzeroni <i>The immune response across the life course (Why can't Granny fight the superbugs?)</i> Professor Janet Lord
1630-1800	Teacher-led workshop <i>Sharing good practice</i>	Teacher-led workshop <i>Sharing good practice</i>
1800-1930	Break	
1930	Reception and dinner After dinner speaker: Anu Ojha OBE	

TIME	MATHEMATICS	SCIENCE
0900-0920	Introduction to the PTI Schools Programme	
0920-1030	Lecture <i>The creation of number</i> Ben Sparks	Lecture <i>What's so special about Science education?</i> <i>Myths and realities</i> Yvonne Baker
1030-1130	Choice of lecture <i>How to see clearly: The power of statistical models</i> Professor Adrian Bowman <i>Resources and investigations: Correlation and hypothesis tests</i> Kate Richards	Teacher-led workshop <i>What are the current issues for secondary Science education?</i>
1130-1200	Refreshment break	
1200-1315	Teacher-led workshop <i>Beyond the curriculum: Making mathematics engaging for all - how can we overcome the difficulties that occur when teaching Mathematics?</i>	Choice of lecture <i>On the chemical origins of life</i> Dr Matthew Powner <i>Two heads are better than one: Developments in imaging and technology applied to radiotherapy for cancer</i> Dr Ellen Donovan
1315-1400	Lunch	
1400-1500	Lecture <i>So where did this algebra thing come from?</i> Dr Piers Bursill-Hall	Choice of lecture <i>CSI: Crime Scene Insects</i> Dr Amoret Whitaker <i>Frozen in time: The archive of past climate and atmospheric change</i> Dr Rob Mulvaney OBE
1500-1630	Teacher-led workshop <i>Developing subject provision in your department</i>	Teacher-led workshop <i>Developing subject provision in your department</i>
1630-1700	Refreshment break	
1700-1800	Choice of session Lecture <i>The geometry of the Dambusters</i> Peter Ransom Workshop <i>A sense of proportion: Geometry from an architect's perspective</i> Jon Allen	Lecture <i>Freeing the spirit of enquiry</i> Dr Rupert Sheldrake
1800-1930	Break	
1930	Reception and dinner After dinner speaker: Justin Kelly	

TIME	MATHEMATICS	SCIENCE
0900-1100	Workshop <i>NRICHing Mathematics in secondary classrooms</i> Charlie Gilderdale	Workshop <i>Building curiosity in Science lessons</i>
1100-1130	Refreshment break	
1130-1230	Workshop continues	Workshop continues
1230-1315	Lunch	
1315-1415	Seminar <i>What next for Mathematics and Science education?</i> Sue Pope - Association of Mathematics Teachers Shaun Reason - Association for Science Education Andrew Taylor - AQA Brenda Yearsley - Siemens	
1415-1515	What works in schools? <i>The first year of the Schools Programme – my experience</i> David Duncker Brown, The Ecclesbourne School <i>Learning through research: The impact of Additional Mathematics</i> Kiran Raju, Holyhead School	
1515	Evaluations and closing	





Professor Marcus du Sautoy OBE

Featured speakers

Lynne McClure

MATHEMATICS KEYNOTE

Lynne McClure was appointed to the new post of Director of Cambridge Mathematics in November 2014. This University-wide programme brings together the expertise of Cambridge Assessment, Cambridge University Press, the Mathematics and Education Faculties of Cambridge University and the wider University community in a collaborative enterprise. The vision is to secure a world class Mathematics education for students from 5 to 19, applicable to both international and national contexts and based on evidence from national and international research and practice.



Anu Ojha OBE

SCIENCE KEYNOTE AND AFTER DINNER SPEAKER

Anu Ojha OBE has been an Executive Director of the National Space Centre since 2008 and is Director of the UK's National Space Academy programme. He co-led the development for government of the National Higher Apprenticeship programme for the space sector and has contributed to a number of national and international policy studies. He is also a member of STFC's Skills and Engagement Advisory Board and is leading the development of new international teaching programmes for the European Space Agency (ESA) for students and teachers (school and undergraduate level). He has worked as a consultant for the ESA using data from the Mars Express and SOHO space missions and is a current ESA "space ambassador" for skills and education in the UK.

Justin Kelly

AFTER DINNER SPEAKER

Justin Kelly is Director of Strategy & Business Development for Siemens UK. He has a real passion for education and furthering the UK's Engineering and Technology skills pipeline, and is a member of the recently founded Teach First North West Business Leadership Team. He is heavily involved in Siemens' Sustainability and corporate responsibility activity, working on how the company will become carbon neutral in the UK and supporting an extensive Business in Society programme. He is a Chartered Engineer with a BEng (Hons) from the University of Salford in Computers, Management and Electronics.



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The Curiosity Project

Our Mathematics and Science Programmes are supported by Siemens as part of the Curiosity Project.

The Curiosity Project is a three year engagement programme by Siemens, broadening existing investment to bring science, technology, engineering and mathematics (STEM) to life in the UK. By supporting organisations that reach out and nurture the innate curiosity in young people, Siemens hopes to influence five million children over the three year project. The project is underpinned by an extensive education programme providing free, stimulating and unique STEM-related resources that bring STEM education to life and help inspire the next generation of engineers!

Curious?

You'll find everything you need to know at [siemens.co.uk/curiosity-project](https://www.siemens.co.uk/curiosity-project). Why not sign up to the Curiosity Project newsletter for the latest news on events, prize draws and resources? Further resources can be found on their education portal: [siemens.co.uk/education](https://www.siemens.co.uk/education).

Follow them: [@SiemensUKNews](https://twitter.com/SiemensUKNews) [#curiosityproject](https://twitter.com/curiosityproject)

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“A truly inspirational course that has confirmed my passion for teaching and made me excited to walk into the classroom on Monday morning. Thank you!”



Keeping in touch

The PTI Schools Programme

As you have attended this Residential, your 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 staff in your department access to the resources of the Staffroom area of the PTI website, discounts on professional development courses and, after a year, the opportunity to use the PTI Mark on your school's stationery and website (above).

You can join the programme by discussing and agreeing your departmental objectives with your Residential Teacher Leader, with the agreement of your school's head and chair of governors. For further details please talk to any member of the PTI team at the Residential, or email Nicola Bentley: nicola.bentley@princes-ti.org.uk.

Professional development

The Prince's Teaching Institute provides one-day subject-based professional development courses. Combining academic lectures and teacher-led workshops, the courses are similar to a day of the Residential, but are usually focused on a particular area of the curriculum. The days are devised and led by practicing teachers, and the PTI provides all logistical support, including inviting guest speakers.

Details of forthcoming events can be found at www.princes-ti.org.uk/events.

We welcome offers to run these courses. If you are interested, please email Sarah Darrall Shaw: sarah.darrallshaw@princes-ti.org.uk.

Website www.princes-ti.org.uk

Our website contains 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 access a wealth of presentation materials and teaching resources. Should you join the PTI Schools Programme, all members of your department will gain access to these resources.





Thank you to all our donors

The Prince's Teaching Institute would like to thank all our donors, in particular members of the 2012 Club and Patrons who have committed multi-year financial support to the charity.

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BERNICE MCCABE Course Director

Headmistress, North London Collegiate School, and Co-Director, The Prince's Teaching Institute

A Head for over 25 years, Bernice McCabe studied English at Bristol University and has an MBA.

She taught for 16 years in mixed comprehensives in Bristol and London, including 5 years as Head of English and 4 years as Deputy Head of The Heathland School, London Borough of Hounslow. Since 1990 she has been a Headmistress: for 7 years of Chelmsford County High School, a maintained grammar school, and since 1997 of North London Collegiate School, a 4-18 independent school, which opened its first overseas coeducational boarding school on the island of Jeju in South Korea in September 2011; NLCS Dubai will open in 2017 and a third NLCS overseas branch in Singapore is planned for 2019.

She has served on national education committees in the maintained and independent sectors. From 2010 to 2014, she was a member of the National Curriculum Review Advisory Committee and from 2013 to 2016 she was an Expert Advisor for the London Schools Excellence Fund, set up by the then Mayor of London, Boris Johnson, to promote excellent teaching and help tackle underperformance in London maintained schools.

In 2002 she directed the first Prince of Wales Education Summer School. In 2006 the annual Summer Schools grew into The Prince's Teaching Institute (PTI) which she now Co-Directs.

ACKNOWLEDGEMENTS

The PTI would like to thank Oliver Blond, Barbara Pomeroy, Alida Allen, Richard Russell, Natalia Timoshina and Dr Robert Ferguson for the design of this Residential. We would also like to thank all of the speakers and workshop leaders for their contributions and support.

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Mathematics and Science

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