UNIVERSITY OF BIRMINGHAM

STEM Education Centre

National HE STEM Programme

Adopting & Embedding Proven Practices & Approaches

Case Studies Arising from the National HE STEM Programme 'Menu of Activities' Initiative

Compiled and Edited by Michael Grove and Les Jones

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Contents

The National HE STEM Programme

In 2004, the Secretary of State sought advice from the Higher Education Funding Council for England (HEFCE) on strategically important, but vulnerable, higher education subjects or courses. A review was undertaken to identify subjects in need of support to address an imbalance between supply and demand, and a range of disciplines were identified including chemistry, engineering, mathematics and physics. These were all subjects where participation had been falling steadily over a number of years.

In response to the findings from the review, the Higher Education Funding Council for England in 2005 invited the Royal Society of Chemistry, the Royal Academy of Engineering, a consortium of mathematical bodies, and the Institute of Physics, to explore possibilities for profile-raising pilot activities in these disciplines that would encourage increased applications at degree level. Four programmes of disciplinary activity: Chemistry for our Future; The London Engineering Project; More Maths Grads; and, Stimulating Physics, were funded that undertook a range of evaluated discipline-based interventions that were specifically designed to increase demand for, and to widen participation within, their respective disciplines in higher education.

When the last of these four pilot projects completed its work in January 2010, they had undertaken a range of activities and projects within their respective disciplinary communities and much learning had been generated. While many of the interventions had been proven successful, they had taken place on a limited pilot scale across England and Wales and a mechanism was needed for ensuring this learning was transferred more widely and with a higher education specific focus. While the four projects were continuing to operate, the decision was taken to roll-out the activities from the pilots as part of an integrated National HE STEM Programme that would commence in August 2009, but which would also have a wider remit to address the higher skills agenda.

The National HE STEM Programme was a three-year initiative that ran between August 2009 and July 2012 and, by building upon the work of the four disciplinary pilot projects and establishing new approaches, established activities within the higher education STEM sector across three related strands:

1. Widening participation within the STEM disciplines at university level, by supporting higher education institutions to work with those currently within the school and further education sectors.
2. Higher education curriculum developments focusing upon course delivery and design and student support, to enhance student knowledge, progression and skills.
3. Encouraging those currently within the workforce and society to engage with further study to develop enhanced knowledge and skills.

This publication presents the activities comprising one element of the Programme's work to transfer and embed some of the practices and approaches developed by the four pilot projects more widely across the HE STEM sector. It has been compiled by the STEM Education Centre at the University of Birmingham which is committed to making the learning and outputs of the Programme widely available across the HE STEM sector.

The Menu of Activities Initiative

Overview

The National HE STEM Programme 'Menu of Activities' initiative was established in the summer of 2010. It involved the identification of a range of activities, derived from the work of the four disciplinary pilot projects, that could be directly 'adopted' and implemented by higher education institutions without the need for further developmental work.

The initiative involved providing 'pump priming' funds to enable universities to undertake the activity, but more particularly provided access to expertise from those who had worked on the activities as part of the pilot projects; this also included the provision of a range of resources to aid implementation of the activity. The objective of the initiative was that if the universities found the activities complemented or added additional value to their existing work, then they would embed these within their core provision and continue to offer them into the future. A secondary objective was that as the approaches were based upon interventions that had previously demonstrated proven impact (following their evaluation as part of the pilot projects), the experience of implementing these in the described manner might also influence some of the wider practices within the 'adopting' department or faculty. A final objective was that as the outreach activities needed to be demonstrably targeted at traditionally underrepresented groups of learners (widening participation cohorts), the experience generated from working with with other STEM initiatives and organisations or central university departments to achieve this would help embed a longer-term way of working within the sector that would enable continued targeting of hard to reach cohorts.

Implementation

The Royal Society of Chemistry, the Royal Academy of Engineering, the Institute of Mathematics and its Applications, and the Institute of Physics, identified a range of activities that had proved successful within their respective pilot projects. As the activities identified were ones that needed to be rolled-out without further developmental work, their scale was typically small, and they focused primarily upon two areas: enhancing outreach and widening participation practices of higher education institutions, and context and problem based learning.

Once the range of activities had been identified (the full list of activities is shown in Table 1), each Professional Body made available a range of materials, hosted online, for use by those institutions who would be successful in their request to participate within this initiative. Making the materials available online also helped contribute to the objectives of the National HE STEM Programme by making the learning from the pilot projects more widely available to the sector, including to those institutions who did not seek support as part of this Menu of Activities initiative. Each activity was then accurately costed, based upon the experiences of its delivery during the pilot projects, to identify the level resource that would be allocated to each institution for its implementation.

The activities that were available for adoption were collected together in a single document that not only described each activity, including links to further descriptive materials, and the level of resource that was available, but also what each institution would be required to do to ensure successful implementation. This 'Menu of Proven Disciplinary Activities' was then widely promoted to the HE STEM community through the National HE STEM Programme and other communication channels. Two separate calls were offered: one in October 2010 and the second in March 2011, and the intent for a second call was promoted during the first call. The rationale for having two calls was to allow those departments who might not be in a position to respond to the first call a subsequent opportunity to participate in the activities of the Programme.

Those from within higher education institutions wishing to participate in the Menu of Activities initiative were asked to submit their expressions of interest online by a specified deadline. In addition to the requirement for what might be termed 'standard' information (name, contact details, etc.), potential project leads were asked to provide responses to the following questions:

1. Rationale for undertaking activity (200 words maximum): Please articulate the need or reasons for wishing to undertake the proposed activity, the potential impact or benefits on the current practice of your institution, how it will add value to the current range of institutional activities undertaken, and/or how it will help the institution change, enhance or develop its existing practices.

2. Sustainability and Institutional Commitment (200 words maximum): Please demonstrate how the proposed activity and the learning derived from it are expected to influence the future practice of the institution in subsequent years.

3. Targeting of WP cohorts (200 words maximum): Where funding is being sought for activities that will involve work with school or college age students, please indicate how these will be targeted in order that traditionally under-represented groups of learners within the STEM disciplines may be engaged.

4. Timetable and Milestones: Please outline a timetable giving key activities or deliverables and a date for their delivery.

These questions were included not only as a basis for the selection of submissions following a review process undertaking by individuals chosen from across the entire National HE STEM Programme team, but also to encourage project leads to reflect upon their rationale for undertaking the activity, and to aid the subsequent implementation of the activity itself if their submission was accepted. Particularly important was the question that asked proposers to articulate how they would target their activities, and it was suggested during the call that they contact Programme Partners for advice and guidance in this regard. As was the case for all National HE STEM Programme calls for support, all proposers were asked to consider and articulate their sustainability plans for the activity post funding.

During the promotional process, the standard contractual template for National HE STEM programme projects was made available, and proposers were asked to ensure their institutions were happy with its contents in advance of submissions being accepted. This approach worked well, and almost completely minimised any subsequent contractual issues. Guidance on the final case study reports required from successful submissions was also made available during the promotional process to ensure project leads were aware at the outset of the kind of information they would need to collect, and subsequently provide.

Pilot Project	Activity Name	Description & Further Details
Chemistry for our Future	Chemistry Outreach Package[1]	A series of 16, different scale, fully evaluated outreach activities aimed at students from 5 – 18 years of. Full instructions and guidance materials were made available to support higher education institutions with the implementation of each activity. Successful participants were asked to implement at least three of the activities.
	Context & Problem Based Learning (C/PBL)[2]	A series of 6 stand-alone context and problem-based learning activities for which tutor and student materials were made available. Successful participants were asked to integrate one C/PBL activity into existing courses within their department.
	Chemistry at Work[3]	A one or two-day event consisting of careers presentations and demonstrations to benefit students from 11-16 years of age by providing the opportunity for them to appreciate the place of chemistry in everyday life and the world of workbased. The activity was based around the Chemistry at Work Handbook. Successful participants were asked to engage around 10 schools with approximately 150 participants on each day.
The London Engineering Project	Gender Awareness Training[4]	A one-day interactive training workshop, delivered by the UKRC to enable university departments to better understand the issues affecting women and girls within STEM and the positive actions that can be taken to address them. The training workshop was made available to any STEM department and was based around the model widely used and evaluated as part of the London Engineering Project.
	Gender & Diversity Workshop[5]	A one-day workshop exploring gender awareness issues in delivering outreach, familiarisation with diversity guidelines and use of the DRIVE process developed during the London Engineering Project. The training workshop was available to any STEM department and the DRIVE process was designed for use during all interactions and material development for outreach activities.
	Solar Car Challenge[6]	Successful participating higher education institutions were asked to stage a Solar Car Challenge competition and engage local schools to participate within it with support from university student ambassadors. The Challenge was run as a 12-week project for school teams usually in Years 8 and 9.
	Engineering Pick n Mix[7]	Successful participating higher education institutions were asked to stage a one-day hands-on event for 30 – 50 Year 9 pupils with a view to demonstrating the creative nature of engineering. During the event, school pupils worked to develop and market a new product using the available materials.
	Engineering Islam[8]	Successful participating higher education institutions were asked to host a one-day event for 30 – 50 Year 7 – 11 pupils that celebrated Islamic culture and in particular focused upon the contribution made by the Muslim world to engineering and science. Evaluation of the pilot activity showed it to be particularly effective at engaging pupils and their parents.

Table 1: Activities offered through the 'Menu of Activities' initiative

More Maths Grads	Pop Maths Quiz[9]	The Pop Maths Quiz is an event based upon an activity successfully run at Sheffield Hallam University and extended more widely through More Maths Grads. Each Pop Maths Quiz is run in a traditional pub quiz style, with teams of six trying to solve mathematical questions; it lasts approximately an hour and prizes are awarded at the end. The target age group can vary from primary school to A-level, and each quiz is typically followed by a public lecture for parents and pupils. Successful participating higher education institutions were asked to implement the quiz.
	Mathematics Challenge Competition[10]	The Take Home Challenge Competition has been run successfully for many years by Mathematical Education on Merseyside, and its use was extended as part of More Maths Grads. The challenge consists of a range of questions for pupils to complete over February half term and there is a junior and a senior challenge, both aimed at secondary level. Winners of the competition are invited to a celebration evening at the university where further enrichment activities aimed at parents and pupils are offered. Successful participating higher education institutions were asked to implement the Take Home Challenge Competition.
	Maths at Work Day[11]	Successful participating higher education institutions were asked to implement a Maths at Work Day which involved employers delivering interactive workshops to Year 7 – 14 students. Each student typically accessed four workshops per day.
	Hands on Maths Workshops[12]	More Maths Grads tried and tested a range of Hands on Maths Workshops finding that these were preferred by school and college age students to lectures when interacting with higher education institutions. In total 11 hands-one workshops were developed, and successful participating higher education institutions were asked to run a minimum of four of these with a view to attracting around 100 participants.
Stimulating Physics	Ashfield Music Festival[13]	Working in teams, the Ashfield Music Festival activity encourages students to design all aspects of the main stage for a music festival. Each team member picks a role based on the skills they will be using and information is provided through videos and discussions with experts. At the end of the activity, the teams present their plans and a panel representing Ashfield Council decide which proposal wins the contract. Pupils use planning, analytical, negotiation and team working skills, as well as physics and maths in a context that is appealing and challenging. Successful participating higher education institutions were asked to implement the Ashfield Music Festival by running it over a whole day or half day.
	Developing a Physics/STEM Roadshow[14]	Successful participating higher education institutions were asked to host a workshop, led by an experienced teacher and scientific communicator who presents the 'Ever Wondered Why? Roadshow'. The workshop is designed to assist university outreach officers and lecturers to develop their own version of an outreach stage activity that matches their aspirations and objectives for outreach. The workshop enables participants to think through the processes of designing a show, including presentation techniques, responding to their audience and organisational requirements.
	Outreach Workshops[15]: Doing Outreach & Extending Your Outreach[16]	Successful participating higher education institutions were offered the opportunity to host one of two self-contained workshops delivered by members of The Training Group aimed at university staff who are interested in improving their outreach skills as well as their confidence. **Doing Outreach** is a one-day introductory workshop for HEI staff who are interested in getting involved with public engagement and outreach activities. The interactive workshop introduces participants to the social and political context of science communication as well as helping to develop their confidence and skills. **Extending Your Outreach** is a one-day workshop for HEI staff who have some experience of taking part in public engagement outreach activities. The workshop helps participants to develop their own public outreach activities and gain skills related to applying for funding and carrying out evaluations.
	Planet SciCast[17]	Successful participating higher education institutions were asked to establish a short science film-making competition by working with local schools and supporting teachers to enable students to make films and enter the competition. The Planet SciCast competition encourages students of all ages are challenged to make a film explaining a principle of physics that is scientifically correct, entertaining and less than 2.5 minutes long. Films submitted to the competition are uploaded to the website.
	Problem Based Learning (PBL) for Active Learning[18]	The PBL Package provides student and tutor resource packs to contribute to active learning for undergraduate students. The resources are derived from PBL activities at the University of Leicester.

References

[1]http://www.rsc.org/Education/HESTEM/Outreach/index.asp

[2]http://www.rsc.org/Education/HESTEM/CPBL/index.asp

[3]http://www.rsc.org/Education/events-and-competitions/chemistry-at-work/index.asp

[4]http://live.lep.netxtra.net/about/thelepapproach/thelepgoodpracticeguidelns

[5]http://www.thelep.org.uk/filegrab/?ref=45&f=1Girlsintoengineeringprint.pdf

[6]http://live.lep.netxtra.net/filegrab/?ref=105&f=TheSolarCarChallenge.pdf

[7]http://live.lep.netxtra.net/filegrab/?ref=102&f=EngineeringPick'n'Mix.pdf

[8]http://live.lep.netxtra.net/filegrab/?ref=101&f=EngineeringIslam.pdf

[9]http://popmaths.com

[10]http://www.maths.liv.ac.uk/~mem/challenge.html

[11]http://www.hestem.ac.uk/sites/default/files/maths_work_days.pdf

[12]http://www.mathscareers.org.uk/viewItem.cfm?cit_id=382835

[13]http://www.iop.org/education/teacher/extra_resources/ashfield/page_39512.html

[14]http://www.youtube.com/watch?v=HylLyTuvHHU&feature=related

[15]www.iop.org/outreachworkshops

[16]http://www.thetraininggroup.org.uk/case-studies/doing-outreach/

[17]http://scicast.org.uk

[18]http://www.iop.org/education/higher_education/stem/problem-based/page_55225.html

Engagement

In total, 118 submissions were received by higher education institutions to participate in the Menu of Activities initiative. Of these, 57 were submissions from the first call, and 61 were from the second call. A number of institutions submitted proposals to engage in multiple activities.

From the 118 submissions, a total of 90 proposals were selected to undertake the activities of the initiative; these were broken down as follows: 52 from the first call, and 38 from the second call. Those submissions not selected to participate in the initiative was primarily as a result of them failing to clearly articulate how adopting the activity would add value to current institutional practice, or that sufficient consideration had been given as to how the activity would become sustainable in the longer-term. There were also a small number of instances of requests being made to undertake the same activity within an institution but by individuals from different departments.

The projects that successfully completed all aspects of the initiative, including both implementation and delivery of their activities and submission of their final case study reports, are shown below along with the headline statistics of the extent of their engagement with other members of university staff, undergraduate or postgraduate students, schools, colleges and targeted future cohorts of learner. Projects highlighted in **bold** have case studies included within this publication and are appropriately indexed; the case studies for the other projects are available online by visiting **www.hestem.ac.uk/MofA**.

Using the data provided within each case study, which project leads were asked to include, it is possible to determine that a minimum of 87 members of higher education staff and postgraduate students have benefited from training opportunities afforded by this initiative; around 420 schools or colleges have participated in activities with higher education institutions which have involved approximately 8,400 school and college age students; around 175 teachers have participated in, or supported, the activities undertaken; and, 390 undergraduates have experienced problem-based learning activities developed by the disciplinary pilot projects. This collected data, however, does not give a conclusive overview of the extent of the overall engagement with the initiative as not all case studies included a common range of data.

There is a difference between the number of submissions initially accepted for support and those that completed the initiative. A total of 25 projects either subsequently decided not to participate in the initiative, or did not submit final case studies. Excluding the 11 projects that decided not to progress at the outset, either shortly after notification or through failure to return the contract agreement, the majority of the remaining 14 projects declared in their early stages, typically when interim reports were required to 'draw-down' allocated funds, that they would not continue, and the staggered nature of payments linked to outputs meant that funding was never at risk; this is an approach that is recommended to others leading similar initiatives involving the distribution of public sector funds. The reasons given for non-continuation were almost universally linked to their identified lead no longer being in a position to deliver the activity; this was either due to a change in personal or professional circumstances. It is recommended that for others seeking to establish similar activities, a second proposer is identified who will become responsible for the implementation of the activity if the identified lead is no longer in a position to undertake or oversee delivery; successful projects typically engaged a number of staff from the lead institution within their activities.

Successful First Call Projects

Case Study Reference	Institution	Project Lead/ Proposer	Activity Name	Engagement
[Abr1 - 25]	**Aberystwyth University**	**Debra Croft**	**Mathematics Challenge Competition**	• **26 schools or colleges contacted; 11 participated in competition** • **386 student entries**
[Ban2 - 1]	**Bangor University**	**Robyn Wheldon-Williams**	**Chemistry Outreach Package**	• **13 schools or colleges participated** • **190 school or college students involved**
[Cov1]	Coventry University	Farzana Aslam	Mathematics Challenge Competition	• 24 schools or colleges participated
[Cov2]	Coventry University	Farzana Aslam	Engineering Pick n Mix	• 6 schools or colleges participated • 80 school or college students involved • 12 teachers
[Cov3]	Coventry University	Farzana Aslam	Outreach Workshop: Doing Outreach	• 14 members of higher education staff
[Gly1]	Glyndŵr University	Julie Cowley	Engineering Pick n Mix	• 1 school participated • 40 school students involved
[Gly2 - 18]	**Glyndŵr University**	**Graham Sparey-Taylor**	**Solar Car Challenge**	• **9 schools or colleges involved in initial event; 6 participated in final event** • **82 school or college students participated in final event; 389 students participated in 12-hour activity programme.** • **14 teachers**
[Kle1]	Keele University	David Bedford	Hands on Maths Workshop	• 3 cohorts of learners participated (two from school/colleges and one from Keele Subject Knowledge Enhancement Programme)
[Kle2 - 22]	**Keele University**	**Liz Maddock**	**Pop Maths Quiz**	• **6 schools or colleges participated** • **144 school or college students involved**
[Kle3]	Keele University	Ant Sutcliffe	Ashfield Music Festival	• 2 schools or colleges participated • 90 school or college students involved
[Lds1 - 2]	**Leeds University**	**Annette Taylor**	**Chemistry Outreach Package**	• **7 schools or colleges participated** • **375 school or college students involved**
[Ljm1 - 3]	**Liverpool John Moores University**	**Ian Bradshaw**	**Chemistry Outreach Package**	• **12 schools or colleges participated** • **161 school or college students involved**
[Mmu1 - 23]	**Manchester Metropolitan University**	**Nicolette Rattenbury**	**Pop Maths Quiz**	• **13 schools or colleges participated** • **130 school or college students involved** • **22 teachers**
[Ncl1 - 26]	**Newcastle University**	**Phil Ansell**	**Mathematics Challenge Competition**	• **9 schools or colleges participated** • **In excess of 300 school or college students involved**

Case Study Reference	Institution	Project Lead/ Proposer	Activity Name	Engagement
[Ntu1 - 10]	**Nottingham Trent University**	**Karen Moss**	**CPBL Package**	• **81 undergraduate students**
[Smu1]	Swansea Metropolitan University	Roger Dowden	Solar Car Challenge	• 3 schools or colleges participated • 48 school or college students involved
[Swn1]	Swansea University	Peter Douglas	Chemistry Outreach Package	• 4 schools or colleges participated • 248 school or college students involved • 60-70 school or college students engaged at public event. • 126 school or college students through additional activities
[Bth1 - 5]	**University of Bath**	**Declan Fleming**	**Chemistry Outreach Package**	• **9 schools or colleges participated** • **810 school or college students involved** • **700 individuals engaged at Cheltenham Science Festival.**
[Cam1 - 4]	**University of Cambridge**	**Elaine Wilson**	**Chemistry Outreach Package**	• **23 schools or colleges participated** • **320 school or college students involved** • **24 teachers and 26 new physics and chemistry teachers**
[Cla1]	University of Central Lancashire	Joanna Heaton	Planet SciCast	• 5 schools or colleges participated • Approximately 20 school or college students involved
[Exe1 - 6]	**University Of Exeter**	**Nicola King**	**Chemistry Outreach Package**	• **21 schools or colleges participated** • **170 school or college students involved**
[Gla1 - 35]	**University of Glamorgan**	**Laura Roberts**	**Planet SciCast**	• **7 schools or colleges participated** • **72 school or college students at launch, 10 entered competition, and 4 entered SciCast competition** • **8 teachers**
[Lei1 - 7]	**University of Leicester**	**Katy McKenzie**	**Chemistry Outreach Package**	• **17 schools or colleges participated** • **549 school or college students involved** • **45 teachers**
[Liv1 - 28]	**University of Liverpool**	**Chris Marchant**	**Hands on Maths Workshop**	• **4 secondary schools and 30 primary schools participated**
[Liv2]	University of Liverpool	Chris Marchant	Maths at Work Day	• Approximately 120 secondary school students
[Liv3 - 15]	**University of Liverpool**	**Lynn Moran**	**Gender Awareness Training**	
[Liv4 - 32]	**University of Liverpool**	**Lynn Moran**	**Outreach Workshop: Doing Outreach**	

Case Study Reference	Institution	Project Lead/ Proposer	Activity Name	Engagement
[Man1]	University of Manchester	Frank Mair	Chemistry Outreach Package	• 14 schools or colleges participated • 271 school or college students involved • 2 science festivals with approximately 2,450 individuals engaged
[Oxf1]	University of Oxford	Jayne Shaw	Chemistry Outreach Package	• 27 schools or colleges participated • 203 school or college students involved
[Rdg1]	University of Reading	Elizabeth Page	CPBL Package	• 79 undergraduate students
[Rdg2 - 8]	**University of Reading**	**Elizabeth Page**	**Chemistry Outreach Package**	• **16 schools or colleges participated** • **285 school or college students involved**
[Slf1]	University of Salford	Edmund Chadwick	Maths at Work Day	• 6 schools or colleges participated • 28 school or college students involved
[Shf1 - 13]	**University of Sheffield**	**Julie Hyde**	**Chemistry at Work Package**	• **15 schools or colleges participated** • **Approximately 400 school or college students involved**
[Shf2]	University of Sheffield	Julie Hyde	Chemistry Outreach Package	• 179 school or college students involved
[Sth1 - 11]	**University of Southampton**	**Paul Duckmanton**	**CPBL Package**	• **110 undergraduate students**
[Sth2 - 12]	**University of Southampton**	**Paul Duckmanton**	**CPBL Package**	• **40 undergraduate students**
[Sth3 - 29]	**University of Southampton**	**Ruth Edwards**	**Hands on Maths Workshop**	• **8 schools or colleges participated** • **96 school or college students involved**
[Sth4]	University of Southampton	Ruth Edwards	Mathematics Challenge Competition	• 20 schools or colleges participated in Junior Challenge with 301 student submissions • 18 schools or colleges participated in Senior Challenge with 192 student submissions
[Sth5 - 9]	**University of Southampton**	**Jonathon Speed**	**Chemistry Outreach Package**	• **6 schools or colleges participated**
[Yrk1 - 14]	**University of York**	**David Jenkins**	**Physics at Work**	• **5 schools or colleges participated** • **104 school or college students involved** • **9 teachers**

Successful Second Call Projects

Case Study Reference	Institution	Project Lead	Activity Name	Engagement
[Abr2]	Aberystwyth University	Debra Croft	Hands on Maths Workshops	• 6 schools or colleges participated • 138 primary and 93 secondary students involved • 19 undergraduate and postgraduate students and 6 university staff involved in training event
[Abr3]	Aberystwyth University	Debra Croft	Maths at Work Day	• 3 schools or colleges participated • 49 school or college students involved • 4 teachers
[Abr4 - 31]	**Aberystwyth University**	**Debra Croft**	**Developing a Physics/STEM Roadshow**	• **43 attendees at show and training workshop including 16 young people**
[Ast1 - 20]	**Aston University**	**Baljinder Rana**	**Engineering Pick n Mix**	• **4 schools or colleges participated** • **45 school or college students involved**
[Bdf1]	University of Bradford	Tasnim Munshi	Chemistry Outreach Package	• Approximately 140 school or college students involved
[Bru1]	Brunel University	Emily Danvers	Hands on Maths Workshops	• 1 school or college participated • 89 school or college students involved
[Ccc1 - 19]	**Canterbury Christ Church University**	**Helen Ward**	**Solar Car Challenge**	• **10 schools or colleges at initial event** • **12 student teams participated in final challenge from 5 schools or colleges** • **50 school or college students involved**
[Cov4 - 16]	**Coventry University**	**Caroline Lambert**	**Gender Awareness Training**	• **10 members of higher education staff, undergraduate and postgraduate students**
[Dhm1 - 33]	**Durham University**	**Paula Martin**	**Outreach Workshop: Extending Your Outreach**	• **10 members of higher education staff and students**
[Dhm2]	Durham University	Claire Willis	Planet SciCast	• 2 schools or colleges participated • Approximately 30 school or college students involved
[Gly3]	Glyndŵr university	Cedric Belloc	Engineering Pick n Mix	• 1 school participated • 36 school or college students involved
[Lmu1]	Leeds Metropolitan University	Duncan Folley	Planet SciCast	• 2 schools or colleges participated • Approximately 70 school or college students involved
[Lmu2]	Leeds Metropolitan University	Stephen Wilkinson	Solar Car Challenge	• 4 schools or colleges participated • 27 school or college students involved
[Liv5 - 30]	**University of Liverpool**	**Lynn Moran**	**Ashfield Music Festival**	• **3 schools or colleges participated** • **138 school or college students involved**

Case Study Reference	Institution	Project Lead	Activity Name	Engagement
[Nwp1 - 27]	**University of Wales, Newport**	**Kerie Green**	**Maths at Work Day**	• **4 schools or colleges participated** • **50 school or college students involved**
[Nwp2 - 21]	**University of Wales, Newport**	**Jenny Hann**	**Engineering Pick and Mix**	• **1 school participated** • **21 school students involved** • **1 teacher and 1 technician**
[Nwp3]	University of Wales, Newport	Jenny Hann	Gender Awareness Training	• 8 members of higher education staff
[Nth1]	University of Northampton	Tricia Goodchild	Gender Awareness Training	• 9 members of higher education staff
[Nba1]	Northumbria University	Anne Willis	Chemistry Outreach Package	• 4 schools or colleges participated • 300 school or college students involved • Participation in regional public engagement event
[Pmh1]	University of Portsmouth	Joe Walters	Maths at Work Day	• 3 schools or colleges participated • 21 school or college students involved
[Ssu1 - 17]	**Southampton Solent University**	**Geeta Uppal**	**Gender & Diversity Workshop**	• **10 members of higher education staff**
[Sth6]	Southampton University	Ruth Edwards	Maths at Work Day	• 6 schools or colleges participated • 75 school or college students involved
[Ucl1 - 34]	**University of Central London**	**Wendy Brown**	**Outreach Workshop: Extending Your Outreach**	• **20 postgraduate students**
[Uea1 - 36]	**University of East Anglia**	**Martin Loftus**	**PBL Packages for Active Learning**	• **Approximately 80 undergraduate students**
[Wlv1 - 24]	**University of Wolverhampton**	**Bryan Fryer**	**Pop Maths Quiz & Hands on Maths Workshops**	• **16 schools or colleges participated** • **76 school or college students involved** • **10 teachers**

Analysing the Menu of Activities Initiative

Legacy of the Initiative

It is perhaps most appropriate to explore the impact and legacy of this initiative relative to its three objectives identified in Section 2:

1. That universities adopt a range of proven activities and incorporate these within their current provision;
2. In adopting the activities there is a wider influence upon the practices of the department or faculty;
3. The activities are appropriately targeted at widening participation cohorts, and in doing so a longer-term way of working is embedded within the sector to enable continued targeting of hard to reach cohorts.

In total 65 projects successfully completed the Menu of Activities by providing final case studies analysing their work. Of these projects, 51 were focused upon delivering outreach activities to local schools and colleges, 5 were context or problem based learning activities with undergraduate students, and 9 involved the provision of professional development opportunities to higher education staff and students. The case studies provided by 39 of the outreach projects, 5 of the problem based learning activities, and 7 of the training or professional development sessions all provide either evidence of how the activities have influenced or informed institutional practices, or an explicit intent to continue the activities in some form in future academic years.

Continuation plans for the projects were particularly evident for the problem based learning activities where all project leads indicated the modules would run again during the next year academic year, and for the outreach projects. Not all activities will continue in their current format however. Some have been modified to align with, or complement, the range of institutional provision available. For example, several higher education institutions intend to undertake these activities, with others, during the annual National Science and Engineering Week as this is an occasion where schools and colleges are actively seeking to participate in STEM activities and have timetabled 'space' available to engage with universities. In other instances, the activities have been merged with existing offerings to enhance overall provision, or have been modified to complement the disciplinary areas of expertise of the department or faculty. Another feature of some of the modifications, or planned future modifications, is providing sustained opportunities for student engagement with STEM activity; this is known to be important for continuing to raise student aspirations and interest. For example at the University of Cambridge **[Cam1 – 4]** a 16 week science club was run in local schools that engaged over 215 students and culminated in the Year 9 Chemistry Day. The Solar Car Challenge **[Gly2 – 18]** and Planet SciCast [Lmu1] projects also allowed similar sustained engagement utilising either academic members of staff or undergraduate and postgraduate students; in the latter instance this was to provide technical expertise to assist with the production of the final videos. There are instances where there are future plans to complement the main activity itself with pre- and post-activities involving STEM ambassadors, for example the Ashfield Music Festival project at Keele University [Kle3].

In addition to activity continuation, there is also evidence of these projects exerting a wider influence upon the adopting department. For example, the University of East Anglia **[Uea1 – 36]**, who acknowledged the use of problem based learning within physics was previously rare, have now indicated that they intend to extend the approach to other modules relating to the teaching of mechanics and astrophysics. For the outreach activities, Bangor University **[Ban2 – 1]** has combined several of the workshops undertaken to produce an activity designed to enable students to achieve a British Science Association CREST Bronze award; this has already been successfully undertaken by 50 pupils. At the University of Reading **[Rdg2 – 8]**, the project has increased the confidence of staff in working with younger pupils, and indeed increasing the range of activities for pupils of a younger age was a key factor for many departments wishing to adopt the Chemistry Outreach Package. At Brunel University [Bru1] the authors reported that the mathematics activities have *"widened our understanding of student transition"* and as a consequence the University will now *"use these activities within our current maths and statistics teaching and support programme, particularly for induction and promotional events for first-year and foundation students",* and at Keele University **[Kle2 – 22]** the undergraduate STEM mentoring scheme has been extended to include mathematics.

At Canterbury Christ Church University **[Ccc1 – 19]** the Solar Car Challenge was delivered collaboratively with the University of Kent, and despite the proximity of the two institutions it was reported that *"no previous collaborative activities had been undertaken within STEM outreach projects"*; as a consequence of this project

not only was collaboration established between the two institutions it is continuing. At the University of Wales Newport **[Nwp2 – 21]**, who delivered a Mathematics at Work Day, collaboration will continue with Careers Wales Gwent, and the continuation of the activity will provide *"an opportunity for local employers to engage more readily in the learning process and enable student teachers to develop employability skills and prepare effectively for professional practice."* Undertaking the activities also sometimes had an unexpected influence. For example, at Swansea University [Swn1] one of the Chemistry Outreach activities has now been adopted as a practical activity for first-year students, and at Bangor University **[Ban2 – 1]** the process of developing a timeline for delivering an outreach activity, which was required as part of the expression of interest submission to the National HE STEM Programme, has now been implemented for other activities.

The activities have also helped develop future capability across the higher education sector. At Southampton **[Sth5 – 9]** postgraduates and postdoctoral researchers have gained experience in outreach and *"will be able to carry on the various activities learned during the project next year"*, and similarly at the University of Bath there is a *"plan to begin training more undergraduates to deliver outreach and to begin training postgraduates earlier in the year before they have time to make commitments elsewhere."* At Exeter **[Exe1 – 6]** the activities were also *"used as a learning experience for undergraduate students interested in a career in teaching."* At the University of Cambridge **[Cam1 – 4]** experienced teachers commented that *"they had learned some new chemistry ideas as a result of attending the Year 9 Chemistry Day."*

The training events have perhaps had the greatest impact in enhancing both capability and capacity to deliver outreach activities across the HE STEM sector. The activities focused upon enhancing outreach skills and embedding a greater understanding and awareness of gender and diversity issues within the HE STEM disciplines; nine such activities were undertaken as part of this initiative.

The University of Liverpool ran both the Gender Awareness **[Liv3 – 15]** and Doing Outreach **[Liv4 – 32]** workshops. The Gender Awareness Training was undertaken in response to a difficulty identified by the Physics Outreach Group of attracting girls and young women to participate in outreach events, particularly those from all girls' schools. In response the University had encouraged female undergraduates and postgraduates to plan some events, but wanted to ensure they were appropriately supported by members of staff; this event therefore met an identified need. Since undertaking the training, the Physics Department has *"run a Women in Physics event for AS-level students, and its success has led to the development of Young Women in Physics, Women in Physics 2012 [events] and involvement in all-girls science events in schools."* Following the Doing Outreach workshop, not only are collaborative activities now taking place between departments who hadn't previously worked together, but staff within the University have reported they now feel more confident in relation to delivering outreach activities.

At both Coventry **[Cov4-16]** and Southampton Solent **[Ssu1 – 17]** Universities, who participated in the Gender Awareness and Diversity training, activities have been identified to incorporate the learning within the core practices of the intuitions. For example, Southampton Solent has already undertaken a range of (collaborative) activities *"with the aim of increasing participation amongst female students"*; a number of which have "targeted a female only cohort". At Coventry University, the impact has been more at an individual level, with staff identifying how they will respond to the issues discussed, and good practice identified, during the workshop session. At the University of Central London **[Ucl1 – 34]**, an innovative approach was offered whereby the Extending Your Outreach training event was offered to 20 first and second year postgraduate chemistry students to equip them with the skills to plan and deliver their own outreach activities. As a consequence of this activity, *"many events coordinated by the students who attended this training event are now in the early or late planning stages. These include several events for National Science and Engineering week which include 4 new workshops designed by people who attended this training event."*

A key feature of the training workshops offered through this initiative is that they were tailored by the facilitators to the needs of those attending. As such, they provided a mechanism for addressing departmental or institutional issues, challenges or concerns in an open an honest manner; in doing so the participants can benefit from the collective experience on offer, not just from the facilitators, but also their peers. A particular element of good practice seen at these workshops was the development of individual action plans where participants detailed how they would take forward what they had learned in the future; this provides a useful benchmark or reference point for exploring the subsequent impact of any such similar sessions.

Throughout the submitted case studies describing the outreach focused activities, there is clear evidence that project leads have sought to ensure these are appropriately targeted at widening participation cohorts. There is no evidence within the case studies to indicate that this targeting approach was adopted solely as a result of undertaking this National HE STEM Programme activity. What is demonstrated, however, is that there is significant evidence of good practice in the appropriate targeting of widening participation cohorts across the HE STEM sector and that this is often undertaken in

a collaborative manner either with central university units or external STEM organisations and initiatives.

Many universities reported that the targeting of schools and colleges was undertaken by centralised widening participation units, for example at the University of Manchester [Man1], or by faculty members of staff with responsibility for outreach or access [Oxf1], using widely accepted indicators of widening participation status. Other particular approaches observed were the targeting of 'Communities First Schools', which is one of the Welsh Assembly Government's targets for widening participation; this targeting mechanism was widely used for activities undertaken in Wales. A related approach was observed for a number of activities within England whereby 'Aimhigher schools' were particularly targeted; for the activities at Coventry University [Cov2] widening participation schools were identified by the Local Education Authority.

A number of case studies indicated particularly innovative approaches to targeting schools had been adopted by their universities. For example, at Keele University [Kle3], there is the 'Keelelink programme' whereby joining schools and colleges are ranked for widening participation status using a series of indicators; some University activities are then only available to schools or colleges with a high widening participation ranking, or these schools are given priority when booking events. The University of Exeter **[Exe1 – 6]** maintains an 'aspirational schools' list which contains details of schools who perform below the national average for UCAS tariff points per student and who are in the bottom 40% of schools nationally. When the Chemistry Outreach activities were then undertaken in Exeter, these schools were then asked to put forward students who met the well established Aimhigher criteria, indicating a clear intent to target widening participation students directly. Access and Community Engagement at the University of Leeds classifies schools engaging in outreach activities by the percentage of students from the bottom 13,000 super output areas in the country; the Higher Education Funding Council for England classifies these as 'disadvantaged learners'. This approach enables schools to be placed into bands according to their percentage of students from the lowest 13,000 super output areas, and as a consequence allows schools with the highest percentages of such learners to be targeted.

A number of project leads also sought to 'verify' the widening participation status of those students who participated in the activities. The University of Bath for example [Bth1 – 5] highlighted explicitly, in a letter to schools, what was meant by the phrase 'students from disadvantaged backgrounds' and asked that such students be prioritised for the activities. At Liverpool John Moores University **[Ljm1 – 3]**, during the activity day students were asked to indicate if family members had previously studied at university.

In addition to collaboration with centralised institutional units, there are a number examples of collaboration with other STEM organisations and initiatives to enable targeting of widening participation cohorts. At the University of Liverpool [Liv2], Maestro Services Ltd, formerly the Greater Merseyside and Cheshire & Warrington SETPOINT, was engaged to assist with the organisation of the activity. At the Universities of Sheffield **[Shf1-13]** and York **[Yrk1 – 14]** activities were undertaken collaboratively with Business and Education South Yorkshire and NYBEP (the STEMPOINT for York and North Yorkshire) respectively who provided organisational expertise and enabled the targeting of appropriate schools; similarly Canterbury Christchurch University **[Ccc1 – 19]** worked with Kent and Medway STEM which holds the STEMNET contract for Kent and Medway. The University of Durham [Dhm2] targeted schools on the basis of those who had previously engaged with provision offered by the North East Science Learning Centre. The University of Wolverhampton has, for many years, facilitated a STEM focus group to bring together STEM practitioners from across the University, local schools and colleges, and the regional STEMNET provider; the activities undertaken were delivered through this group and targeted on the basis of this collective expertise.

Learning Emerging from the Initiative

The activities undertaken through this Menu of Activities initiative collectively represent a significant body of work to transfer and embed effective practice more widely. As such, the learning that has merged from this initiative offers potentially helpful insight for others wishing to undertake similar activities in the future. The key messages emerging are summarised by theme below and are cross-referenced to the individual case studies where further information is available.

Activity Location

For outreach activities, determining where the intervention takes place is an important consideration, and both school-based and university-based activities have their advantages and disadvantages. Holding the activity within a school or college removes the need for the mass transport of students or the need for the school to engage supply cover for teachers, but this potentially adds to the cost for the university, means staff and students are away for longer as travel time needs to be factored in, and limits the equipment or resources that can be used with students to that which can be easily, and safely, transported.

Outreach activities requiring access to specialist laboratories or equipment are particularly attractive to widening participation schools and colleges who typically might not have access to such facilities **[Rdg2**

– 8] [Lds1 – 2]. For non laboratory based activities, students can also be inspired by the range of university facilities, and so a number of projects recommended the incorporation of a campus tour **[Ast1 – 20] [Wlv1 – 24]**; the University of Bath **[Bth1 – 5]** reported, following the analysis of collected student feedback, that experiencing a higher education environment was one of the most beneficial aspects of the day. Several projects reported difficulties in encouraging schools to engage due to the need for them to source supply cover for the teachers who would attend the activity. One project **[Rdg2 – 8]** overcame this issue by allowing school students to attend without a teacher providing the school took responsibility for the pupils travelling to and from the University; the project lead reported that the activity *"ran perfectly well without the need for a teacher present."*

One challenge often encountered when running laboratory-based events in a university is that such facilities are not always readily available during term-time. One approach to address this is to have a specialist laboratory solely for use by schools and colleges **[Shf1 – 13]**, but another is to utilise other appropriate facilities in the surrounding area such as the regional Science Learning Centres **[Lei1 – 7]**. Another approach, which offers the opportunity for not only the engagement of larger school and college age cohorts, but also engagement in the activities by their family members, is to run activities at local science fairs **[Bth1 – 5]** [Man1]. If running an event within a school or college, universities might wish to considering doing this as an 'off-timetable' activity where students determine how, and when they will work, in order to simulate a true working environment. However, caution is needed as not all students possess the necessary maturity needed for such an approach to work effectively **[Liv5 - 30]**.

For Problem Based Learning activities within universities an issue often cited as a barrier for engaging with such forms of delivery is the lack of a suitable room. The project at Nottingham Trent **[Ntu1 – 10]** demonstrated that Problem Based Learning can be delivered effectively within a lecture-room environment.

Implementation and Delivery

Those engaging in outreach activities through this initiative reported that it was important that these were included within the university outreach calendar at the outset, and their timing was clearly communicated to schools at the start of the school year [Man1]. Approaches to targeting schools varied, but many projects reported the benefits of what might be termed 'direct targeting', where named individuals in specific roles were contacted about the activities. A number of projects tried more general mechanisms, such as mailouts, flyers, and website or press advertising, and while it is possible these might work in combination, direct targeting appeared, within this initiative, to result in the more effective engagement of schools and colleges. Very few projects discussed how students were registered onto the activities, but Manchester Metropolitan University **[Mmu1 – 23]** and the University of Oxford [Oxf1] utilised an online booking system to minimise the administrative burden. When using such systems, however, it is important to ensure schools can easily register large cohorts of students.

When planning the delivery of activities, several projects reported using a committee or working group based approach with regular meetings of the organising team [Gly3] which might also include external stakeholders who can contribute to the activity **[Wlv1 – 24]**. The explicit delegation of tasks should be undertaken to ensure roles and responsibilities are clear **[Ljm1 – 3]**, and dedicated administrative support should be identified to chase schools and check planned attendance. A number of projects reported instances of where schools or colleges had booked to participate and then subsequently withdrew shortly before the activity. While sometimes such instances are unavoidable, this is less than ideal, particularly if other schools or colleges were rejected due to limited capacity. Having several contacts within the school or college is essential, and universities might wish to consider a 'penalty' system for schools that book to attend but fail to do so without providing sufficient advance notice. A significant underpinning point here is that the organisation of the activity should involve multiple individuals, both within the school or college and the university in order that delivery of the activity is not compromised should one individual become unexpectedly unavailable.

To support the delivery of activity, the University of Reading **[Rdg2 – 8]** engaged a retired teacher, and a number of projects reported the benefits of providing school and college teachers with a briefing of the activity in advance. Such an approach enabled the appropriateness of the activity, in terms of benefit and level, to be checked in advance of delivery **[Lds1 – 2]**, or to allow the teachers to participate in delivery [Gly1] **[Sth3 – 29]**. Instead of a briefing document the University of Durham [Dhm2] organised a twilight briefing session for teachers. At Newcastle University **[Ncl1 – 26]**, there is a future intent to provide a briefing document to schools in order to enhance the consistency of student submissions for the Mathematics Challenge activity.

For the delivery of activities themselves, there is a need to not only ensure an appropriate ratio of demonstrators to students **[Exe1 – 6]**, but thought should be given to their structure in order to enable students of all abilities to participate. A recommendation is to encourage mixed group activities which allow students of all abilities to demonstrate their individual skills sets [Gly1]. Student feedback indicates they appreciate interactive and 'hands on' activities, and an effective

way of facilitating an interactive quiz is through the use of personal response (clicker) devices [Nba1].

Evaluation

A core part of the Menu of Activities Initiative, and indeed of the National HE STEM Programme's entire activity, was that all projects were asked to undertake some form of evaluation. In the instances where this did not occur, this in itself was identified to be an important learning experience **[Ncl1 - 26] [Nwp2 – 21]**.

The evaluations undertaken by the projects primarily focused upon gathering information that would help inform and enhance future delivery, and also contribute to the case studies that were required by the National HE STEM Programme post-delivery; some innovative approaches to collecting information were demonstrated **[Ntu1 – 10]**. For the outreach activities, the approach to collecting evaluation data extended beyond the students who participated to include both teachers and university staff; at Leeds Metropolitan University [Lmu1] debriefing sessions were held within both the University and the schools who participated. A number of the projects sought to capture to data relating to how the perceptions of students to STEM subjects and their desire to engage in STEM study had changed following the activities. While such data is often collected immediately after the event, and as such is subject to limitations, it is nevertheless useful as an indicator of the impact of the activity. If students leave and don't report that the event left them feeling inspired, then it is a good indicator that the activity isn't necessarily meeting its desired purpose and perhaps needs changing; students can also provide recommendations as to how this might be achieved. For example, at the University of Oxford [Oxf1] students reported wanting further scientific explanation to complement the hands on activities; the future intent following this project is to implement a lecture and an interactive quiz to consolidate learning.

For those projects who did not capture evaluation data immediately after the event, by this it is meant before the students and teachers left the activity, a number reported difficulties in subsequently capturing large-scale data. Although a delay in requesting feedback until a short while after the event can allow individuals to reflect upon the impact of their experience, and as such might be considered more reliable as to the longer-term impact of the activity in changing perceptions or future motivations, this needs to be offset against the challenge of actually obtaining a meaningful sample size. Analysing a significant number of responses to a paper-based survey is time-consuming, but there are potential approaches that could be utilised, for example the use of an online system **[Nwp1 – 27]** or the use of personal response (clicker) devices [Nba1].

Post-Activity and Sustaining Engagement

The four disciplinary pilot projects that preceded the National HE STEM Programme all identified that if we wish to raise the aspirations of school and college students to engage with STEM study in higher education then there is a need for them to experience sustained activities to help inform and influence their decisions. While a number of the activities within the 'menu' focused upon the implementation of a single event, several, for example the Solar Car Challenge, included a series of activities, often undertaken within the school or college, that acted as a 'build-up'. A number of project leads, however, decided to modify the implementation of their activities in order that they included some form of pre or post-engagement with either students or their teachers.

At the University of Leeds **[Lds1 – 2]**, teachers were consulted about the proposed activities in advance in order to ensure that they were at an appropriate level and offered added benefit to the curriculum the students were studying. The University of Cambridge **[Cam1 – 4]** used the Year 9 Chemistry Day as the culmination of a 16-week programme of STEM club activity which was facilitated within the participating schools and colleges by PGCE chemistry teachers; a related approach involves assigning undergraduate STEM students to individual schools to support the build-up to an activity **[Gly2-18]**. Other approaches for universities to consider include running support workshops in advance of the activity on a university campus **[Gla1 – 35]**, offering the activity as part of a wider university residential event or summer school **[Exe1 – 6] [Sth5 – 9]**, and aligning the activity with a competition or accredited award such as the National Science and Engineering Competition linked with the Big Bang Fair or the British Association CREST Awards scheme **[Ccc1 – 19] [Ban2 – 1]**.

Post-activity follow-up is also important, and websites provide an appropriate means for enabling post-event interaction **[Ncl1 – 26]**, or a wiki can be used to allow teachers to download resources and information relating to the activities undertaken during the day **[Cam1 – 4]**. In one of the projects teachers requested a lesson plan to support the activity undertaken [Abr2], and university led outreach activities can be readily adapted to actively involve the teachers who attend so that they provide professional development opportunities for teachers, for example, by running parallel sessions for teachers alongside main outreach event [Oxf1]. Another consideration is how universities might develop links with those schools within which their PGCE graduates are now based; the University of Southampton indicates that trainee teachers are eager to maintain links with their universities once they have been placed in local schools **[Sth3 – 29]**.

A number of projects incorporated a recognition or celebration event for not only those who had participated

in the activities but also their family members. For many learners, family members will have perhaps the key role in influencing decisions regarding future study and as such it is important they are appropriately informed about the benefits that STEM study offers. The celebration event brings added prestige if it includes participation by a senior member of the University **[Abr1 – 25]**, or a high profile individual from the local area such as the Mayor **[Gly2 – 18]**, and should ideally coincide with a talk about the benefits of university study or careers in STEM [Sth4] **[Ncl1 – 26]**. Some projects awarded prizes to those who participated, if universities adopt this approach it is perhaps worth considering awarding a prize to all who participate; these can be of differing values but recognise the contribution of all students regardless of where they might have been ranked in what might be perceived as a competitive activity.

(Student) Engagement and Wider Buy-in

Although each Menu of Activities project was awarded to a single higher education institution, there were many instances of these being subsequently undertaken in a collaborative manner with other regional stakeholders. For example multiple universities from the East Midlands engaged with the Chemistry Outreach Package activities based upon disciplinary collaborations that had been previously established **[Lei1 – 7]**, and a regional approach can also be based around a regional professional body network **[Shf1 – 13]**. Such an approach allows not only the identification of appropriate expertise but also the ability to delegate tasks based upon this expertise; through such an approach all partners can undertake activities that contribute towards fulfilment of their own aims and objectives. Regional or cross-institutional activities also allow mechanisms for the subsequent sharing of effective practice **[Lei1 – 7]** and the development of further collaborations **[Liv4 – 32]**.

A key feature of almost all of the activities undertaken was the involvement of university students, both undergraduate and postgraduate. For the outreach activities, school and college students reported that talking with undergraduate and postgraduate students was one of the beneficial aspects of the activity [Bth1 – 5]. In the majority of cases, students supported the activities taking place 'on the day', but in others, they were utilised as ambassadors to check on the progress of developmental activities within local schools and colleges [Swn1].

In some instances the students received payment for participating, in others they did not. Where the students were not paid this was linked to aiding the development of transferable or graduate skills **[Mmu1 – 23]**, possibly through the development and delivery of their own outreach activities **[Liv4 – 32]**, outreach activities linked to educational projects **[Lei1 - 7]**, or to enable undergraduates to develop appropriate experience relating to future career plans **[Exe1 – 6]**. For postgraduate students, participating in the development and delivery of activities allows them to accrue 'training points' which contribute towards the approximately 210 hours of development activities they are advised to undertake by the UK Research Councils throughout the duration of their studies **[Ucl1 – 34]**.

Mentoring was another key feature of undergraduate and postgraduate student participation in the activities. Keele University possesses a 'register' of undergraduate STEM mentors who are employed on a casual contract and who are then notified of appropriate work opportunities that are available to them **[Kle2 – 22]**. The activities also demonstrated that secondary school students, following appropriate selection and allowing for appropriate supervision during the event itself, can successfully work as facilitators for activities aimed at primary school pupils **[Liv1 – 28]**. Mentoring also worked effectively within undergraduate and postgraduate cohorts by enabling those looking to develop expertise in outreach to work with those who had more experience. For the problem based learning activities, a peer support system **[Uea1 – 36]** that developed between foundation year and first year undergraduate students in Physics was a further positive outcome of the project.

For all activities there is a need for university staff to effectively manage student expectations, particularly in relation to problem based learning **[Ntu1 – 10]**. Students will not always appreciate the format of a particular activity, but will do so if the reasons behind it are explained to them **[Sth2 – 12]**. There are also well documented challenges of encouraging student participation in a non credit bearing activity after summer examinations have completed **[Sth1 – 11]**, even if this is targeted at enhancing essential skills, but where participation forms part of a formal module, even when this particular component is non assessed, attendance is often in line with other modules **[Sth1 – 12]**.

Funding Sources and Cost Reduction

While many projects indicated a clear intent and commitment to continue the activities, they also highlighted the challenges around obtaining funding that is essential for delivery. Many of the activities that were undertaken through this Menu of Activities initiative were implemented prior to the commencement of the revised Office For Fair Access (OFFA) Agreements associated with an increased contribution by students to their tuition fees. It is however the case that there is a need for the sector to ensure that the financial resources highlighted by universities as part of their commitment to increasing and widening participation continue to be made available for activities at a departmental level.

A number of the projects identified other sources of funding, or were able to include other (non-financial) contributions. Alumni are often keen to engage with

outreach activities within a department, and will contribute their time 'in kind' [Slf1]. One project proposed focusing future activities towards public engagement and understanding in science [Man1] as additional sources of funding then become available. Other projects focused upon reducing costs, this included preparing materials that can be reused to minimise future costs [Shf2], or asking pupils to bring a packed lunch **[Sth3 – 29]**.

Conclusions

The approach of the National HE STEM Programme to transfer and embed the activities from the four disciplinary pilot projects has proved to be particularly successful. A maximum of £3,000 was provided for each activity, and while this might imply the activity would only be offered on a limited number of occasions, there is not only clear evidence within the submitted case studies that these activities will continue into the future but also that they have impacted more widely upon institutional practices and approaches. The learning from implementing this Menu of Activities initiative has also benefited the National HE STEM Programme. It informed a subsequent initiative, the 'Practice Transfer Adoption Scheme', which was implemented in late 2011 with a view to enabling the transfer and embedding of effective practices developed through the Programme; over 80 'adoptions' of effective practice have been facilitated through this scheme.

Key to the success of this Menu of Activities initiative has been the commitment and dedication of those involved in not only delivering the individual activities, but also extending the approaches utilised and generating further learning that will benefit the higher education sector. It is these individuals that deserve the success and credit associated with this initiative.

Michael Grove
Director – National HE STEM Programme
Director – University of Birmingham
STEM Education Centre
March 2013

About the Case Studies

This section contains a number of case studies produced by those who participated in the Menu of Activities initiative. While each case study adopts an individual style, a degree of editing has taken place by the Editors to ensure they are presented in a consistent manner; in all cases, the nature and tone of their contents remains unchanged. Case studies were produced by their respective project leads at different times throughout the initiative, but they have been published collectively now so that the full nature of the learning emerging from this initiative can be analysed.

Not all case studies have been selected for inclusion, but all submitted case studies are accessible through the National HE STEM Programme website at **www.hestem.ac.uk/MofA**. Case studies have been selected this publication on the basis that they offer learning or insight that will benefit the wider HE STEM sector; although each case study relates to a specific activity or discipline, the learning generated is applicable much more widely and in particular crosses disciplinary boundaries. This might, for example, be in relation to implementation, approach to delivery, evaluation, or sustainability. Each case study does not seek to describe the specific details of the activity itself as this has been thoroughly addressed during pilot project activity, but more the process of its implementation and impact upon the targeted cohorts. Where authors have submitted multiple case studies, describing different activities from the 'menu', some repeated background information has been removed for brevity.

The case studies specific to each activity within the Menu of Activities initiative are listed in Table 2 overleaf.

Pilot Project	Activity Name	Case Study Exemplars Included
Chemistry for our Future	Chemistry Outreach Package	**Case Study 1:** Robyn Wheldon-Williams, Bangor University **Case Study 2:** Annette Taylor, School of Chemistry, University of Leeds **Case Study 3:** Ian Bradshaw and Linda Seton, Liverpool John Moores University **Case Study 4:** Elaine Wilson, University of Cambridge **Case Study 5:** Declan Fleming, University of Bath **Case study 6:** Nicola King, University of Exeter **Case Study 7:** Katy McKenzie, University of Leicester **Case Study 8:** Elizabeth Page, University of Reading **Case Study 9:** Jonathon Speed, University of Southampton
	Context & Problem Based Learning (C/PBL)	**Case Study 10:** Karen Moss, Nottingham Trent University **Case Study 11:** Paul Duckmanton, University of Southampton **Case Study 12:** Paul Duckmanton, University of Southampton
	Chemistry at Work	**Case Study 13:** Andrew Ross, Julie Hyde and Will Davey, University of Sheffield **Case Study 14:** David Jenkins and Catherine Brophy, University of York
The London Engineering Project	Gender Awareness Training	**Case Study 15:** Lynn Moran, University of Liverpool **Case Study 16:** Caroline Lambert and Kusky Makota, Coventry University
	Gender & Diversity Workshop	**Case Study 17:** Geeta Uppal, Southampton Solent University
	Solar Car Challenge	**Case Study 18:** Graham Sparey-Taylor, Glyndŵr University **Case Study 19:** Helen Ward, Canterbury Christ Church University
	Engineering Pick n Mix	**Case Study 20:** Baljinder Rana, Aston University **Case Study 21:** Jenny Hann, University of Wales, Newport
	Engineering Islam	No activities completed through Menu of Activities initiative
More Maths Grads	Pop Maths Quiz	**Case Study 22:** Liz Maddock, Keele University **Case Study 23:** Nicolette Rattenbury, Manchester Metropolitan University **Case Study 24:** Bryan Fryer, University of Wolverhampton
	Mathematics Challenge Competition	**Case Study 25:** Debra Croft and Roger Morel, Aberystwyth University **Case Study 26:** Phil Ansell and Tom Nye, Newcastle University
	Maths at Work Day	**Case Study 27:** Ceri Pugh and Kerie Green, University of Wales, Newport
	Hands on Maths Workshops	**Case Study 28:** Chris Marchant and Michael Jones, University of Liverpool **Case Study 29:** Ruth Edwards, University of Southampton
Stimulating Physics	Ashfield Music Festival	**Case Study 30:** Lynn Moran, University of Liverpool
	Developing a Physics/STEM Roadshow	**Case Study 31:** Debra Croft, Aberystwyth University
	Outreach Workshops: Doing Outreach & Extending Your Outreach	**Case study 32:** Lynn Moran, University of Liverpool **Case Study 33:** Paula Martin, Durham University **Case Study 34:** Wendy Brown, University College London
	Planet SciCast	**Case Study 35:** Laura Roberts, University of Glamorgan
	Problem Based Learning (PBL) for Active Learning	**Case Study 36:** Martin Loftus, University of East Anglia

Examples of the Transfer & Embedding of Activities from the Royal Society of Chemistry's 'Chemistry for out Future Programme'

Chemistry Outreach Package

Robyn Wheldon-Williams, School of Chemistry, Bangor University

Engagement and Target Audience

1. Title of event: *Chemistry is Fun*
Date: 28 March 2011
Venue: Ysgol Y Moelwyn, Blaenau Ffestiniog (CF)
Target Audience: Year 6
Number of Pupils: 70
Primary schools attending; Ysgol Tan y Grisiau, Ysgol Manod, Ysgol Bro Hedd Wyn, Ysgol Maenofferen, Ysgol Gellilydan

2. Title of event: *Snap Crackle Snot*
Date: 9 May 2011
Venue: School of Chemistry, Bangor University
Target Audience: Year 7
Number of pupils: 60 (15 from each school)
Schools attending: Ysgol David Hughes, Howells School, Ysgol Dyffryn Ogwen (CF), Rhyl Hugh School (CF)

3. Title of event: *Year 9 Chemistry Day*
Date: 20 June 2011
Venue: School of Chemistry, Bangor University
Target Audience: Year 9
Number of pupils: 60 (15 from each school)
Schools attending: Ysgol Gyfun Llangefni (CF), St David's College, Ysgol Rhosnesni, Wrexham (CF), Alun School, Mold

- Total number of pupils engaged: 190 in three activities offered between March 2011 and June 2011
- Number of schools engaged: 13
- From Communities First (CF) areas: 130
- Welsh first language: 100
- Boy/Girl split: Approximately 50/50

In line with the Welsh Assembly Government's aim of widening participation into higher education, Bangor University's Talent Opportunities Programme (TOP) is a widening access programme which operates across North Wales. The nine schools involved are located in areas which have been identified as having socially-disadvantaged or deprived communities under the Welsh Assembly Government's Communities First Programme. Schools under the TOP programme were given priority to attend the proposed outreach activities, spaces were then allocated on the basis of first come first served. 70% of the pupils involved in the activities were from the Communities First areas. All the activities were bilingual catering for the regional cohort. The *Chemistry is Fun* activity was held at Blaenau Ffestiniog, an area which falls within the 25% to 30% most deprived in Wales according to the Welsh Index of Multiple Deprivation (figures provided by the Welsh Assembly Government).

Background and Rationale

The School of Chemistry at Bangor has for many years had a very successful record in engaging with pupils in Key Stage 4 and at A-level. The purpose of this project was to enhance our outreach provision to include events for children in Key Stages 2 and 3, eventually embedding the activities in the University's annual outreach calendar.

Our objectives in adopting the activities was to:

i. Raise aspirations of children by providing exciting experiences using postgraduate students as positive role models.

ii. Increase motivation between Key Stages with the aim in the long term of increasing the take up in STEM subjects at Year 12 and beyond.

iii. Provide opportunities and engage with schools in the Welsh Government's Community First Areas.

iv. Provide engagement experience at the KS2/KS3 age range for the School's staff and students.

Implementation

The School of Chemistry is committed to outreach and as such has well defined roles and practices in place. Critical to the success of our activities is the contribution in kind of staff and a successful teamwork approach; an outreach planning committee meets on a regular basis. The committee consists of:

- Project Leader (Teacher Fellow): Overall responsibility for the project.
- Head of School: Maintains an overview of all outreach activities and staff responsibilities.
- Schools Liaison (Academic): Responsible for long term adoption of the project and embedding into other events.
- Health & Safety (Academic): Along with project leader responsible for risk assessments.
- Secretarial Staff: Responsible for contacting schools and general logistics for the events.

- Technical Staff: Procurement of equipment and consumables, setting up and test-run of experiments.
- Senior Student Demonstrator: Along with project leader responsible for ensuring that staff/students are able to demonstrate the activities effectively.

Development of Activities

As part of the application process a detailed timeframe was produced with set targets and deadlines to achieve. This provided to be very useful and has been adopted as good practice for our other outreach activities. The events were incorporated into the School's outreach calendar which is sent to all schools in North Wales. An additional letter was sent to schools six weeks prior to the event giving them the opportunity to attend either the Year 7 or Year 9 activities but not both as we wanted as many different schools as possible to attend. An important part of the project was to make the activities inclusive for children that study science through the medium of Welsh; all the original Royal Society of Chemistry literature was translated.

The project leader performed a test run on all the activities with Year 9 pupils at Ysgol Brynhyfryd (where he is also a chemistry teacher) to identify any potential problems with the literature and experiments. A few weeks before each event all staff involved on the day attended a training session in the laboratory. Four postgraduate students were recruited to work with the project leader; these were students that were enthusiastic and wanted experience of working with school pupils. Each student was then allocated a school to mentor. Two academic staff were also on hand in the laboratory. The project leader presented the *Chemistry is Fun* show for primary schools along with a postgraduate student and technician, this show was 80 minutes in length.

Evaluation

As part of our evaluation exercise pupil questionnaires were completed and analysed. Face to face interviews were also held with teachers. The activities were discussed at length at the School's outreach committee.

Analysis of questionnaires - pupil results:
Question1: How would you rate the event?

Chemistry is Fun	Very	Fairly	Not very	Not at all	Don't know
Enjoyable	65	5			
Interesting	62	8			
Snap Crackle Snot					
Enjoyable	50	10			
Interesting	52	8			
Year 9 Chemistry Day					
Enjoyable	58	2			
Interesting	55	5			

Question 2: What did you like most about the event?

In response to the *Chemistry is Fun* event the following responses were recorded:

- "The experiments were interesting and it was fun to watch."
- "When they took people on stage to do experiments."
- "I liked the really big experiments."
- "I loved the way they showed different experiments, all the experiments were very interesting."

In response to the *Snap Crackle Snot* event:

- "I learnt new things I didn't know before and they also made the experiments fun."
- "The experiments were fun, we loved making slime, the liquid nitrogen experiments were awesome!"
- "The student ambassadors were really friendly and fun to be with, I want to be a scientist now!"
- "I am so happy that I was chosen to come on this day, I like everything about the day, I want to come again next year."

In response to the *Year 9 Chemistry Day* event:

- "I loved using the Infrared machine, it was so cool to use the same machine as real scientists."
- "I enjoyed the trip to University, I have never been before."
- "Doing loads of experiments were fun, we have never done so much."
- "I really enjoyed the session about Smart materials, thank you for the UV beads."
- "We love slime!"
- "Our student ambassador was really helpful."
- "Our milk fridge magnet was the best, I really enjoyed making it."
- "The event was excellent – everything was good, please can we come again?"

Question 3: What would you improve about the event?
(Note: not many responses to the this question)

Chemistry is Fun:

- "I would like to have more volunteers take part as only five were chosen."
- "It was hard for people at the back to see."
- "Don't need to improve anything, as it was cool and interesting."

Snap Crackle Snot!:

- "I enjoyed everything, nothing to improve."

- "More experiments in the laboratory."

Year 9 Chemistry Day:

- "Our custard bouncy ball didn't work!"
- "Make an individual fridge magnet rather than between a pair."

Question 4: How strongly do you agree/disagree with this statement: This event has increased my interest and understanding of science in general?

	Strongly agree	Agree	Disagree/ Strongly Disagree/ No change
Understanding	124	66	
Interest	110	79	

Question 5: Have you ever been to a science and/ or engineering event in the past 12 months?

Yes	No	Not sure
15	145	20

Question 6: Would you attend similar events in the future?

Yes	No	Not sure
180	5	5

Analysis of Teacher Results: Ten teachers were interviewed, all of whom were grateful for the opportunity. The activities slotted in well with the National Curriculum. Year 7 students were excited to be at the University, most schools using the event as a reward. This was the practice adopted by one school who selected two pupils from each class in Year 7 based on their attitude, effort and achievement in class. This seems like an excellent method to select pupils. Teachers really appreciated the *Year 9 Chemistry Day*, the timing was perfect at the end of the year. The event was ideal grounding for the children before they go to Year 10 GCSEs.

One teacher commented:

"The Year 9 Chemistry Day at Bangor University was extremely enjoyable for both pupils and staff. The day was undoubtedly of great educational value for the pupils allowing them to experience science beyond the classroom and to gain an insight into the opportunities available to them in the future."

Summary

We are especially pleased with the response of the children to the activities undertaken, for most of the children this was their first taste of an outreach event. In a bid to guide pupils to pursue a career in STEM gaining a positive experience is immensely important. We are delighted with the feedback and the project outcomes.

Outcomes

All events were successful. Staff and students at the School of Chemistry have gained important engagement experience with pupils from younger year groups. Some of the students want to become teachers and are in the process of becoming STEM Ambassadors.

We have discovered that there is a demand for activities for Key Stage 3 in North Wales, this was especially true for the *Year 9 Chemistry Day*, the activity was four times oversubscribed. The events also enticed schools that do not normally attend our other outreach events for older students – it was a great opportunity to publicise these events to teachers.

The experiments adopted will now be used in other events; this means a variety of experiments based particularly around the theme of large molecules will be on offer in UCAS Open Days and most importantly Year 9 University Taster Days, this was one of our targets.

Further Development of Project

In July 2011 the project leader combined activities from the *Snap Crackle Snot* and *Year 9 Chemistry Day* workshops to produce an activity to achieve a British Science Association CREST Bronze award. A small team from the School of Chemistry visited a school in Caernarfon for a day where 50 pupils achieved the award; we will be working further on combining activities with CREST in 2011/12. It is unlikely however that the School of Chemistry will host another day for Year 7 in house due to lab demand and staff pressures; instead this 2 hour activity will be adapted to be taken on the road into schools. This way schools will not have to pay transportation and supply teacher costs.

In response to the high demand for places on the *Year 9 Chemistry Day* course the team are developing the project so that it can additionally be run in schools as part of the *Spectroscopy in a Suitcase* initiative. This is on-going. The *Chemistry is Fun* activity will continue under the 'Flash Bang Show' banner and will be supported by Bangor University.

Chemistry Outreach Package

Annette Taylor, School of Chemistry, University of Leeds

Engagement and Target Audience

The schools that took part in the chemistry outreach activities are shown in Table 1. Access and Community Engagement at Leeds suggest that schools engaging in outreach activities are classified by the percentage of students from the bottom 13,000 super output areas (SOA) in the country: the Higher Education Funding Council for England (HEFCE) classifies these as 'disadvantaged learners'. Thus schools are placed in the following bands: Band B: Widening Participation Schools with >66% of students from lowest 13,000 SOAs; Band C: Intermediate Schools with >30% and <66% of students from the lowest 13,000 SOAs; Band D: with <30% from the lowest 13,000 SOAs. With this classification, Carlton is in Band B, Bruntcliffe, Boston Spa, Allerton and Kings' are in Band C and Queen Elizabeth and Wakefield Girls' are in Band D.

The students on the photolithography session were recruited through the Leeds Reach for Excellence Programme. Students apply to the scheme and in order to take part they must satisfy two of the following criteria: receive Educational Maintenance Allowance (EMA); be in, or have grown up in public care; have had their studies disrupted or adversely affected by circumstances in their personal, social or domestic life; be the first member of their family to apply to Higher Education. Thus we may conclude that probably in excess of 50% of the 375 students taking part were classified as widening participation' students.

Background and Rationale

The National HE STEM Programme presented an opportunity for universities to engage in activities developed by Professional Body partners by providing funding and support to implement ready-to-use resources. For chemistry outreach, the resources were produced by the Royal Society of Chemistry as part of Chemistry: The Next Generation (C:TNG). The activities chosen by us (Table 2) were thought to complement the existing programme of outreach and widening participation events run by the department and provide a valuable opportunity to add new 'tried and tested' resources with year groups that we had few dealings with, in particular the 9 -14 age group.

Implementation

The *Year 9 Chemistry Day* was run at the University of Leeds. The schedule for the activity was planned

Activity	Date	School	Number of participants
Year 9 Chemistry Day	13 Dec 2010	Bruntcliffe	45
Year 9 Chemistry Day	14 Dec 2010	Boston Spa	35
Year 9 Higher Education Day	11 Jan 2011	Allerton Grange	20
Chemistry in your shopping basket (Year 10)	1 Feb 2011	Allerton Grange	20
Chemistry in your shopping basket (Year 9)	23 March 2011	Queen Elizabeth Grammar School Wakefield Girls High School Carleton Community High School Kings High School	140 30 30 30
Photolithography	26 July 2011	Various	25

Table 1: Schools taking part in chemistry outreach activities

Activity band	Description	Target age group	Number of students	Approximate funding needed to deliver single activity
Large scale	Year 9 chemistry day	14	60	£2,050
Medium scale	Photolithography	16-18	200	£830
Small scale	Chemistry in your shopping basket	9-13	40	£50

Table 2: Chemistry outreach activities

as suggested in the resource. The practical sessions were supposed to involve isolating casein from milk and making bouncing custard. Unfortunately, a week before the activity, the worksheet was sent to the teachers involved in organising the day and the following response received: *"Looks like some fun stuff in there, but I think the teacher from Bruntcliffe would feel he could do this himself in school. He is keen for students to be pushed/challenged, and experience a real chemistry lab environment and the kind of equipment they are unlikely to meet in schools."* Thus it was decided that the morning practical session would involve a simpler version of the Royal Society of Chemistry Master Class with analysis of a painkiller using infrared, thin-layer chromatography and melting point, and the afternoon session would involve using the Belousov–Zhabotinsky reaction reaction to observe chemical waves. We also incorporated a departmental tour into the day. Four postgraduates were paid to demonstrate for the day, and a technician helped set up.

The *Chemistry in your Shopping Basket* activity was run in the schools using the provided PowerPoint slides. In the session at Allerton Grange, the students were split into teams and asked to write their group's answer to questions on a whiteboard. The session at Queen Elizabeth Grammar School involved 230 students so as there was such as large group, a show of hands was requested for answers to questions.

The *Photolithography* activity was run as part of an event at the University on Chemical Patterns for Materials, including an introduction on different approaches to producing chemical patterns: templating and self-organisation. The equipment for the Photolithography session was purchased and this session was run as suggested on the handout sheet. Two undergraduates helped supervise the students and a technician helped set-up and run the activity.

Evaluation

Our main goal with regards to obtaining feedback was to determine whether the activities encouraged the students to continue to study science. The *Year 9 Chemistry Day* did not go according to plan, as a result of the initial feedback from the teacher regarding the appropriateness of the practical activities. Thus, while Bruntcliffe reported that the activities were pitched at a good level for the students, Boston Spa felt the sessions were too hard. The activities were run for Allerton Grange as part of a year 9 Higher Education Experience Day also involving sessions in maths. The feedback received from the students themselves was positive. Here are some of the comments:

"I found it very interesting and good. It encouraged me to go to university. I would definitely rather do this than go to lessons as it was fun and helped me make a choice."

"I am more interested in science now and really enjoyed the day. Surprisingly, I enjoyed the maths!!"

"I enjoyed all of the day, especially the tour of the campus. I enjoyed the maths and science too. I think I'm more likely to go to university now."

"I enjoyed today because we found out lots of information about university and did fun experiments. The student (post grad) who showed us around was very useful as he explained lots of things."

"I enjoyed the tour and practical work. I would like to do it again. Our tour guide was very good."

Unfortunately, the teacher was ill for the *Chemistry in your Shopping Basket* session at Allerton Grange and feedback was not obtained from the students themselves; however the teacher from session at Queen Elizabeth Grammar School sent the following comment:

"Thanks again for putting on the talk and demonstrations - it went down really well, as you could probably tell from the non stop questions from some of the girls. You obviously inspired them! I hope you will be available for a repeat performance some time during the next academic year."

Feedback sheets were collected in the photolithography session and the results are shown in Table 3.

	Strongly agree	Agree	Disagree	Strongly Disagree
I had a previous interest in this subject area	0	7	1	0
I found the session useful	1	6	1	0
The session was enjoyable	6	2	0	0
The session was interesting	6	2	0	0
I found the material to be at the right level for me	5	3	0	0
The session has increased my knowledge of this subject area	2	4	2	0
I would now consider studying this subject in the future	0	3	5	0
The length of the session was just right	3	3	2	0
The departmental lecturer was enthusiastic and approachable	5	3	0	0

Table 3: Feedback obtained from the photolithography session

The aspects of the session I enjoyed the most were…

"The experiments."

"The different experiment that we did and the results we saw."

"The patterns experiment."

"Practical stuff."

"The practicals."

"The experiments particularly the 2nd one, with the catalyst."

"Being able to do an interesting practical myself."

"The chemical patterns on the membrane."

What could have improved this departmental session?

"More information about the chemistry side of the experiments."

"Made the session slightly shorter."

"Ensuring the timing was right, as the session was a little too long and we ended up standing around for a while."

"If we had understood the subject area better."

Any other comments about today?

"The lecturers were kind and explained in good detail."

Discussion, Learning and Impact

In general the feedback was positive regarding the events, and we were reasonably successful in our goal to encourage students to continue in their science studies. However, some valuable lessons have been learnt. With regards to organising activities at the University, it is important to maximise the students' view of the equipment and facilities on offer in the department and the University itself. Tours are often the most memorable parts of the days for the students. The enthusiasm of the lecturers and demonstrators involved in the activity is vital. We also learnt that the timing of activities is important, particularly ensuring that there is no time when students are standing around doing nothing, as this negatively impacts on their experience. Additionally, any proposed activity involving a visit from one school group should be sent in detail to the school taking part well in advance to gauge the appropriateness of the level of the activity. Every group of students and teachers will have different expectations and background knowledge and thus in order for them to gain the most from the experience the activity should be adapted to the specific group in question. In future, the events will be planned to challenge, with plenty of activities to fill the time, but with inbuilt ways of simplifying those activities as appropriate.

Further Development and Sustainability

All of the activities will be continue to run by the Chemistry Outreach Team Leeds, with some changes in response to the feedback obtained.

The *Year 9 Chemistry Day* was thought to be more successful as part of a Year 9 Higher Education Day involving some sessions in other departments at the University. It also requires much organisation and planning to run two practical sessions for year 9 (who require a lot of supervision), thus one chemistry practical session is probably sufficient. The polymer practical will be trialled once the school attending approves the activity: the sheets will be sent well in advance to teachers.

For the *Chemistry in your Shopping Basket* activity, slides have been added, including more demonstrations and more discussion on careers in chemistry to make the talk appropriate for higher year groups. The sessions will be run in schools and are already planned for the new school year.

The *photolithography* activity will continue to run at the University as part of a session on Chemical Patterns for Materials. However the overall session will be expanded upon and improved to give more background chemistry information, more questions to challenge the students and the opportunity for them to experience other equipment used for characterising materials in the department such as optical microscopy and electron microscopy.

Chemistry Outreach Package

Ian Bradshaw, School of Pharmacy & Biomolecular Sciences, Liverpool John Moores University

Linda Seton, School of Pharmacy & Biomolecular Sciences, Liverpool John Moores University

Engagement and Target Audience

This project involved the delivery of three outreach events in chemistry to school students in June 2011. The schools/colleges that attended the events are shown below. In addition, the number of students that participated in each event are indicated in brackets.

***Colour Chemistry* (Year 7):**

- Huyton Arts & Sports Centre for Learning (15 students); and, University Academy Birkenhead (15 students)

***Year 9 Chemistry Day*:**

- Kirkby Sport College (24 students); St Chad's Catholic High School; Halton (15 students); and, Malbank School, Nantwich (15 students)

***Chemistry Master Class* (Year 12):**

- St Edwards College (10 students); Aim Higher Cheshire (6 students); Broughton Hall School (5 students); Holy Family School (10 students); St Julie's School (4 students); and, Hugh Baird College (2 students)

The vast majority of students that took part in the above activities were of widening participation status. This was achieved by utilising the Aimhigher unit within the University and also Aimhigher Cheshire and Warrington to contact and recruit the various schools and colleges for the outreach events. The widening participation status was verified on the day by asking students if they had any family members at university; very few responded positively to this question.

Background and Rationale

The authors have been involved in delivering outreach events in chemistry for a number of years. In particular, we were actively involved with the *Chemistry: The Next Generation* project run by the Royal Society of Chemistry (RSC). Thus, it was a natural extension for us to become involved with this project. The outreach events selected by us were chosen from the menu of activities offered by the RSC. The particular events that were selected for use allowed us to extend our range of outreach activities both in terms of the nature of the chemistry experiments as well as the target age range. We had previously worked with Year 9 and Year 12 cohorts, but this was the first time that we had delivered an outreach event to a Year 7 cohort.

Implementation

As none of the events had been delivered before within our institution, it was necessary to formulate a plan of action and also to train a team of staff to deliver the events. The planning process was undertaken by the two authors who worked together to deliver the events. Regular planning and logistics meetings were held during the course of the project to ensure that the plan was on schedule and on track. The delegation of responsibilities was important to the planning and delivery of the events. This allowed the authors to concentrate on the development of the scientific side of the activities as well as the relevant resources required. Thus, regular meetings were held with a member of the University's Aimhigher team who took responsibility for the recruitment of the schools/colleges to attend the events. In addition, the same team took responsibility for the registration process and the organisation of the refreshments for the events. Equally, the senior laboratory technician was left to carry out specific tasks such as the ordering of chemicals and lab coats etc., as well as trialling the experiments. Finally, briefing meetings were held with the postgraduate demonstrators in the week prior to the events to ensure that they were fully aware of their role and responsibilities.

Evaluation

The evaluation process was intended to seek information on the success of delivering the events both in terms of developing an interest in chemistry for the students and also monitoring the skills that they had gained. It was also intended to gauge their interest in going to university and in particular to studying for a science or chemical sciences degree. The evaluation of the events was undertaken by asking the students to complete a one-page feedback sheet at the end of the activity. The feedback sheets were developed in association with our Aimhigher team and consisted of a series of questions to allow graded answers as well as some space for free standing comments, if volunteered. The feedback sheet was divided into two parts for the participants: questions

on their opinions on the activities and questions on their future intentions with regard to higher education.

Discussion, Learning and Impact

The objective of delivering the three chemistry outreach events within the timeframe of the project was successfully achieved. Eleven different schools attended the three events and the target number (120) of student participants was met.

The analysis of the evaluation sheets showed that the events were successful as judged by the responses from the students. Around 90% of all participants found the events to be interesting, fun, useful and well-organised. The percentage of students that felt that they had gained new skills was very high and it was pleasing to note that the figure was 97% for the Year 12 cohort. Overall, the data suggests that all groups fully engaged with the events and the activities were set at a level that could stretch the students, but not overwhelm them.

As might be expected, the percentage of students that considered that they had learned the most about going to university from the events was highest (85%) at the Year 7 cohort. This figure is likely to have been enhanced by the additional activities about university life that were run for this event by our Aimhigher team (in addition to the chemistry activities). The corresponding figures for the Year 9 and Year 12 events did drop to 65% and 40% for Year 12. However, these figures are likely to reflect the fact that older students have a better knowledge of university before coming to outreach events.

The vast majority of students seemed to be motivated about the prospect of going to university. The figures were 85%, 80% and 93% for the Year 7, 9 and 12 cohorts respectively. In terms of studying Sciences, 41% of the Year 7 group said that they might consider this type of course at university and this rose to 48% for the Year 9 group. Some 57% of the Year 12 cohort indicated that they would consider a chemical sciences course at university. Since only around 10% of the students that study A-level chemistry currently go on to study for a chemical sciences degree course at university, it is evident that running outreach events of this type is beneficial to the recruitment of undergraduate students in the STEM area. In the case of the organisation of the Year 12 activity, the invitations to attend the events were directed at individuals rather than a whole class cohort and this seemed to result in a very motivated group of students. The quotes obtained from students demonstrate that the events were successful both in terms of the enjoyment and the learning experience for the students:

"I have learned more about lab work in a university and the standards of experiments and practicals at higher levels of education."

"University really seems like a great place to go and I will consider science as a subject to study."

"I have learnt about different science techniques and I would like to go to university as the students seem to enjoy it."

The previous experience of the authors in the planning and delivery of outreach events was crucial to the success of this project. In particular, it is important to have a sound understanding of both the existing knowledge and practical ability of the student cohort to be able to deliver an outreach event at an appropriate academic level. Also, a well trained and motivated staff team is essential to be able to stimulate the school students and pass on enthusiasm for chemistry. The use of postgraduate students was very helpful in this respect and encouraged informal discussion with the school students about many aspects of life at university.

Figure 1: Students participating in the Year 7 Colour Chemistry outreach event

During the planning and development stages for these events, it was apparent that some aspects of the activities needed to be modified for our delivery purposes. It is quite likely that the originators of these activities would be able to deliver them in a manner identical to their original suggestions. However, in our experience there does need to be some degree of flexibility in order to modify the activity if required. In the case of the *Colour Chemistry* event, some of the experiments were difficult to reproduce in our hands and perhaps seemed slightly trivial. We were able to modify the experiments to make the event more effective in our opinion. For the *Chemistry Masterclass* event, it was decided that a full structural interpretation using nuclear magnetic spectroscopy (NMR) might be demanding for the students. In particular, we were dealing with a broad range of students from an Aimhigher background and not a select group of top students. Thus, the activity was modified to set the aim of the activity to identify paracetamol from a group of unknown drug compounds, rather than rigorously determining an exact chemical structure. This still allowed the students to engage with infrared spectroscopy, but avoided exposing them to the more difficult concepts of

NMR. Although the feedback for the Year 9 event was similar to the other events, there was a general feeling within our team that this event could have been set at a slightly more demanding level for the students.

Figure 2: Students participating in the Year 12 Chemistry Master Class outreach event

A very detailed and helpful resource document was available from the RSC to help plan the delivery of each activity. Generally, these events have been tried and perfected by the person that developed each event. Nevertheless, there is still a large amount of work required to develop a set of resources when you undertake to run these events for the first time. This includes a PowerPoint presentation for the introduction, risk assessment documentation, practical sheets for the students and feedback sheets for the evaluation. It was found that a considerable amount of time had to be spent developing the resources for these one-off events. However, these resources are now embedded in our School for further use.

Publicity for the project was gained though a news item that appeared on the front page of University website and which is available for both internal and external viewing [1].

Further Development and Sustainability

As there is a cost to running outreach activities, sustainability is going to be reliant on receiving continued funding in the future. The National HE STEM Programme will only run for one further year and thus this source of funding will be drawing to a close. Some of the other previous outreach activities that we have delivered have been funded by Aimhigher Cheshire and Warrington, but this funding source itself came to a close in July of this year.

We are committed to try to seek additional funding to continue our interest in delivering outreach activities in chemistry. It is to be hoped that the University will be able to support us in some way in this respect in the future. Indeed, it is expected that it will be a requirement for universities to show that they are actively engaging with widening participation with respect to recruitment of undergraduate students when the new fee regime commences in Autumn of 2012. The delivery of outreach activities to Aimhigher students is one way in which this could be achieved. Also, it is to be hoped that the RSC will continue to be able to fund outreach activities in some way in the future.

References

[1] http://www.ljmu.ac.uk/NewsUpdate/index_120535.htm

Chemistry Outreach Package

Elaine Wilson, Faculty of Education, University of Cambridge

Engagement and target Audience

Three different events were held during the year involving a total of 393 people of whom, 320 were secondary school students, 24 secondary science teachers and 26 new physics and chemistry teachers. Table 1 shows the level of engagement from the 23 partner schools.

Three strands of activity were offered to the schools:

1. Extracurricular science clubs (January – June 2011):

18 PGCE chemistry students who were placed in Faculty of Education partner schools for their practicum experience were involved in either setting up an extracurricular science club or contributed to an existing school based science club.

Support from the National HE STEM Programme enabled us to provide kits and resources to help run the club for the 16 weeks of the placement. During this period over 215 students were actively involved in extracurricular science clubs doing 'hands on' chemistry activities. This involved carrying out risk assessments, and setting up and organising practical chemistry activity under the supervision of an experienced chemistry teacher. The culmination of the 16 week club activity was the selection of 3 students from the club to come to the University of Cambridge for a Year 9 Chemistry day.

2. Year 9 Chemistry Day:

Part of the training of new chemistry teachers at the Faculty of Education is learning how to plan for school trips. Leading up this May 2011 event, the new teachers had to work closely with their

School	Students	Teachers	PGCE students
Bottisham Village College, Cambridge	(10) 4	1	1
Chesterton Community College ,(*) Cambridge	10	1	2
Coleridge Community College, (*) Cambridge	10	1	1
Comberton Village College, Cambridge	(10) 3	1	1
Farlingaye High School ,Woodbridge	(10) 3	1	1
Freman College, Buntingford	(10) 3	1	1
Hertfordshire and Essex High School, Bishops Stortford	(20) 3	1	1
Hitchin Girls School, Hitchin	(20) 3	1	1
Jack Hunt School, Peterborough	(10) 3	1	1
Linton Village College, Cambridge	(20) 3	1	1
Parkside Federation (*) Cambridge	10	2	2
Perse Girls School,(*) Cambridge	10	1	1
Prince William School, Oundle	(5) 3	1	1
Saffron Walden County High School, Essex	(20) 3	1	1
Samuel Ward Academy, Haverhill	(10) 3	1	1
Sawston Village College, Cambridge	(10) 3	1	1
Sharnbrook Upper School,Bedford	(10) 3	1	1
Soham Village College, Cambridge	(10) 3	1	1
St Bede's School (*) Cambridge	10	1	2
St Ivo School, St Ives ,Cambridge	(10) 3	1	1
The Netherhall School and Sixth Form College, Cambridge	(10) 3	1	1
Thomas Deacon Academy, Peterborough	(10) 3	1	1
Thurston Community College, Bury St Edmunds	(10) 3	1	1
Total: (**393**) **23** Schools, **215** students in science clubs,**105** students at day events, **24** teachers and **26** new chemistry and physics teachers. (*) Schools involved in a local Gifted and Talented programme (10) Students involved in school based extracurricular science clubs	(**215**) **105**	**24**	**26**

Table 1: Engagement at STEM events in 2011

school-based mentor to consult and follow school policy to arrange to take students out of school. This process included carrying out risk assessments, organising transport, and consulting parents.

Each PGCE student successfully arranged the trip and arrived at the Faculty of Education along with their team of three students accompanied by an experienced school based chemistry teacher. National HE STEM Programme support enabled us to pay the travel costs for each group and the supply cover costs for the experienced teacher. 124 students, 18 science teachers and 18 new chemistry teachers were involved in the day event.

The event was held at the Science Education Centre (SEC) at the Faculty of Education, University of Cambridge. In order that experienced teachers could use the materials with other students when they were back in school and the new teachers could also access the materials in their first teaching posts we set up a wiki page with links to follow up reading, activity instructions and photographs of the day [1].

3. Cambridge Schools Gifted and Talented Programme

A further five schools involved in a Cambridge school gifted and talented programme brought 50 different students and five other secondary science teachers to the SEC at the Faculty of Education on the 15 June 2011. We ran a slightly revised programme from the May Year 9 Chemistry Day. The chemistry teachers were supported by 9 new physics teachers from the PGCE course.

Widening Participation in STEM Subjects

The Faculty based events allowed the school based students and teachers to work in university laboratories alongside recent chemistry and physics graduates. The vast majority of the students (200/215) attended state maintained comprehensive schools within the partnership area. Furthermore, at the finale, a short talk about pursuing STEM based subjects beyond school was given along with Royal Society of Chemistry recruitment literature and information about applying to study Natural Sciences at the University of Cambridge in particular.

Evaluation

We were keen to find out the views of all three types of participants: students, experienced teachers and new teachers. We wanted to find out the following:

i. Whether the students enjoyed the day and which activities had they found most interesting?

ii. What the views of experienced teachers were and how successful the new teachers had been in using school policies to plan the trip. Also, which activities were useful and of interest to them.

iii. Whether the new teachers used the materials provided in the STEM extracurricular clubs, and if so, which they found useful. What problems did they encounter in planning and carrying out a school trip? How could we improve the university based Chemistry Day?

Figure 1 and Table 2 summarise the evaluation process.

Participants	Data Collected	Data analysis
55 secondary school students involved in the May Year 9 chemistry day.	Semi structured interviews in a focus group of three students. New teachers interviewed the small group back in school following the Year 9 day.	New teachers analysed interview transcripts and provided a short report the university lecturer.
18 experienced school based teachers.	New teachers end of course reports and informal communications with the University lecturer who organised the day.	University lecturer analysed end of year reports of the new teachers and talked informally with teachers during the day.
18 new teachers who planned and helped organise the Year 9 Chemistry day.	Individual interview with University tutor.	University tutor discussed the planning process and outcomes with new tutors as part of the overall supervision process at the University.

Table 2: Methods of data collection for evaluation process

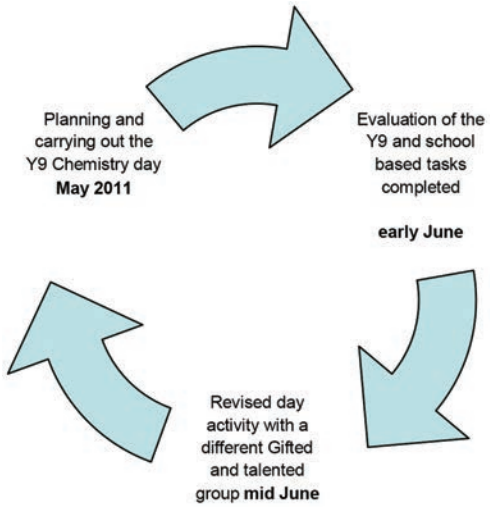


Figure 1: Evaluation process and timescales

Evaluation

9 of the 18 of the schools already ran extracurricular clubs and the other 9 schools represented had dormant or no science club provision. These were reinstated or restarted by the new teachers during their practicum. Provision of consumable and ideas for practical STEM activities came from a range of sources, such as Salters' Chemistry Club, and meant that new teachers were supported and able to sustain the activity throughout the 16 week period. These materials and ideas are now in the school departments and so will make it easier for the experienced teachers to sustain the Clubs beyond the initial intervention.

One new teacher involved in the STEM intervention had had focussed her empirical classroom based study on extracurricular science and had come to the conclusion that:

> *"in the case of the 'truly extracurricular' Key Stage 3 Science Club, students have chosen to attend due to genuine interest in science and a desire to learn and experience more than is possible within lessons. This appears to have resulted in these students either having gained an increased enthusiasm for chemistry compared to their peers through increased positive exposure to the subject, or conversely that an existing preference for chemistry contributed to their original decision to attend the Science Club. It was seen as a benefit of the club that there was no pressure to achieve, only to enjoy and practically explore."*

All of the students who had attended the Year 9 Chemistry Day had found the experience very interesting and motivating. The activities that were particularly identified by the students were the slime problem solving activity and the chocolate tempering process. The use of technology had, as ever, posed the most problems. During the day this was evident in problems with students editing their video clips and this was identified by a number of students as a frustrating negative point. The students appreciated being able to work in well equipped labs and being allowed some measure of autonomy by being able to work independently with minimum teacher supervision.

Experienced teacher mentors had added comments in their end of term reports about the excellent contributions all the new teachers had made to STEM club activities. All of them also said they would incorporate the new ideas into their existing resources and would be more inclined to Science Club activity in the future. Four teachers said that they had learned some new chemistry ideas as a result of attending the Year 9 Chemistry Day and would access 'the wiki' in the future. A subsequent survey of wiki usage indicates that 10 of the 18 experienced teachers have visited the wiki; five of these have taken images from the site to include in school newsletters. The experienced teachers also provided some useful advice on how we might adapt the tasks in future.

All of the new teachers commented on how useful it had been to have easy access to ideas and support to help sustain STEM activities. During a busy practicum having readily available packs of consumable and resources had enabled them to carry on despite their teaching workloads. All of the new teachers commented on the usefulness to their own professional development in being able to plan and carry out an authentic school trip and felt well equipped to be able to do this in their new schools post in the next academic year. One new teacher wrote:

> *"The students really enjoyed the day and it has definitely inspired them in ways I didn't imagine! I heard Jake telling his friends all about it in the corridor this morning and at Year 7 parents evening last night Faye's parents were raving to staff about how much Faye had enjoyed it and what a fantastic opportunity it was."*

Using feedback from experienced and new teachers and incorporating my own reflections on the Year 9 day, the following changes were made to the second Year 9 day:

i. Revision of the introductory lecture to include more structural information about triglycerides and polymorphism.

ii. Remove the melting point task to spend further time on tempering chocolate and so allowing further time to analyse the AFM maps and to think about how thee are interpreted so that the video content was more technical.

iii. Further guidance on what a good video might include was provided.

iv. The new teachers also suggested including a lecture demonstration at the finale; they planned and carried this out at the end of the second chemistry day.

Discussion, Learning and Impact

The key learning outcome from this activity was that new teachers are highly effective at raising the profile of STEM subjects during their practicum. The experienced teachers working within the Cambridge partnership perceive that one main reason for working with new teachers is that they bring new ideas into the school which help enhance student learning. Furthermore working closely with a university department can also develop more experienced teachers' ideas about teaching STEM subjects by bringing new recent ideas into the school. Five of the experienced teachers reported that the school was unwilling to allow them to attend external CPD unless it was related to examination subjects and so new teachers served an important role in bringing new ideas into their school.

One other interesting outcome was that the new teachers were able to see other models of effective teaching. All of the new teachers commented on how surprised they were at just how well the students had coped with the more complex chemistry involved in the Year 9 day. All of the new teachers said that in future they would not underestimate what students are capable of doing and that they would strive to challenge students further in their new posts.

References

1. http://cambridgechocolate.pbworks.com/w/page/40578610/Cambridge%20Chocolate%20Home%20Page

Chemistry Outreach Package

Declan Fleming, RSC National HE STEM Programme School Teacher Fellow, Department of Chemistry, University of Bath

Engagement and Target Audience

Three activities were offered as part of the Chemistry Outreach Package:

1. *Snap, Crackle and Snot:*

- Abbeyfield School, Chippenham (10 Key Stage 3 students)
- Kingsdown School, Warminster (10 Key Stage 3 students)
- Matravers School, Westbury (10 Key Stage 3 students)
- Nova Hreod School, Swindon (10 Key Stage 3 students)
- Stonehenge School, Salisbury (10 Key Stage 3 students)

The schools form part of the University of Bath's widening participation cohort and were invited by our widening participation (WP) office. The following text was used in the invitation letter:

"We are particularly keen for pupils from disadvantaged backgrounds to participate and would be grateful if you could prioritise these pupils. Students from disadvantaged backgrounds could be any pupil who would not normally be able to engage in an enrichment programme and are likely to form part of your school's Aim Higher Cohort (if applicable) and may be eligible for Free School Meals (FSM). We hope that you will be able to recommend pupils who would benefit most from such provision."

2. *Chemistry is Fun:*

- St. Thomas Aquinas School, Bletchley (280 Primary students)
- Westfield Primary school, Radstock (330 Primary students - additional workshops with 30 Key Stage 2 Students)
- Lainesmead Primary School. Swindon (35 Primary students - additional workshops with 60 Key Stage 2 Students)

The geographical areas these schools serve range from 48% to 86% on the Index of Multiple Deprivation [1]. The first school was chosen due to the good contacts that were held there and the ease of entry. The latter two schools, which are more local to the University, had previously made contact with our WP office and requested outreach assistance.

The talk was also delivered twice at Cheltenham Science Festival to approximately 700 Key Stage 2 students from the local area and around 350 members of a 'family audience'.

3. *Organic Synthesis Day:*

- Cirencester College, Cirencester (25 Key Stage 5 students)
- Scheduled post case study: Hardenhuish School, Chippenham (25 Key Stage 5 students)

Cirencester College and Hardenhuish School were chosen because of the mixed nature of the cohorts they serve. Both schools serve rural communities where they have limited access to local university support. At Bath we were keen to develop relationships with further education colleges and more of the local rural comprehensives as part of our transition work so used this opportunity to work with staff at both schools who later attended teacher meetings and other professional development events.

Background and Rationale

Bath Chemistry Department already provides a number of outreach activities (Salters, Spectroscopy Workshops, Synthesis and Spectroscopy, the Salt Cellar Mystery and Gratzel Cell workshops) but would like to further develop its portfolio.

The Department has developed a new website [2] for outreach this year and funding to provide outreach activities in the local area was provided to help broaden the portfolio of activities we can offer and the number of schools with whom we have contact. Many of these schools look to Bristol ChemLabs for their outreach needs even though Bath is closer, but the costs of meeting ChemLabs' sustainable pricing as well as 'rarely cover' has made it difficult for some teachers to provide opportunities for their students. We hoped that the needs of some of these schools could be met by providing pre-funded outreach events.

Implementation

Chemistry is Fun: An adapted version of the talk was delivered at 3 schools as well as the Cheltenham Science Festival. In addition to this, a series of primary outreach kits were established - pupils were given access to small workshops where they made cross linked PVA 'slime', worked with polymorph and worked as a team to hit a target time for an iodine clock reaction.

Snap Crackle and Snot: The exact setup and implementation of this day did not align with what I had in mind. Instead I split the 50 students into 3 groups. They had 3, 30-minute lab sessions followed by lunch and a demonstration lecture.

The lab sessions consisted of:

- A PVA cross-linking activity followed by an activity working with polymorph (in other words an adapted form of 'snot').
- A microscale ester synthesis activity wherein students produced a series of esters from 5 alcohols and 5 acids - this was run as a competition.
- An oxalate ester chemiluminesence activity wherein students were required to adjust sensitisers and concentrations of components in order to produce the brightest 'glow stick' - this was also run as a competition.

The talk after lunch was an adapted form of the Chemistry is Fun talk with some extra material on particles added to increase relevance to the Key Stage 3 curriculum. This contained all of the activities from the Snap and Crackle sections.

Organic Synthesis Day: This day was delivered with some minor alterations. Students nitrated their methyl benzoate before getting a tour of the spectroscopy facilities in 3 groups - characterising their compound using NMR, IR and MS. After lunch they had a series of talks from staff and students at the department on their current research.

Electrochromic Polymers: This activity was not delivered. The instructions as given do not work. After much assistance from Katy McKenzie (Leicester), and adaptations to the technique suggested by Frank Marken (Bath) the desired outcome was achieved but wholly unimpressive. In the interim there had been very poor uptake from schools on the activity with only one school requesting it (who later cancelled).

Evaluation

Chemistry is Fun: Pupils were asked to write an account of their day by teachers following the event. These statements were collated and coded for Generic Learning Outcomes (GLO) (Figure 1). A small adaptation was made to the GLO scheme to create a subdivision in 'knowledge and understanding' between knowledge of chemistry itself and an understanding of the work done by chemists.

Responses were compiled and normalised (from the 73 pieces of feedback received) to give the number of responses per student. It is immediately clear that the greatest impact was in factual recall (although given the task of describing their day this is hardly surprising). Most students expressed enthusiasm for or described their enjoyment of the day. In addition to these statements, there were a pleasingly large number of statements that expressed an improved attitude towards chemistry such as *"I think that chemistry is not as boring as it seems."*

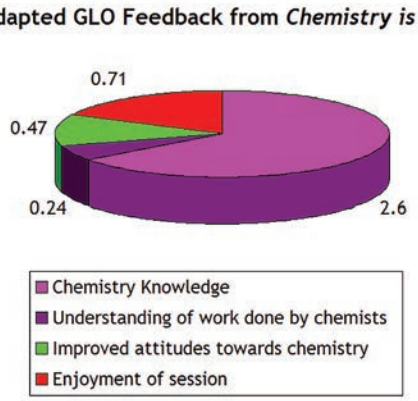
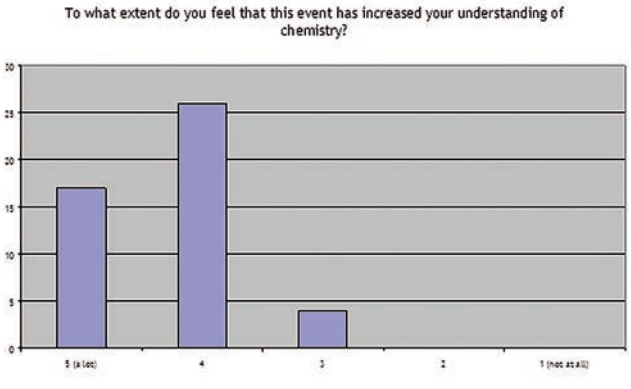


Figure 1: Adapted GLO feedback from Chemistry is Fun

One of the potential pitfalls for this kind of activity is the introduction or reinforcement of the misconception that this kind of 'exciting chemistry' is the sort of activity they can expect to encounter on a regular basis at secondary school (as has been cited by Dillon [3]). One student commented: *"the best bit was when he blew up a balloon and created an enormous ball of fire in the air. When I'm at Norton Hill* [the local secondary school] *I will get a chance to do some-things like Declan."*

Snap Crackle and Snot (billed as 'Exploring Chemistry Day'): Feedback was very positive from the 47 responses to the evaluation of the Exploring Chemistry Day with the vast number of respondents saying that the day had made them more likely to study triple rather than double science and to pursue a science-based career.



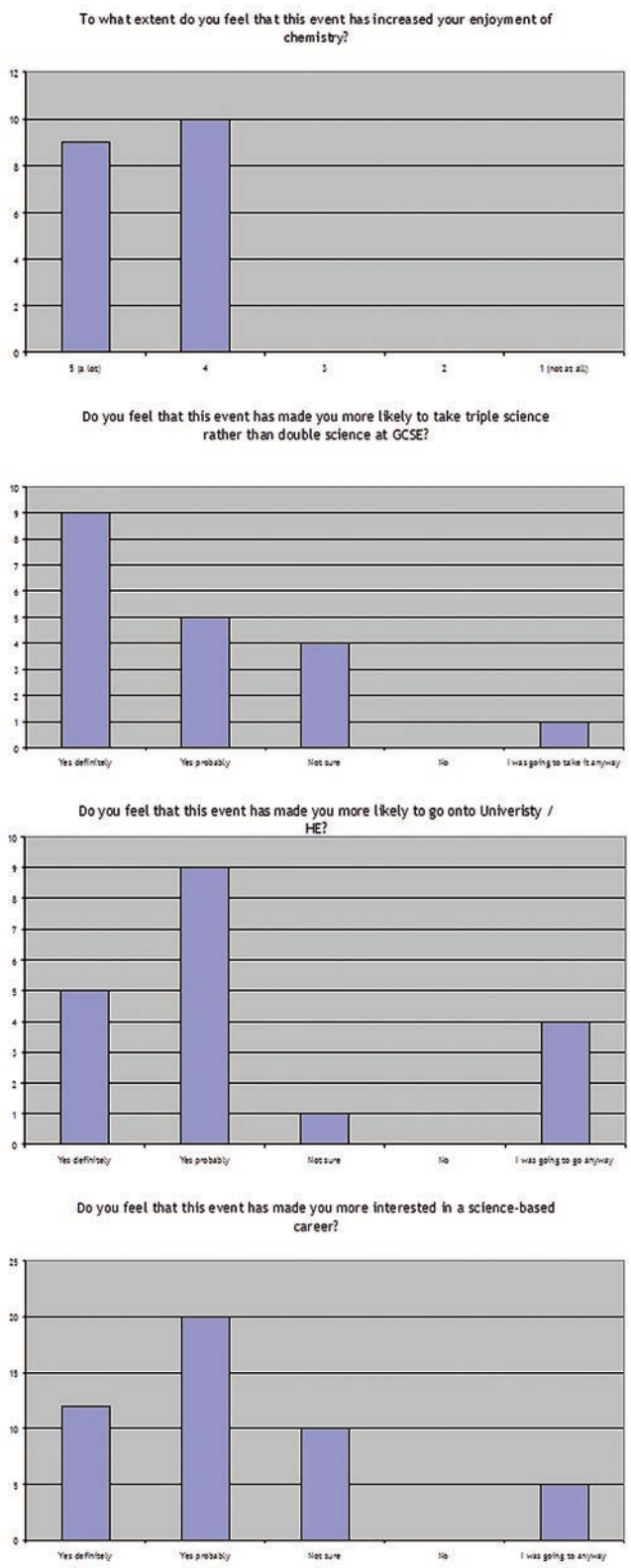


Figure 2: Student feedback from 'Exploring Chemistry Day'

Organic Synthesis Day: Finding a day that worked both for our lab technicians and local teachers was problematic for this event. By the time it ran we only managed to get 25 students to attend. We have already booked a further 25 for a repeat of the day later in the year.

All the students were from Cirencester College and made their own way to Bath. At the end of the day, we over-ran and 15 students had to leave immediately in order to make the trains they had booked leaving only 10 behind to provide feedback. For brevity, a short group interview was conducted. Of the ten that remained, all of them intended to go on to university to study a STEM subject. 5 of them were planning originally on doing chemistry, biochemistry or chemical engineering. One extra said that the day had made him consider biochemistry as an alternative to medicine.

The students cited the following as the most useful things about the day:

- The experience of being in a university.
- The talks from staff and students.
- The opportunity to talk to postgraduates about their university experiences.
- Seeing how the labs were laid out.
- Experience of using specialised equipment.

Students would like in future to have the chance to visit working labs and to have more time to talk to researchers and/or see them 'at work'.

Discussion, Learning and Impact

The main objective for this project was to increase the number of connections Bath has with local schools and the portfolio of outreach events we can offer. Over the course of the year the mailing list has doubled in size with a dramatic increase in the quality of the addresses we have (a 3% click-through rate has increased to 40% for the last mailout). The equipment the money has helped us to buy as well as the connections we have been able to make will ensure a far stronger connection with local students. The targeting of WP schools means that almost all additional subscribers to the mailing list come from comprehensive schools.

Further Development and Sustainability

Going forward, we aim to continue to provide these outreach activities as part of the portfolio of activities we offer. In future we would like to develop a strategy for more efficient use of our students. This year we have relied too heavily on a small number of postgraduates while other postgraduates have been unable or unwilling to help due to their commitments to other programmes which have a compulsory outreach component or pay much better rates.

From this coming October, we plan to begin training more undergraduates to deliver outreach and to begin training postgraduates earlier in the year before they have time to make commitments elsewhere.

References

[1] http://www.imd.communities.gov.uk

[2] http://www.bath.ac.uk/chemistry/extracurricular/

[3] Justin Dillon, 'Doing' Science versus 'Being' a Scientist: Examining 10/11 year-old School Children's Constructions of Science Through the Lens of Identity: http://www.kcl.ac.uk/sspp/departments/education/research/aspires/ArcheretalScienceEducation2010.pdf

Chemistry Outreach Package

Nicola King, Department of Biosciences, University of Exeter

Engagement and Target Audience

1. **Organic Molecules Day** - 30 pupils from: Thomas Hardye School, Dorchester; Woodroffe School, Lyme Regis.

2. **Green Plastics** - 60 pupils (2 sessions) from: The Axe Valley Community College; Teignmouth Community College; Falmouth Community School; King Edward VI Community College; Launceston College; Newton Abbot College; Kingsbridge Community College; Bideford College; St Luke's Science and Sports College, Wadham School; Helston Community College; The King's School; Liskard School and Community College; Lipson Community College; West Exe Technology College.

3. **Chemistry is Fun** - 80 pupils from: Westcliff Primary School, Dawlish; Lady Seawards Primary School, Clyst St Mary; Awliscombe Primary School; Kentisbeare Primary School.

The *Organic Molecules Day* and *Green Plastics* were targeted at widening participation schools using our 'aspirational schools' list. These are schools who perform below the national average for UCAS points per student and who are in the bottom 40% nationally. Schools were then asked to put forward pupils who met the Aimhigher criteria; disaffected with education; living, or had experience of, living in care; no parental experience of higher education; free school meals; or, for 2010/11, students in receipt of the Education Maintenance Allowance (EMA). The *Chemistry is Fun* activity was not targeted at specific schools as it was felt that at this age the experience was equally valuable for students of all backgrounds, however all schools invited were state funded.

Background and Rationale

Organic Molecules Day: This activity was undertaken because it allowed the students an opportunity to experience the practical side of chemistry to a level beyond that which they are able to do at school. Getting the students into a well equipped lab, with access to reagents and equipment they have not previously encountered brings alive the excitement of studying chemistry and the Royal Society of Chemistry (RSC) designed workshop allowed us to do this within the framework of our own teaching. Focusing on natural products as sources of new medicines and the overlap with areas of biochemistry and biology aligned well with our teaching in Biological and Medicinal Chemistry and complimented the outreach activities which we undertake in Biosciences, allowing us to build a full spectrum of outreach workshops from organic chemistry to synthetic biology.

Green Plastics: This activity was run as part of our pre-16 residential, a taster event for Year 10 students to introduce them to higher education and which offered a range of non-academic activities in addition to this workshop. The *Green Plastics* workshop was ideal for use in this situation as it was accessible to students with different interests, key for a residential where students had not actively chosen a chemistry activity. This complimented our teaching, research activities in not just synthetic chemistry but also ecotoxicology and aquatic biology and helped broaden our outreach activities in these areas.

Chemistry is Fun: This activity was undertaken because I believe it is key to excite children about science from a young age, before their learning becomes too bound by curriculum. The activities allowed the children to experiment and explore science through play and having fun. The workshop was combined into a whole day of science activities for Years 4 and 5 across biology and chemistry.

Implementation

Organic Molecules Day: This activity was delivered in a very similar way to the original RSC workshop however due to restrictions in the analytical equipment available in Exeter some changes were made to the final analysis of the products. It was not possible to analyse the products via mass spectrometry but instead we gave a short talk to the students about the technique and how it could be used. We also made use of library spectra of the product and starting materials in order for the students to work out the differences between the compounds and understand how mass spectrometry can be used to aid analysis. With the NMR and IR analysis we introduced an element of competition in order to motivate the students and asked each school, upon examination of the students NMR and IR spectra, to nominate a the pair of students with the purest product, which the academics then compared to judge the winning school. This encouraged the students not just to follow the protocol but also to think about their

technique and how to ensure product purity. We will use this structure again to repeat the activity in future.

We did find that the practical skills of the students were very limited and without significant help and guidance they would have struggled to complete the practical. We had 8 supervisors for 30 students and found this to be a good supervision ratio for an inexperienced group.

Green Plastics: This activity was delivered as designed by the RSC but was combined with a presentation and discussion on the fate of plastics in the environment, complimenting the work in Biosciences on ecotoxicology. This was found to be an effective approach, making the chemistry accessible to students who would not otherwise have chosen a chemical science workshop.

Chemistry is Fun: This was also delivered as described by the RSC but incorporated into a day of 'hands-on science' for Year 4 children, allowing them to explore many different areas of biology and chemistry. In particular the children also made slime from PVA and borax solution and we explored the difference between changes of state and chemical reactions through the experiments with slime and the demonstrations. The day was also used as a learning experience for undergraduate students interested in a career in teaching. The children were split into groups of 5, each group working with 2 undergraduates. This very high supervisor to child ration meant that the children got a personalised and very hands-on experience of science.

Evaluation

Organic Molecules Day: Unfortunately, due to a serious incident which took place in the laboratory during this event, it was not possible to collect the intended evaluation data from the students involved. However the staff who attended the workshop were very impressed with the way in which it was run and the level at which the majority of the day was pitched. Schools have requested that the workshops are repeated again next year. The only issue identified was that of the practical skills of the students who attended the workshop not being as extensive as previously thought.

Green Plastics: This was evaluated alongside the other aspects of the residential course of which it was part; this was done via a questionnaire at the end of the residential. The key aims of this evaluation were to gauge student interest in the scientific content but also to encourage the students from widening participation backgrounds to better understand what it is like to study science at university and identify risks which may hinder their success in higher education or their likelihood of applying to a research intensive institution like Exeter. 65% of students (54 responders) said that the experience helped them make a decision about going into higher education. As a result of the experience 83% said they felt academically able to go into higher education and 85% felt that they would enjoy studying at university. 48% of students found the green plastics session interesting but it must be remembered that the residential was open to all students and was not specifically targeted towards those with an interest in chemistry, so whilst a little low this response is not too disappointing.

Chemistry is Fun: It was not felt that formal evaluation, via questioning of students, was appropriate for this age group but anecdotal feedback was overwhelmingly positive. Teachers commented that it was the best organised and most interesting trip that the children had been on during the year and two of the four schools are coming back to a repeat of the event which we are running this year. I have heard from one of the teachers that those children who came in 2011 have been telling this year's attendees how much fun it was!

Discussion, Learning and Impact

All three workshops were carried out successfully with positive feedback from those involved. Key measures of success are the requests from teachers for workshops and events to be rerun, in the case of *Chemistry is Fun* and Organic Molecules, and the response that 85% of students felt that, as a result of the *Green Plastics* workshop and residential, they would enjoy studying at university.

All three workshops have enabled us to develop widening participation experiences which build the promotion of chemistry into our existing strengths in Biosciences and also to effectively demonstrate to students the links between the sciences and the interdisciplinary research led approach to teaching at Exeter. The key lessons learnt from the RSC designed workshops were that, whilst the staff to student ratio recommended by the RSC was sufficient to deliver the workshops safely, the limited practical skills of the students meant that when it was possible to have more staff present (for example for *Organic Molecules* and *Chemistry is Fun*) the learning experience was enhanced.

Further Development and Sustainability

Using funding from the RSC International Year of Chemistry (IYC) Challenge fund we plan to re-run the *Organic Molecules Day*, and whilst we are unlikely to change the overall structure to the day we will look to add illustrations of the techniques to the instruction set used in order to aid those students who have not had much practical experience.

We have already planned a second *Chemistry is Fun* day, which will take place in June 2012. We will once again use a significant number of undergraduate students as demonstrators to work with groups of

students and we hope to make this an annual event for local primary schools. Funding for this will also come through the RSC IYC Challenge grant.

There are no current plans for a rerunning the *Green Plastics* workshop however it is hoped that using institutional funds for widening participation we will be able to incorporate the workshop into our National Science and Engineering Week events for 2013, where we endeavour to take a multidisciplinary approach to widening participation and work with colleagues from other disciplines, for example with Engineering exploring applications of green plastics in manufacturing.

It is intended that through the experience of running these workshops from the National HE STEM Programme they will form a core part of our work with local schools promoting not just chemistry but other sciences too.

Chemistry Outreach Package

Katy McKenzie, Department of Chemistry, University of Leicester

Engagement and Target Audience

The following stakeholders and schools were involved in the activities:

Year 12 'Hands Free and Hands On' Event – 8 March 2011:

School	Number of Year 12 pupils attending	Number of teachers attending
St. George's Academy, Sleaford, Lincolnshire	10	2
Heanor Gate Science College, Derbyshire	12	1
Joseph Chamberlain Sixth Form College, Birmingham	15	1
King Edward VII Science and Sport College, Coalville, Leics	15	1
Countesthorpe College, Leicestershire	17	2
Gateway College, Hamilton, Leicester	17	2
Long Eaton School, Derbyshire	19	2
Hind Leys, Shepshed, Leicestershire	22	1
De Lisle Catholic Science College, Loughborough, Leics	35	2
Wyggeston & Queen Elizabeth I College, Leicester	48	2
Total	210	16

Other stakeholders involved:

- Colleges-University of Leicester Network (recruitment of pupils)
- Science Learning Centre East Midlands (venue & technical support, provision of CPD session for teachers, provision of external examiner to talk to pupils)
- University of Leicester (Chemistry and Physics & Astronomy departments) – **Electrochromic**
- **Polymers Activity** & Jingles in Your Pringles Activity
- University of Nottingham (Chemistry department) – Photolithography Activity
- Nottingham Trent University (Chemistry and Physics departments) – Liquid Crystals Activity and
- Space Weather Activity
- Loughborough University (Chemistry department) – Sunlight to Electricity Activity
- Industrial partner: AstraZeneca (Charnwood) – Green Plastics Activity

Year 9 Activity Days – 4 & 8 April 2011:

School	Number of Year 9 pupils attending	Number of teachers attending
Welland Park Community College	40	3
Netherthorpe School	39	4
Crown Hills CC	10	2
Total	89	9

Other stakeholders involved:

- University of Leicester School and College Services (recruitment of pupils)
- University of Leicester Chemistry department (Venue and technical support) – A Journey Through the Periodic Table Lab Activity, Demonstration Lecture, Liquid nitrogen ice-cream making activity
- Loughborough University (Chemistry department) – **Sunlight to Electricity** activity

Year 5/6 Primary School Lecture – 27 June 2011:

School	Number of Year 5/6 pupils attending	Number of teachers attending
Charnwood Primary	34	3
Holy Cross Catholic Primary	45	4
Uplands Junior	120	9
Wolsey House Primary	51	4
Total	250	20

Other stakeholders involved:

- University of Leicester School and College Services (recruitment of pupils)
- University of Leicester Chemistry department (refreshments, technical support and preparation & presentation of Demonstration Lecture) – Lecture titled 'Feel it, hear it, see it smell it…' incorporating demonstrations from the **Chemistry is Fun** resource plus some extra more spectacular experiments.
- University of Leicester Rattray Lecture Theatre (venue)

The University of Leicester has a strong commitment to work with schools and colleges regionally. In collaboration with the East Midlands STEM based Centres of Excellence in Teaching and Learning (CETLs) (CELS, GENIE, pi-CETL) and the universities of Nottingham, Nottingham Trent and Loughborough, we reach a wide network of schools in the region and are well placed to understand which pupils to target. Widening Participation (WP) audiences are identified and outreach activities heavily promoted through the Colleges-University of Leicester Network and the University's School and College Services. Both facilities ensure that appropriate schools are targeted.

Background and Rationale

We chose to undertake these activities because we are keen to engage with pupils of all ages and already offer many outreach activities throughout the academic year targeted at different year groups. As part of a network of East Midlands universities, the University of Leicester has a sustained record of effective collaboration in outreach based upon activities of the HEFCE pilot project *Chemistry for our Future*. As the lead institution for the *Chemistry: The Next Generation* (C:TNG) project, we have already laid the foundations for sustainable long-term outreach delivery. We sought support from the National HE STEM Programme to further develop and enhance the portfolio of activities we can offer to pupils in our region.

We continue to run the C:TNG developed flagship event 'Hands Free and Hands On: the chemistry behind mobile phones' for Year 12 pupils. In the past 5 years this ran as a chemistry event, we sought support to develop this into an Integrated STEM activity for A-level students, and this event was held on 8 March 2011 during National Science and Engineering Week. In addition to running 3 nationally evaluated activities chosen from the 'Menu of Activities' (*Electrochromic Polymers, Green Plastics, and Sunlight to Electricity*) we also introduced for the first time, two physics & astronomy based activities (Space Weather & Jingles in Your Pringles) which enabled us to increase the number of participants at the event from around 150 pupils to 210 pupils. As a University we have moved to a 'College structure' and as such the chemistry department is now involved in cross-disciplinary outreach events with other departments in the College of Science & Engineering. The new STEM version of the 'Hands Free and Hands On' event has served as a useful model to demonstrate how activities can be integrated.

We are also keen to engage with younger pupils (primary and pre-GCSE) as we believe in the importance of promoting science as early as possible to these age groups. At the time of writing the proposal we had no outreach activities targeted at these age-brackets, and we sought support to build future capacity across STEM subjects for further collaborative working regionally.

Implementation

The 'Hands Free and Hands On' event has for the past 5 years run successfully as a chemistry only event. It was decided in 2011 to broaden the scope of the event to include other STEM disciplines, this allowed us to apply for National HE STEM Programme support and we were able to incorporate new experiments whilst continuing to successfully implement our existing activities (*Green Plastics*, *Sunlight to Electricity* and *Electrochromic Polymers*). The activity was run as a collaborative event hosted by the Science Learning Centre East Midlands (SLCEM) and delivered by the Universities of Leicester, Loughborough, Nottingham, and Nottingham Trent, along with an industrial partner, AstraZeneca. The funding also allowed us to increase the impact of our event, we were able to recruit 40% more pupils to attend and thus fill the SLCEM venue to its maximum capacity. Its popularity continues, and it will run again on 14 March 2012 subsidised by the Royal Society of Chemistry.

As part of our programme for engaging younger pupils, the Year 9 Activity Days gave Aimhigher pupils in this

age group the opportunity to visit the University and participate in some fun hands-on experiments whilst meeting University staff and students informally. The University of Leicester lab activity was developed by one of my Educational BSc project students as part of their final year project, and has run successfully many times since as an outreach activity. These new experiments were effectively incorporated whilst our partner University (Loughborough) continued to successfully implement their existing activity (*Sunlight to Electricity*). The Year 5/6 demonstration lecture also gave Aimhigher pupils in this age group the opportunity to visit the University and participate in some fun hands-on experiments whilst meeting University staff and students informally. The chemistry department at University of Leicester has in the past run demonstration lectures for a variety of age groups. With the full resources of our department available to us, it was decided to create a lecture that has been adapted especially to suit primary pupils and which uses fast paced delivery in combination with some spectacular experiments which expand on those listed in the 'Menu of Activities' for the lecture *Chemistry is Fun*. This lecture will continue to be used at future events, for example the Salters' Festival.

Evaluation, Discussion, Learning and Impact

Hands Free Hands On event: Unfortunately it was not feasible to collect individual student feedback from this event. However, the three activities presented (*Electrochromic Polymers, Green Plastics*, and *Sunlight to Electricity*) have already been nationally evaluated as part of the Royal Society of Chemistry outreach programme 'Chemistry: The Next Generation' led by University of Leicester (UoL). The Electrochromic Polymers activity presented by UoL has already been extensively evaluated hence its incorporation into the menu of activities along with the others. The following feedback comment was received from one teacher:

"The event was fantastic and the students talked about their experience and thoroughly enjoyed it. Thanks again."
Teacher, King Edward VII Science and Sport College, Coalville, Leicestershire

Year 9 Activity Days: Feedback questionnaires were completed by both pupils and teachers. 95% of pupils who attended the event completed an evaluation form. Question 1 consisted of four parts and was designed to gain feedback on pupils' impressions of the day. Data collected is shown in Figure 1.

The next question related to the pupils' favourite activity of the day ranked from 1-4 (1 being their favourite, 4 being their least favourite).

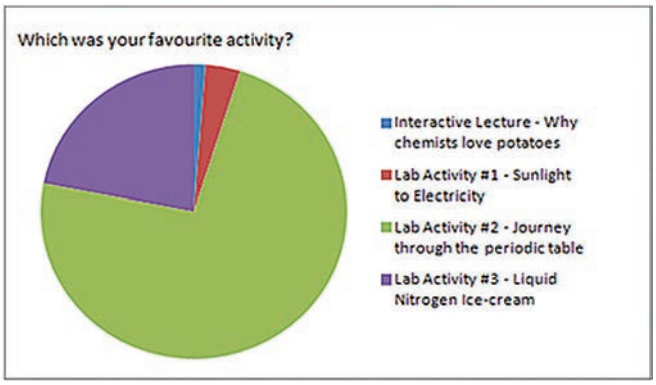


Figure 2: Pupils' favourite activity of the Year 9 Activity Day

It is worth noting that feedback on all laboratory based activities was excellent. There was a noticeable increase in student engagement with the activities from morning to afternoon as pupils became more confident in their surroundings and interacted more with university staff and ambassadors throughout the day. The programme of the day was lecture followed by the *Sunlight to Electricity* activity, and in the afternoon it was a Journey through the periodic table, and finishing with making and eating ice cream. The periodic table activity consisted of many short experiments where pupils were able to take with them things they had made, for example soap,

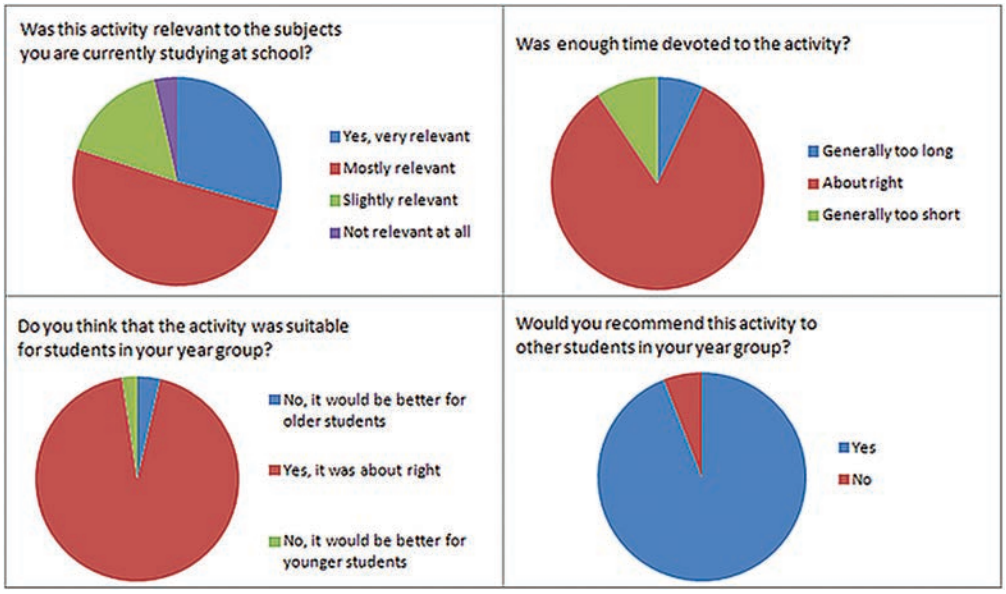


Figure 1: Pupil impressions of the Year 9 Activity Day

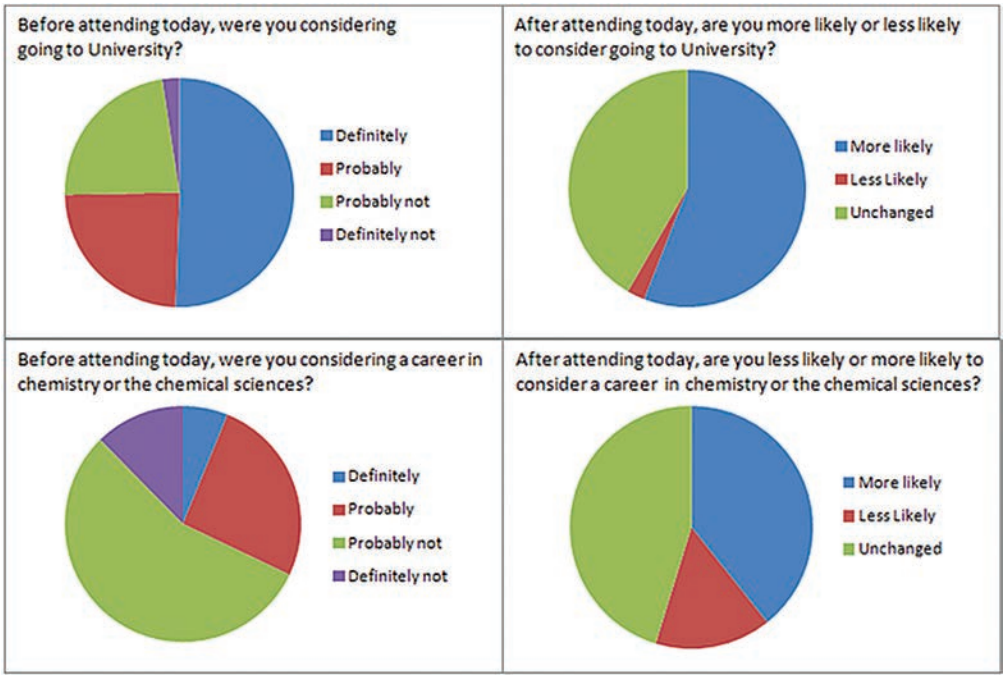


Figure 3: Pupils' attitudes to chemistry and higher education study

slime and anodised titanium. The pupils also enjoyed the spectacular nature of making ice cream using liquid nitrogen, and generally seemed to prefer more short activities rather than one longer lab experiment.

The third evaluation question (Figure 3, overleaf) concerned 'looking forward to the future' and was designed to find out if the attitude to university studies of the pupils who had attended had changed on carrying out the activities.

We were pleasantly surprised that approximately 75% of pupils attending were already considering applying to university and after carrying out the activities more pupils were aware of what chemistry is like at university and would consider choosing chemistry as a career. The remaining part of our evaluation questionnaire asked for feedback on how we could improve the event in future and for any other comments the pupils wished to make.

The general improvements suggested included air conditioning for our labs, longer breaks, more refreshments, more explosions, more lab time. Some feedback comments from pupils are below:

"All the staff were nice and helpful and I enjoyed it."

"I liked all of the activities we did."

"I really enjoyed all the activities today and wish to come back soon. Thank you to all staff for your help today."

"All the staff were very nice and very informative. The day helped me learn things about the periodic table in depth that I did not know before."

"The staff were really nice and talkative"
"It was a fun day with great activities."

"The whole day was fun and we should get the chance to do it again."

"The staff were really good and helped me through all the activities."

"I liked making slime and exploding things! It was soooo fun!"

"Fab workshops." Teacher, Welland Park School

Year 5/6 demonstration lecture: Unfortunately it was not feasible to collect individual student feedback from this event. However anecdotal evidence suggests it was very successful and the primary schools involved have recently attended another of our large outreach events ('Connecting with chemistry' exhibition at the Abbey Pumping Station museum in Leicester – December 2011).

In conclusion, the intended outcomes of the project were achieved. The funding was used to deliver high impact outreach events to a total of 549 pupils from Year 5-12. The approach was successful because it built on our existing network of partner institutions in the East Midlands, which enabled us to access extra resources – in particular, help with coordination of events and recruitment of schools. The impact on the target audience of these events has been clear. The 'Hands Free Hands On' event was oversubscribed in 2011, and is due to run for its 7th time during National Science and Engineering week 2012. Many students attending this event go on to apply for a science degree course at one of the partner East Midlands Universities. Positive feedback was received for both the Year 9 and Year 5/6 activities. These are both included in our portfolio of events and experiments developed have been used for future outreach events such as the Salters' Festival and a schools demonstration lecture programme.

As a busy academic I found it very difficult to keep on top of administration of all these events, for example recruiting schools. My advice is to seek administrative help where possible in your institution to chase

schools up and check that all pupils are attending. If undertaking the activities again I would like to be more ambitious and do a series of demonstration lectures over perhaps a week giving more pupils the opportunity to get involved. The key threshold points that made implementing the activities difficult were the University timetable and the demands on academic staff at all institutions across our region. During term time staff are generally too busy to do outreach and the teaching labs at Leicester (and other universities) are booked solid for undergraduate practical teaching. Therefore alternative venues for activities have to be found which is significantly more effort, or we are only able to run activities outside term time. The activities were enabled due to the University of Leicester's strong commitment to outreach and widening participation, and our reliance on an already established East Midlands network of partners and many activities already developed.

Further Development and Sustainability

In future the Year 9 and Year 5/6 activities will continue funded jointly by the University of Leicester College of Science & Engineering and the Department of Chemistry. The Year 12 activity is being coordinated and funded by the Royal Society of Chemistry for 2012. Transfer of best practice is ongoing, through the recently formed University of Leicester *College of Science & Engineering Widening Participation and Outreach Working Group*. Furthermore, I have been in discussion with the new RSC coordinator for the Midlands Region on publishing details of sharing best practice on University of Leicester outreach activities.

The University of Leicester has well established links with schools and colleges across the region and a strong commitment to partnership working through the Colleges-University of Leicester Network (CULN). CULN comprises 18 FE Colleges and 3 HEIs across the Midlands, optimising collaboration for the benefit of staff and learners. It engages with STEM subjects, offering Chemistry for our Future (CFOF) events to partners/students. HEFCE funded CFOF activities used the university's School and College Services with their considerable experience of brokering interdisciplinary activities, accessing regional development funding and identifying WP audiences. They are crucial to developing strategies for sustainability. For collaborative outreach events, the University of Leicester and our partner East Midlands Universities have the mechanisms and resources in place to continue to support HE STEM outreach going forward. Sustainability continues to be achieved by promoting changes in practice across HE, and through sharing models and materials.

Chemistry Outreach Package

Elizabeth Page, Department of Chemistry, University of Reading

Engagement and Target Audience

In all activities delivered we have aimed to target Aimhigher Schools wherever possible in order to fulfil the widening access philosophy of the National HE STEM Programme.

Schools	Number of pupils	Date(s)	Age Group
Colour Chemistry			
The Holt School, Wokingham	120	7 June 2011	11-12
St Teresa's, Wokingham	65	9 June 2011	9-11
Snap, Crackle and Snot			
Cox Green School, Maidenhead	15	16 March 2011	11-13
St Joseph's College	15	16 March 2011	11-12
St Nicholas School, Church Crookham.	15	16 March 2011	11-13
Easthampstead Park School	15	16 March 2011	11-12
Aspirin the Wonder Medicine 8 July 2011			
The Ashcombe School	4		Year 12
Warlingham School	4		Year 12
Desborough School	4		Year 12
Slough Grammar School	4		Year 12
The Forest School	4		Year 12
The Bulmershe School	4		Year 12
Garth Hill College	4		Year 12
Theale Green Community School	4		Year 12
The Angmering School	4		Year 12
Denefield School	4		Year 12

Table 1: School participation in activities

Background and Rationale

The activities chosen for delivery were selected mainly on the basis of the age range of the pupils. The Department of Chemistry at Reading has little experience of delivering outreach to younger school pupils. We therefore elected to deliver two activities which would target very young children (primary and lower secondary). We wanted to exploit the expertise of a recently retired chemistry school teacher to help us tailor the delivery of these activities to this target audience. We also chose to deliver the Aspirin activity which we know is very attractive and beneficial particularly to Aimhigher schools which do not have the appropriate facilities to carry out such laboratory work.

Implementation

Colour Chemistry: This activity was taken out to local schools by a retired school teacher accompanied by current students and members of departmental staff.

Figure 1: Pupils watch the colour changes brought about by acidifying an alkaline solution with solid carbon dioxide

Snap Crackle and Snot: This activity was conducted in the Science Studios at the University of Reading. It was organised by our Department Director of Outreach. Four different hands-on activities were used in the event. Pupils rotated around the activities in their school groups.

Our retired teacher adviser helped prepare the activities and ensure their suitability for the target age group. Each activity was supervised by a postgraduate demonstrator or a member of staff. Pupils were given safety spectacles and disposable lab coats to impress upon them the hazards of dealing with chemicals. Each activity took around 20 minutes and involved a short introduction and demonstration generally followed by some hands-on activity.

Figure 2: Pupils watching the effects of very low temperatures on a range of everyday items.

The Science Studios proved to be an excellent space for these types of activities.

Aspirin the Wonder Medicine: Aspirin synthesis and analysis was carried out with 40 Year 12 pupils. The pupils were selected after responding to a flyer circulated by our University Widening Participation coordinator to a number of schools. We restricted numbers for the event to 4 per school. The event was vastly over-subscribed with over 80 pupils unsuccessful in securing spaces. We took the decision to allow pupils to attend the event without a teacher – provided the school took responsibility for the pupils travelling to and from the University. This approach worked very well. A small number of the teams attended with a teacher but the activity ran perfectly well without the need for a teacher present. The event was co-organised by our School Director of Outreach and our chief laboratory technician.

The activity started with a brief introduction to the discovery of aspirin and its therapeutic activity. Pupils then started on the synthesis working in pairs with one fume hood to each pair of pupils. The activity could not be extended to more pupils as the laboratory only contains 20 fume hoods. Each group of 10 pupils was supervised by a postgraduate demonstrator. This ensured there was an excellent staff-to-student ratio for the exercise.

A sample of the aspirin was prepared and recrystallised in the morning and left to dry over lunch. After lunch the pupils returned to carry out analysis on their product. The aspirin was analysed by melting point, thin layer chromatography and infra-red spectroscopy. A yield was also calculated for the product.

The activity worked extremely well. The timings were 3.5 hours in the morning session and 2.25 hours in the afternoon.

Figure 3: Students recrystallising aspirin and calculating yield

Evaluation

Evaluation was carried out by different approaches depending upon the age groups of the pupils attending the activities. It was felt that, in the case of the younger pupils attending the *Colour Chemistry* and *Snap, Crackle and Snot* activities the preferred evaluation method would be through the teachers. In the case of the *Aspirin the Wonder Medicine* activity both pupils and teachers were surveyed.

A response form was used in each case which was subsequently analysed.

Snap, Crackle and Snot: The teachers who responded were overwhelmingly satisfied with the activities. The quality of the experiments scored on average 4.3/5 and the pupil response was judged to be 4/5. The hands-on activities were followed by an interactive talk on liquid crystals and light which was possibly slightly above the level of the pupils; this scored an average of 3/5. Some comments from the teachers were:

"The pupils were really excited about the experiments and demos. Overall the event was excellent."

"Perhaps more activities for the pupils to keep them busy and less trying to listen to the demonstrator in a noisy lab. However the pupils really enjoyed it."

Aspirin the Wonder Medicine: 81% of all pupils attending the activity found it was relevant and almost 100% claimed it was useful for finding out about studying at university. 98% of the pupils attending found it to be pitched at the right level and all found it interesting. All pupils liked the method of delivery and found ample opportunity to get involved. All the pupils attending were considering applying to university before the event, and 19% said they were more likely to apply after the event. The teacher responses were uniformly positive and provoked comments such as the following when asked what they particularly liked about the event: *"A chance to do a sustained 3 hour practical and work in well-equipped lab",* and, *"…using high quality equipment".*

Below is an extract from a letter from one of the teachers who visited:

"The girls got so much out of it (the day) and said how much it helped them with their current study of the A-Level course. The help and support you showed us all due to our very delayed arrival as well was fantastic and greatly appreciated by us all. I wish you well with any further organised days you do and would be very interested to hear of any more that you intend to hold for sixth form students in the future."

Discussion, Learning and Impact

The goal of the project to expand the Department of Chemistry's range and experience of outreach activities to lower age groups and thus stimulate a long-standing interest in science has been achieved. Through the activities we have established contacts with primary schools in the Wokingham area, and have had requests for repeat visits (because of demand more visits were carried out than listed in the report above, but were funded separately from the National HE STEM Programme). After the summer vacation we will begin visits to primary schools in the Reading area. The recent RSC Chemistry Landscape Meeting, (June 2011) identified primary science as one which is currently very vulnerable because of the small number of qualified science specialist primary teachers. We have increased the number of practitioners who can deliver the activity and so hope to visit more schools – dependent upon funding.

At the other end of the age range the aspirin activity was extremely effective in attracting pupils from schools identified as having a low uptake of higher education. Reading is in a relatively affluent geographical locality and the institution easily meets its widening access targets. However, there are schools which typically have never engaged with any of the activities offered by the Chemistry Teachers Centre (which has been established for over 11 years now). The aspirin activity was effective in attracting pupils from many schools that the University has not, to date, had much contact with. By restricting the number of pupils from each school to 4, and not requiring a member of staff to accompany the pupils the activity proved to be very attractive and easily slotted into school timetables during the post-exam period.

Various adaptations were made to the methods to enhance the procedure: All equipment and chemicals were laid out ready prepared in a fume hood for each pair of students before the start of the session; two students shared a fume hood; ice was used to assist with the recrystallisation of the product; only a portion of the product was recrystallised to reduce solvent requirements; the yield was calculated by scaling up; dividing the practical into two sessions allowed time for drying the product over lunch. The afternoon session began with a short talk about analytical techniques. We had planned a visit to the Chemical Analysis Facility in the afternoon session but this was rather ambitious. Although it is desirable for pupils to see the multi-million pound instrumentation in the department, it was felt that the time could have been better spent focussing on the actual spectra (IR was run by each group and NMR spectra recorded).

Further Development and Sustainability

The *Colour Chemistry* activity will continue next year. This is an activity which is taken out to local primary schools by a retired school teacher. It gives our current undergraduates who are interested in teaching the opportunity to visit primary schools prior to applying for PGCE places. Primary experience is a pre-requisite for PGCE study at secondary level. Schools visited this year have requested repeat visits and we plan to offer the activities to further schools in the Reading area.

Through the *Snap, Crackle and Snot* activity we have been able to trial some hands-on activities for younger pupils in our dedicated Science Studios. This

was found to work very well. Staff now have more confidence in interacting with younger pupils.

The *Aspirin Synthesis* was an unequivocal success. We intend to offer this in future years should we have the resources to do so. It provides an excellent opportunity for pupils to taste degree level study and experience university life for a day. Providing the target schools are those formally described as 'Aimhigher' this is a proven way of widening access to higher education in under-represented groups.

Clearly delivery of all the above activities requires resource – the aspirin day being the most costly due to the duration of the activity and the consumables involved. It is not possible to make such events fully sustainable without a small amount of funding to cover demonstrator payments and consumables. These may be more forthcoming from central reserves post-2012 as institutions aim to fulfil access agreements, but in the meantime the future of such activities is uncertain due to financial constraints.

Chemistry Outreach Package

Jonathon Speed, School of Chemistry, University of Southampton

Abstract

The project undertook the delivery of activities *Snap, Crackle and Snot, Chemistry is Fun* and *Year 9 Chemistry Day* to a variety of schools in the Hampshire, Wiltshire and Dorset areas, from a wide range of socioeconomic backgrounds. The 'off the shelf' activities had to be changed and modified as it was felt they were unsuitable for delivery as described, but on the whole only minor modifications were required. The finished article was extremely well received by every school, and this was quantified in the form of a questionnaire filled in by the teachers of the classes involved. The project also featured the training of postgraduate and postdoctoral members of staff, who are capable and willing to continue the project over the coming years.

Background and Rationale

Southampton University has a strong background in outreach and public engagement, most notably through Family Day taking place during National Science and Engineering Week. The Chemistry Department plays an important role in the event, this year providing activities such as 'Light, Colour and Luminescence, 'Science in a bubble', 'Electrochemistry for Energy and Art' among others, as well as a talk entitled 'How to Build a Firework in 45 minutes', and a photographic exhibition of exciting and 'beautiful' experiments.

Throughout the rest of the year the Department tries to provide an outreach service to local schools, and has encouraged local schools both to visit the University and have visits come to them. We have strong links with students undertaking their GCSE and A-levels at a number of schools in the Hampshire area and beyond, and aim to use the activities to widen our remit to a much larger age range of students.

We aimed to forge new links with schools in the surrounding area, especially those with whom we did not have previous contact. There are numerous schools who expressed an interest in outreach, but we did not have the resources to respond to all requests. The support provided by the National HE STEM Programme has allowed us to deliver outreach to a new audience and establish contact and possible future interactions with new schools.

Implementation

It was decided that the activities would be delivered by the Department's Postdoctoral Outreach and Impact Officer. This is a full-time position focusing on maintaining current outreach projects as well developing novel activities and demonstrations. This caused minimal disruption to any other members of staff whilst still ensuring that the activities were delivered by a qualified chemistry graduate, and an 'expert'.

The project was managed by the Outreach Coordinator for the Department who is the first point of contact for the schools wishing to be involved in outreach, and so was the natural choice for the role. By utilising their existing contacts as a starting point we could hit the ground running and managed to book in some schools immediately for the *Chemistry is Fun* talk.

The activities were all risk assessed beforehand, and discussed with the class teacher(s) in advance to ensure that everyone was familiar with any hazards, and the topics covered.

Chemistry is Fun: The *Chemistry is Fun* activity was held five times, at Talbot Heath School in Bournemouth, St Swithuns School in Winchester, Thomas Hardye School in Dorchester and at Wicor and Cams Hill Schools in Fareham. The initial plan was to replicate the talk detailed in the Activity 14 Worksheet provided as part of the *Chemistry for Our Future* pack. However, it was felt that the methylene blue and oxygen experiment described required a much higher level of knowledge to understand than the rest of the demonstrations. As a result the intended participants would probably struggle to understand the science behind it, and so it was dropped in favour of the 'whoosh bottle' demonstration – the combustion of methanol in a large (18.5 L) bottle. It was also thought that the hydrogen bottle experiment described in the worksheet lacked detail in the user's explanation as well any adequate safety data, as this is a potentially incredibly dangerous experiment – and the experienced demonstrator was not happy to perform it given the circumstances described in the activity sheet, particularly transporting hydrogen gas in his car. This was then dropped in favour of the 'methanol gun', as this was a logical progression from the 'whoosh bottle'. The talk itself was delivered over the course of 45 minutes, followed by a fifteen-minute question and answer session with the students.

Snap, Crackle and Snot: The *Snap, Crackle and Snot* activity was taken to Lymington Junior School, at the request of a teacher who had asked for an outreach event, as the school had not had any previous involvement with the Chemistry Department. The session was delivered to a large group of students aged 9-10, which despite being a slightly lower age-range than suggested in the worksheet still coped with the level of science.

The activity was marketed to the rest of the school and the parents as *Snap, Crackle and Snot*, and on discussing the suggested content with the teacher, it was decided that the self siphoning liquid and magic sand (particularly as the sand is available as a commercial product and so could be brought in to the school by the teacher with no outside support from the University) were largely irrelevant, and as a result the format was changed. The resulting format is shown below:

> **Snap:** Liquid nitrogen demonstrations, freezing everyday objects, throwing it on the floor and showing the changing properties of rubber when frozen.
>
> **Crackle:** Burning methanol, the whoosh bottle, the 'canon fire' experiment.
>
> **Snot:** This was left unchanged, and involved the class making their own PVA slime and silly putty.

The teacher also pointed out that the suggested order of activities in the worksheet would probably lead to rowdy behaviour from the students as it ended with a workshop that had no definitive structure or leader. As a result the order was changed slightly to place 'Snot' in the middle, as this also gave the students a chance to move around and did not require them to focus for too long on any one thing.

Year 9 Science Day: The *Year 9 Science Day* was run as part of a residential course at the University where various schools targeted as part of the widening participation scheme are invited into the Department to take part in activities they would not normally be able to.

It was decided that the project to extract casein from milk was not long enough to fill the required time, and so this was combined with the 'developing a glue' experiment listed on the practicalchemistry.org website. The students were also asked to predict whether they would see a difference between the skimmed and full fat milks before the experiment, and then to explain why the skimmed milk performed best. The 'bouncing custard' was expanded to include slime as well. This was partly to show the difference in properties in the end result as a function of slightly different reaction conditions, but also as this activity was also found to be too short.

It was pointed out that with the advent of the *Spectroscopy in a Suitcase* the school could get hold of an IR spectrometer, so the identifying unknown polymers was replaced entirely with a workshop on light, colour and luminescence. It was felt that this was more a site-specific activity, as experiments on fluorescence are often expensive and cannot be organised by the teacher in a school environment, whereas calculating the density of plastics is well within the budget of most schools.

Evaluation

The teachers of classes shown the *Chemistry is Fun* and *Snap, Crackle and Snot* talks were asked to evaluate the activities with a simple questionnaire in order to gain feedback and advice on future events. A total of 38 teachers were questioned and their responses are given in Table 1:

I enjoyed the demonstrations: (multiple choice)	**Responses**	
Strongly agree	34	89.47%
Agree	4	10.53%
Neither agree nor disagree	0	0%
Disagree	0	0%
Strongly disagree	0	0%
Totals	**38**	**100%**
How many of these demonstrations have you seen before? (multiple choice)	**Responses**	
None of them	3	7.69%
One or two	16	41.03%
Most	16	41.03%
All of them	4	10.26%
Totals	**39**	**100%**
This talk gave me new ideas for demonstrations: (multiple choice)	**Responses**	
Strongly agree	10	26.32%
Agree	20	52.63%
Neither agree nor disagree	8	21.05%
Disagree	0	0%
Strongly disagree	0	0%
Totals	**38**	**100%**
I think my students will benefit from this talk: (multiple choice)	**Responses**	
Strongly agree	11	28.21%
Agree	23	58.97%
Neither agree nor disagree	4	10.26%
Disagree	1	2.56%
Strongly disagree	0	0%
Totals	**39**	**100%**

Table 1: Teacher feedback on the *Chemistry is Fun* and *Snap, Crackle and Snot* sessions

It is clear from the statistics that the majority of the teachers enjoyed the event, and more important felt

that it was a useful activity for the students that they will benefit from in the future. Over half the teachers also said that the talks gave them ideas to use in their own classrooms and to incorporate into their teaching. This is of particular relevance in the current financial climate, as the amount of money universities can spare for outreach is highly likely to decrease in the next few years, so helping teachers to develop their own exciting demonstrations is of paramount importance.

One issue that is apparent is that comparatively few teachers (3 out of 38) had seen none of the demonstrations featured before. A similar number (4 out of 38) had seen all of the demonstrations before, but it certainly seems that many of the more exciting aspects of outreach talks are becoming expected and their novelty is waning. Indeed, in conversations with teachers I have found that they feel there is significant need for an injection of novel demonstrations that explain modern science (such as nanotechnology or renewable energies) in an exciting and engaging way.

Discussion, Learning and Impact

The intended goals were certainly met, as we successfully managed to not only foster links with new schools (such as Cams Hill and Lymington Schools) but also strengthen the existing ties (such as with Talbot Heath and Thomas Hardye Schools). The feedback from the teachers was altogether positive, and in fact repeat visits have been requested to most of them, including a talk detailing the impact of research at the University, at Cams Hill School to be undertaken in July.

However, there has been one significant result from the project, which is that the activity packs provided as part of *Chemistry: The Next Generation* were, in the opinion of the author, not entirely fit for purpose. In many cases there is significant overlap between the activities, particularly the 'talk style (as opposed to the 'workshop' style activities). A noticeably large contingent of students expressed that they had seen the demonstrations before, particularly those involving liquid nitrogen.

The activities also fall short of providing sufficient advice on health and safety (in many cases the required information is missing entirely), and very often do not fill the length of time suggested. The example detailed above with the extraction of casein from milk supposedly fills an hour long session, whereas in our experience only half that time could possibly be spent on it before the students became unruly and uncooperative. Moreover, the content itself very often relied on buying commercial kits (or in the case of magic sand' and toy) and acting more of a middle-man demonstrating a third-party experiment than actual outreach. It is the opinion of the author that if the future work is intended to buy in ready-made outreach the funding used would be better spent allowing schools to buy the kits in themselves, as that way the peripheral overheads of outreach would be avoided.

It is also worth mentioning that the outreach team at the University contains some very competent and experienced individuals, and as a team managed to deliver the activities – but with minimal help from the activity sheets. It is strongly thought that a more inexperienced team would have struggled to follow the instructions, and in cases where the experiment was found to not work or be too dangerous to perform, they would have not been able to modify the activities sufficiently.

However, despite these shortcomings in the actual activity sheets themselves, many of the ideas and demonstrations discussed are effective and were delivered efficiently and economically. In fact, the cost of the *Chemistry is Fun* talk was brought down significantly so it could be performed many times in different schools. Overall the concept of the activity pack was thought to be an excellent idea, but did not achieve its full potential.

In future outreach events will almost certainly be held without consulting the activity pack, but instead making use of the pre-existing excellent resources such as practicalchemistry.org. Moreover, novel and topical demonstrations will be developed to explain such concepts as nanotechnology, renewable energies, 'green' chemistry etc.

Further Development and Sustainability

The major aim of this project was to widen participation and forge new links with local schools that have not previously had involvement with the University. This has been overwhelmingly successful, and future visits have been discussed, and in some cases already booked for the summer and into the new academic year. The University currently runs outreach activities through a dedicated office, and it is hoped that the schools that previously had little involvement will book in visits both to and from the University over the coming year. Various postgraduates and postdoctoral researchers have also gained experience in outreach during the course of this project, and will be able to carry on the various activities learned during the project next year.

Context and Problem Based Learning: The Titan Project

Karen Moss, Centre for Effective Learning in Science, School of Science & Technology, Nottingham Trent University

Engagement and Target Audience

The *Titan Project C/PBL Package* was introduced for the first time to all Year 1 chemistry students as part of the core 20-credit Level 4 module *Skills for Chemistry* within chemistry degree programmes at Nottingham Trent University (NTU). 81 students started on the module in term 1 (2010/11 session).

Background and Rationale

Industry needs graduates with high levels of professional and transferable skills. In science, at NTU, we are committed to enhancing our curriculum to better equip our graduates for professional practice.

Previously the 'Skills for Chemistry' module contained IT seminars, maths and personal development planning (PDP). Assessed by a portfolio, and originally designed to deliver QAA PDP requirements, it needed updating to include professional skills: team working; problem-solving and communication. The C/PBL package *The Titan Project* provides an excellent vehicle to achieve this. Using real-life contexts, it engages students who:

- Work as team members to solve problems and produce an outcome.
- Practice oral communication.
- Build their research skills with instruction on use of databases and referencing software.

Implementation

I ran the Titan Project over five, one-hour contact sessions, using the materials developed at the University of Hull. The internationalised version involves developments at a Titanium Dioxide processing site in Kerala, India. The resource was downloaded [1] and used unchanged.

Students were assigned to groups in week 1, and not allowed to self-select who they worked with. This was explained in context of professional life: 'You don't get to chose who you work with.' The schedule of activities is in Table 1.

Assessment was aligned to the expected learning outcomes as follows:

- Oral presentation of recommendations 40%
- Group review and report on analytical methods 40%
- Peer assessment of an individual's contribution to group's activities 20%

Session Number	Activities from Titan Project for session	Student work
1	Introduction to scenario, consideration of the future of the Kerala site including factors of chemistry, politics, economics, safety, environment etc. Briefing about group oral presentation for week 2.	Examine info from Kerala site, analyse chemistry & organise group meetings to prepare for next week
2	Group presentations assessed live	Each team have 1 slide & 3 minutes to present their recommendations on the future of the Kerala site. Their worksheet answers on pigments were submitted in their portfolio
3	Introduce information and activity about choosing analytical techniques for effluent analysis	Work through questions and begin own research into methods of determining chloride ion in effluent
4	Session on referencing and use of databases	Student carry out research & plan report
5	Hand in group review, discuss pros and cons of each method, problem solving sheets, evaluation	

Table 1: Programme of activities

Assessment forms were developed specific to NTU.

"Titan enabled me to learn how to communicate and work with people within a team."

Evaluation

The evaluation aimed to capture a range of data: from attitudinal questions to reflection on the learning process to explore evidence of learning gains from students participating in the *Titan Project*. Two approaches were used to collect data:

1. Student reflections on the process in final week using a questionnaire.
2. Evidence of achievement of learning outcomes – from samples of student work, and reflections within their portfolios.

The questionnaire was semi-structured with a range of open- and closed-questions. Closed questions looked at attitudes to the *Titan Project*, using a set of bi-polar adjective pairs (i.e. a *semantic differential scale*, after C.E Osgood). These allow students to rate the *Titan Project* on a 5-point scale set between opposing pairs of words: e.g. Useful/Useless; Uninteresting/Interesting. Pairs were alternated so that the positive word changed sides to reduce superficial answers. In addition, open questions asked students to say what they had learned in terms of science/skills during the activity.

"I learned to work in a team or small group to complete a task."

To analyse the responses the boxes ticked were converted to an ordinal scale with the positive word rated as 5, its negative partner as 1. The results were then converted into frequency tables. The open questions were analysed using word clouds and textual analysis; the results are discussed in the next section.

Discussion, Learning and Impact

72 of 74 students who completed year 1 submitted assessed work for this part of the module and 57 students completed the questionnaire; a 77% response rate.

Skills Acquired: Using an online Text Analysis Tool [2] like phrases were sorted and ranked together (i.e. team work & group work). The most common phrases are given in Table 2.

Type of Skills	No. of occurrences
Team work	35
Presentation skills	17
Research	14
Organisation	12
Time management	6
Report writing	4
Communication	4
Referencing	3
IT skills	3

Table 2: Simplified textual analysis of 'skills acquired'

This evidence clearly shows that the activity succeeded in its intention to give practice at working in teams, presentation skills and carrying out research. In addition, when identifying the best thing about the activity, 50% of students who replied stated that it was group/team work.

Science Learnt: Text was subjected to a word cloud analysis [3] of the phrases used. The resulting word cloud is shown in Figure 1.

Figure 1: Word cloud analysis of science learnt statements

The word cloud clearly identifies key phrases in student learning – the raw phrases in the word cloud can be grouped under a smaller number of headings of similar phrases, for example 'm*ethods of chloride detection*' is clearly the same as '*chloride detection methods*'. Using the text analysis tool above like phrases were sorted and ranked together, outputs are given in Table 3:

Phrases	Frequency
TiO2 processes	18
Chloride detection methods	16
Analytical techniques	11
Commercial aspects of chemistry	9
Environmental factors	8
Industrial processes	8
Chemical processes	3
Calculations	2
Effluents	2
Uv-vis spectroscopy	2

Table 3: Simplified textual analysis of 'science learnt'

Hence it can be seen that students also learnt about aspects of chemistry and industrial practice from the *Titan Project*. This was also clearly demonstrated in their oral presentations and written reports. They made some very sensible suggestions.

Attitudinal analysis: The results were converted to a score out of 5, listed in Table 4 and are shown as histograms in Figure 2.

Attitude Factor	Rating /5	
	Mean	SD
Interesting	3.4	1.1
Ease of Comprehension	3.3	0.9
Level of Interactivity	3.5	1
Encourages Questions	3.8	1
Encourages Teamwork	4.2	1
Usefulness	3.4	0.9

Table 4: Numerical analysis of semantic differential attitude statements

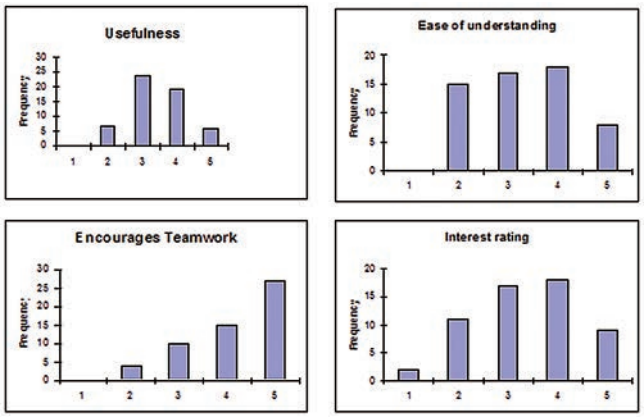


Figure 2: Histograms of attitude responses

The activity was well received by the majority of students. One student commented: *"It was different to the rest of the way we're taught."* The analyses of attitude responses show that, overall, the students did consider that the *Titan Project* was interesting, useful, and encouraged questions and teamwork. As seen from assessed work the intended learning outcomes were achieved; the average mark for the *Titan Project* was 60% for those students completing the activities. In conclusion, the range of student engagement with the *Titan Project* demonstrated the activity fulfilled its goals of skills development to enhance professional practice.

Reflections:

- It was possible to do this activity based in a large lecture room.
- The quality of the materials meant it was easy to initiate the activity.
- Student outputs did vary in quality - more guidance on format is needed for future.
- Students wanted more info/more explanation; note, see lower rating of 'Ease of understanding'.
- Not all students liked group work or topic.
- The referencing/database session and doing their own research was a bigger success than expected.

"I effectively gained information and referenced it appropriately."

Further Development and Sustainability

This activity will be part of the skills module next academic year. Based on the success of this activity the plan is to adopt a further group based C/PBL activity into Year 1 chemistry from 2011/12. This will form part of a bigger National HE STEM Programme curriculum project [4] for skill development within our core programmes which includes support for colleagues in physics in their C/PBL case study development.

Changes to be made to the *Titan Project* for 2011/12 include:

- Better management of group expectations and tips to help them be as productive as possible.
- Peer assessment process needs moderation.
- Extra staff support for session on detection methods.

"The team work was the better part of this project as my skills for working in a group improved."

References

[1] http://www.heacademy.ac.uk/assets/ps/documents/pbl_problems/titan_project_2009_handouts.pdf

[2] http://www.online-utility.org/text/analyzer.jsp

[3] using Wordle™ available at http://www.wordle.net/create

[4] http://www.hestem.ac.uk/activity/enhancing-graduate-employability-and-skills-building-effective-stem

Context and Problem Based Learning: Launch a Lab

Paul Duckmanton, Department of Chemistry, University of Southampton

Engagement and Target Audience

The target audience for this activity was the 1st year undergraduate cohort enrolled on the University of Southampton Chemistry and various 'Chemistry with… 'programmes offered by the chemistry department. In total, this was 110 students. The activity was led by a member of academic staff (Paul Duckmanton), supported by one postdoctoral researcher and two postgraduate students, who helped run the event.

Background and Rationale

The Problem Based Learning activity was chosen as a method of embedding both 'industrial awareness' and CV writing skills into the early stages of the chemistry degree program. At Southampton, the chemistry department has strong links with industry, with a large number of students participating in an industrial-placement scheme as part of their degree. The application process for the scheme requires students to possess a CV, and it has been found in the past that the students are often unaware of what is involved in writing a CV, and the information that should be included.

Due to an increasing number of enrolled students, the task of ensuring students were equipped with the necessary skills to write a CV was becoming more difficult, with most starting the application process having never before encountered a CV, and having no knowledge of reference point from which to start, leading to a great deal of student stress, and a large amount of staff time required to get the students up to speed. It was therefore decided to introduce these skills during the first year, before building upon them in second year to allow the students to create higher-quality outputs to take forward to the application stage.

The 'off-the-shelf' Problem-Based Learning package chosen aligned well with the aim. Not only would it allow students the chance to practice writing a CV, but seemed to go further by introducing concepts important to industrial chemistry as well as giving students the opportunity to take part in the interview process from both the interviewer's and interviewee's perspective. This would embed these key skills into the degree program at an early stage, for reinforcement the following year.

Implementation

The activity is promoted as an 'off the shelf' product, which can be taken and used as is, with all resources, paperwork and information provided to be photocopied and used. In reality however, much of the information in this resource is provided in the form of web-links, and before running the activity with the students, these links were checked and many found to be out of date. Finding new links and updating the information to run the activity therefore took longer than expected.

The original suggested timings for the running of the activity suggested five 1-hour sessions, with at least one day between each session to allow the students to prepare. However, the time allocated to the activity at Southampton meant that this was not a viable model for our trial, and instead the timing was modified to fit into two consecutive days, with approximately the first three of the suggested sessions on day 1 (the 'tendering for the contract' section), and the final two on day 2 ('CV critiquing and interview skills'). To make this workable, some information was provided to the students that ordinarily, if running to the suggested timescale, the students would be expected to go and research for themselves. This was given in the form of printed webpages and examples from the links suggested in the pack, or those subsequently discovered. In the break between days 1 and 2, the students were asked to prepare a CV in application for a job.

The activity itself took place during the final two weeks of the second semester, after the students had completed their end-of-year exams. It was not possible to make attendance compulsory however the students were informed of the activity through email and in-lecture announcements, with the importance of the transferable skills highlighted. We also attributed 'Graduate Passport' points to the activity [1]. We requested that if students were unable to attend, they contact the member of academic staff running the event. Along with highlighting the importance of the activity, a short brief was included so the students knew what to expect from the day, how this linked into other present and future aspects of their course, and what preparation was required before they arrived. On the first day, over 90 students out of a possible 110 total started the activity, with 10 informing the member of staff of their absence.

The activity was run with a single member of academic staff supported by two post-graduate students and one post-doctoral researcher. All had been involved in teaching this group of students in the past, were known to the students, and had taken part in such Problem Based Learning activities previously. All facilitators were provided with a full timetable/running-order for the two days, along with a breakdown of the information the students would be given and the provided tutor notes. Students worked in groups of five, staying in the same groups for the whole two days of the activity. On day two, it was planned that two or more groups would be combined to work together for the interview stage.

Evaluation

The purpose of our evaluative practice was to gauge how the students engaged with the activity, what they took away from it, and whether they found it useful at the time. As such, three methods were used to evaluate the activity:

- Student attendance figures – As this was a non-compulsory activity, attendance was viewed as a measure of how useful the students perceived the activity to be.
- Anonymous student feedback questionnaires – These are in standard use on all modules provided by the University of Southampton to monitor student opinion on lecture content and delivery quality. These use both the Likert-scale questions and comments sections. Students were informed that comments would be particularly useful for evaluating this activity
- Verbal feedback – Select students were asked their opinion on the activity.

From these methods:

- At the beginning of activity, 90 students participated. After a break for lunch, 75 students returned. On day two, only 25 students returned to finish the activity, at which point the activity had to be modified – the interview activity had to be abandoned due to poor attendance, and as a result was turned into a more in-depth CV workshop for those who attended.
- Student feedback forms were filled out on the second day, so are far from indicative of the whole cohort who started the activity on day one. Of those who did fill them out however, it was suggested that the lead-in to what students saw as the main activity (the CV writing and interview skills) was too long, and *"seemed designed to waste time."* This viewpoint was reinforced by the students' verbal feedback. Of those who attended the second day, the almost unanimous view was that the CV skills section was both informative and useful, with many students actively seeking one-on-one feedback on their CV, and finding this invaluable – one student took the opportunity to re-write her CV for an application for a job during the session. Many however expressed the view that day one was largely unnecessary, and the 'useful' skills section could have been introduced earlier. They also expressed disappointment that they could not take part in the interview task, and displayed frustration at their less considerate classmates who failed to attend.

Discussion, Learning and Impact

The intended goals for this activity – to introduce CV and interview skills at an earlier stage in the chemistry degree program – were partially achieved. Of the students who engaged with the course seemed to find it of value, and all expressed the view that prior to the course they were not aware of quite how much work was involved in writing a CV, or why one was necessary. Sadly however, the number of students fully engaging with the course was disappointing.

It is suspected that the reason for lack of engagement was threefold:

1. The activity was non-compulsory (and not assessed) leading to a great deal of cynicism from some students towards the tasks they were asked to perform. These students saw little value in the introductory tasks and failed to engage throughout the first day. As a result, they disregarded the second day.
2. The timing of the activity could have been a factor. At Southampton, traditionally the period after exams has been used for such 'soft skill' development courses however the regularity and formality of what is offered varies on a year by year basis. Despite these weeks still being 'on-timetable', most students see these as free time, and so any activity during this period is traditionally poorly received. Coupled with the non-compulsory nature, it led to poor engagement.
3. The background context to the activity, and therefore the necessary prior knowledge required to be able to easily undertake and engage with the task, is not part of any University of Southampton Chemistry Degree. The content seems aimed more at 'Applied Chemistry' style programs, rather than the more 'Pure Chemistry' style favoured by Southampton (and many other universities).

From this, a number of key lessons have been learnt:

- When running the activity, ideally it should be run at the beginning of the year. Within the department, the consensus is that running such an activity at the beginning of first year would be too early, with most students not utilising the skills until the

middle of year two. One possible alteration is to run this during week one of the second year.

- Modify either the activity or the course for better alignment within the programme. This is a large, time-consuming job, and is currently a work-in-progress.

Of this, there were a number of barriers to this activity. Support for the activity within the department was limited, which resulted in limited academic involvement. To overcome this, help was sought from known, enthusiastic postgraduate students. Also, as the activity was run for approximately 100 students, working in a workshop-style format, room bookings were difficult even given the low teaching load within the university at the time of the activity, as it necessitated round-table discussions rather than a lecture theatre format room. The activity was run concurrently in three adjacent rooms, with all students gathered in one room for discussions before separating for the breakout sessions. This worked well, although did not give as good a learning experience as a single room would allow.

Further Development and Sustainability

To ensure sustainability, in future the timing of the event will be brought forward within the teaching year. The content is currently undergoing modification in an attempt to better align with the content of our course. This is requiring a large number of 'person hours', and as such the course will not run this year, instead being brought back for the academic year 2012/2013. If possible, we wish to break the year into halves and run the event twice however these will effectively double the staffing level. For further into the future, we are hoping to embed this into a more formalised, structured 'employability skills' module.

References

[1] For more information on the Graduate Passport Scheme, see http://www.soton.ac.uk/careers/passport/

Context and Problem Based Learning: Tales of the Riverbank

Paul Duckmanton, Department of Chemistry, University of Southampton

Engagement and Target Audience

The target audience for this activity were 40 first-year undergraduate students enrolled on an optional module, CHEM1008 (Environmental Aquatic Chemistry), which is offered to first-year students within the University of Southampton Department of Chemistry on all chemistry degree streams. The activity was led by a member of staff, with support from two teaching assistants, one of whom who had taken part in the running of a Problem Based Learning (PBL) exercise previously.

Background and Rationale

The module CHEM1008 recently underwent a structural and staffing change, and at that time the decision was made to move away from a traditional 'end of module exam' structure, and instead re-introduce the module with the main assessment in the form of an essay. To accompany this, not only were topic specific lectures and workshops given, but also ones centred on the skills required to complete the coursework element. Alongside this, we wished to innovate further with the introduction of problem solving sessions, and the ability to implement an aquatically environmental themed PBL activity within this course aligned both with the course content, as well as the department and University's wider aim of embedding 'soft skills' within the curriculum.

Implementation

The resources for running the activity were provided as an 'off the shelf' product, ready for use with all the necessary paperwork provided alongside tutor notes. For this activity, a number of timetables were suggested, and one of these fit very closely with the format into which it would be used within the course, with little modification. Whilst the course did not align perfectly with the subject matter encountered in the activity, this was not seen as a large barrier.

To ensure students got the most out of the activity, they were divided into groups prior to the sessions, and guided in the task of researching knowledge that would be used during the sessions but which had not been covered in the lectures and workshops in the course. This allowed them to be fully prepared, and allowed for better engagement with the tasks.

The activity was run across three sessions, and a timetable was drawn up for all three from the outset, which was distributed by the academic leading the session to those facilitating. Information was released to the students over time, and at the end of the session students were asked to give a presentation on their findings from the activity. Whilst not forming a core part of the assessment for the module, overall engagement was high, and since this initial trial, the activity will be taken forward and continue to have a place within the CHEM1008 module.

Evaluation

Evaluation of the activity was through the form of feedback from the students (written and verbal), verbal feedback from those staff assisting, and an inferred evaluation from attendance monitoring.

On attendance monitoring, as the sessions did not form part of the formal assessment process for the course, there was concern that attendance for all three sessions, and overall engagement with the tasks involved may not be as high as was desired. Of the 40 students enrolled on the course however, 34 attended all sessions, which is in line with attendance figures for regular lecture and workshops sessions.

Discussions with those assisting in the delivery of the activity highlighted that whilst there was a degree of cynicism towards the activity initially from some students, by the end all students had a deeper understanding of the activity, and enjoyed the fact that the decisions they made during the activity impacted on the results they obtained, and that the students felt more ownership of their findings as they were drawn together from data-sets unique to each individual group. Whilst all groups requested different data during the tasks, all came to a similar solution for the problem being investigated.

The students themselves found the experience valuable. Around half expressed the view that the activity was too long in the written feedback, and could have been condensed into two sessions. This was before the final

debrief session however, where the reason for the activity being long term was discussed directly. Verbal feedback after and during the debrief the found that most students appreciated that this had been done to introduce a more 'real-world' element, where results are seldom instantaneous. Also highlighted was that at times, students were unsure of what they were supposed to do. This was probably down to the delivery of the activity. As it was the first time that the organisers had run such sessions (and particularly this one), all were unsure on how best to deliver the material. This experience will however better inform future delivery.

Discussion, Learning and Impact

The intended outcome for this project was to embed PBL within a module on the Southampton University Chemistry degree, and on that basis it has been achieved. This success is in a large part because the resource was ready-to-use, and the module into which it integrated was relatively well aligned. Also, as the course was undergoing a restructure, it could be fully integrated, and not just 'tacked on', or integrated at the loss of other components.

The target audience engaged well with the activity, and indicated through feedback that they liked using limited amounts of information to solve problems, as it concentrated their minds on what was important, and 'made them think about what they were doing, and what information they needed'.

When next repeated, the only change to be made will be how the various sections of the activity is delivered, which with hindsight and experience will be made easier. Due to the circumstances under which this was integrated into the course, there were no perceived barriers.

Further Development and Sustainability

There is no need to modify the material for delivery in the future, and with increasing experience of the staff involved in delivery, student engagement will be increased as staff develop the 'flow' of the activity to be more natural. In the distant future, other modules may be identified where PBL activities could be incorporated, and this experience will act as a positive example of its use within a course.

Chemistry at Work

Andrew Ross, Department of Chemistry, University of Sheffield

Julie Hyde, Department of Chemistry, University of Sheffield

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Abstract

In April 2011 a two-day *Chemistry at Work* event was run in Sheffield. Approximately 400 students from 15 schools, from around the Sheffield and surrounding area attended the event. Positive feedback was received from all colleagues that were involved with the event.

Background and Rationale

Within the Chemistry Department of the University of Sheffield, there is a dedicated Schools Laboratory, which, when opened in 2007, was the first and only one of its kind in the country. Since 2007 a few others have followed our lead and have started to create a dedicated space for STEM outreach. Sheffield ChemSchools, the 'outreach arm' of the Department of Chemistry run the Schools Laboratory which invites groups of visiting students to perform chemistry practical work that cannot be carried out at school due to equipment or curriculum limitations. Since November 2007 approximately 1,000 students from Year 13 down to Year 5 per year have visited and have been enthused by our Schools Laboratory (as of January 2011 the number stands at approximately 3,000 students).

All of the ChemSchools team are also members of the Sheffield and District Local Section of the Royal Society of Chemistry (RSC). *Chemistry at Work* is a huge event which is able to inspire 100s of students in one go so, as an extension to the outreach work undertaken by ChemSchools, together with the Local Section of the RSC we decided to run a *Chemistry at Work* event aimed at Year 7 and 8 students.

Implementation

To achieve the aim to run *Chemistry at Work*, a collaboration between Sheffield ChemSchools, the Chemistry Department at the University of Sheffield, the RSC and Business and Education South Yorkshire (BESY) was set up. Preparation of the event involves a lot of preliminary work and BESY took on this role. BESY was responsible for most of the organisation of the schools and the paperwork required. The Department of Chemistry was responsible for organising the visiting demonstrators and the 'freebies' to give out to the students and staff. The planning was done by a small working party from all of the collaborators.

It was agreed that the best way to organise the event was to run a two-day event with between 8 – 10 demonstrations available in each of the half-day sessions. Each of the schools that attended the event came for a half-day session and their students were split into groups each of about 10 students. Each of the groups of 10 visited three of the 25-minute demonstrations.

In order to run the event as smoothly as possible on the day a training day for one or two representatives from each school the day before the main event was arranged. This allowed us to give the teachers complete details about the day and also deliver a teachers presentation to disseminate information about STEM careers and then a second presentation about events and the facilities available in the Chemistry Department of the University of Sheffield.

Chemistry at Work was run on the 5 - 6 April 2011 being held in the Octagon Centre at the University of Sheffield, with the training day on the 4 April in the Department of Chemistry.

The working party all contributed with the liaison of different companies for the event, in the end we settled on 8 different companies. The following demonstrations were given by:

- **University of Sheffield – *Electroplating***. Staff and students from Sheffield University facilitated a practical session on electroplating and students made a key fob to take away at the end of the session.

- **Our Cow Molly - *Ice, Ice Cream***. Ice cream, the favourite of all deserts, has been around for centuries. It is a complex mixture of all sorts of things and many sciences are needed to understand how ice cream is formed. Our Cow Molly, a local dairy farm in Sheffield, explained how their problems with their ice cream were solved by a Chemist. The demonstration looked at all things cold, including seeing a Guinness World Record holder make ice cream in 10 seconds!
- **Brainwaves - *DNA extraction from strawberries***. In this activity participants carried out the same sort of technique that scientists, such as geneticists, use to do the first step in a study on DNA – remove it from the organism, or extract it.
- **Health and Safety Laboratory - *Can You Take Your Gloves Off?*** The workshop involved a demonstration and hands-on practical focussing on the effect of UV light on the skin. Students tested different types of sun-block cream.
- **Think Forensic – *CSI Workshop***. This workshop provided an insight into the world of the forensic scientist. Students examined trace evidence including hair and fibres, blood spatter and entomology in order to solve a crime. The session covered microscopy, velocity of spatter patterns and the life cycle of insects.
- **Think Forensic – *Fingerprint analysis***. Fingerprint identification was introduced over 100 years ago and it is still the most widely used evidence today, no two people in the world share an identical fingerprint. This workshop provided an insight on how the forensic experts use different chemical methods to develop and collect latent fingerprints. Pupils found and lifted their own fingerprint before moving on to identifying patterns and characteristics. Methods used included aluminium powder on none porous surfaces, magnetic powder on porous surfaces and Cyanoacrylate (super glue) fuming.
- **Learn by Design - *Olympic Sports Science***. An interactive workshop showcasing how science can be used to enhance sports performance. From shark swimsuits, isotonic drinks, fitness, to prosthetic limbs and wheelchair design for Paralympics; the workshop raised awareness of the importance of science and engineering to sports. Students were able to monitor their own performance on the rowing machines linked to 'real-time' monitoring graphs via a projector.
- **Yorkshire Ambulance Service - *Emergency Life Support*.** The workshop covered: Signs and symptoms of heart attacks; recovery for an unconscious person who is breathing; rescue, breathing, mouth to mouth resuscitation; how to recognise an unconscious person who is not breathing; performing CPR on adults, juniors and babies; and, skills needed for paramedics.
- **Bloodhound SSC- *Workshop introducing Bloodhound SSC***. Including details of their latest attempt on the World Land Speed Record with a car capable of 1,000 mph. The primary objective of the Project is to inspire the next generation to pursue careers in science, engineering, technology and maths – by demonstrating how they can be harnessed to achieve the seemingly impossible, such as the BLOODHOUND 1,000 mph land speed record.
- **WAK studios - *Animated Elements*.** Interactive workshop showing how young people can animate the elements.

Evaluation

Over the two-day event 400 students from 15 different schools came to the University of Sheffield to take part in the *Chemistry at Work* event. For each half-day session, 3 or 4 schools arrived about half an hour before the event start. All the teachers divided their students into small groups of between 10-15 in number and gave out name badges. At the start of the event, (either 09:30 or 13:30) the students came into the Octagon centre and Professor Charles Stirling welcomed them and introduced the event. Postgraduate and undergraduate chemistry students acted as guides for the groups and ensured that the students were always ready for their next activity. The students attended 2 x 25 minute hands on events before a short tea break and their chance to take part in an individual quiz. At this point the individual quizzes were collected, checked, folded up and were ready for the prize draw after the final workshop. The final workshop finished at approximately 11:30 or 15:30. The students then gathered with their teachers in the centre of the Octagon for the prize giving. Winners were picked from the quizzes, an individual one for a student, and a voucher for the school to purchase approximately £250 of chemistry equipment.

The feedback from the students was very positive and the teachers have told us that they would like

to see *Chemistry at Work* as an annual event. All of the presenters were very pleased with how the event went and all of them commented on how enthusiastic and keen the students were.

Discussion, Learning and Impact

The original aims of this project have been met, a two and a half day *Chemistry at Work* event was run which included teacher and technician training. Approximately 400 students from 15 schools took part and they have been shown how chemistry is involved in everyday life. Hopefully the *Chemistry at Work* team have shown the students that chemistry is not just something that is done in the classroom, but something that is very useful and they could enjoy doing.

In the future it would be great if one or two of the students who attended the event, were inspired by what they took part in during the sessions and eventually studied chemistry or a chemistry related subject at further or higher education, or got a job in a chemistry related field.

The overall aim is that *Chemistry at Work* has been inspirational for these students, and it is felt that this has been achieved.

Further Development and Sustainability

The event was run with 8 workshops, each providing three 25 minute demonstrations in a session (am and pm). As an improvement a suggestion was made to shorten the demonstrations to 15 minutes and reduce the time the students have for a break, meaning that there could be four demonstrations in a session. This would then allow the students to take part in four of the workshops and see more of the demonstrations, and hopefully engage them even more than they were during the event run in 2011.

Overall *Chemistry at Work* was a great success and the students gained a lot of information about how chemistry is everywhere in society. There is now a format set up for running a *Chemistry at Work* event, which can be used in future to allow for easy implementation in future years. We may consider running *Chemistry at Work* as an annual event; the limiting factor is, as always, the funding. We may also consider running the event for a younger audience such as Year 6.

Physics at Work

David Jenkins, Department of Physics, University of York

Catherine Brophy, NYEBP, the STEMPoint for York and North Yorkshire

Engagement and Target Audience

Schools involved:

- All Saints RC School, York: 13 students and 1 teacher
- Ermysted's Grammar School: 14 students and 2 teachers
- Harrogate High School: 19 students and 2 teachers
- Holy Family RC High School: 8 students and 1 teacher
- Selby High School: 50 students and 3 teachers

Workshop Leaders:

- Nick Bielby, Engineer, North York Moors Railway
- Bob Clarkson, Chief Analyst, Allied Space Surveillance RAF Yvette Hancock, Physics Department, University of York
- Jon Kenny and Hannah Baxter, York Archaeological Trust
- Andrew Rogerson, Physicist and NYBEP Associate
- Martin Smalley, Physics Department, University of York
- Tomas Stanton, Centre for Applied Science and Technology Home Office Science

Figure 1: Meeting Home Office Physicist

Background and Rationale

The aims of the conference were:

- To introduce young people to some of the principles of physics as they are applied in industry, research and everyday life.
- To improve the perception students have of physics and to show that it is an interesting and stimulating subject.
- To present physics as a rewarding career, set in a variety of contexts.
- To provide an introduction to studying Physics at University.

The event was held in the Physics Department at the University of York [1], so it provided an excellent opportunity to see the work of the department and take part in workshops in the laboratories at the University. As one of the pupils wrote on their evaluation form, *"It was more advanced and more challenging. Made you think more."*

The approach: Physics at Work was a two-day event held at the University of York on 16 and 17 June 2011. It was designed to bring Year 9 or 10 students from across York and North Yorkshire into contact with companies and organisations that use physics as part of their work. Each day provided a similar programme and school groups attended for one of the two days. The event was organised by the University of York, facilitated by NYBEP [2], and sponsored by the National HE STEM Programme and the Institute of Physics.

NYBEP has facilitated the Royal Society of Chemistry's 'Chemistry at Work' event at The University of York for ten years and used this expertise in linking with schools and physicists in industry, including STEM Ambassadors. It is time-consuming to research suitable workshops and contact participants, and best to start the process at least six months before the event.

On each day schools were welcomed to the University and given a keynote address. The companies and organisations taking part delivered three 40-minute practical, interactive workshops throughout the morning, followed by participating in a physics networking event after lunch. Students in groups of up to 15 spent the morning in three separate workshops getting practical experience of applied physics. Then, in the afternoon networking session, they had the opportunity to meet six of the participating physicists and ask questions about their work.

The individual physicists and organisations taking part were listed in the separate Conference programme together with a brief description of each workshop. This booklet was provided to all participants, including schools, before the event.

It would be useful to start planning earlier in the school year; we had a lot of interest in the event from schools that had no time left in the school calendar to attend, as schools limit out of school activities. It is important to set dates early in the school year and give schools plenty of notice. Over the two days 104 students attended the event, from six schools, with nine teachers. The seven workshops provided would have allowed us to provide the event for slightly larger groups i.e. 7 x 15 each day = 105 students per day. For more schools to attend, more workshops would need to be provided.

The different workshops offered students a range of activities including:

- 'Demonstration of a Millimetre Wave Standoff Imager – how to spot a hidden gun' from Centre for Applied Science and Technology Home Office Science.
- 'Anarchy – the Science of Arches' with a railway engineer.
- 'Smart Materials workshop'.
- 'Making Liquid Nitrogen ice cream'.
- 'Geophysics with York Archaeological Trust'.
- 'Space Surveillance' with the Chief Analyst of the Allied Space Surveillance Network based at RAF Fylingdales on the North Yorkshire Moors.

The networking session was a new activity to many of the physicists taking part but they were enthusiastic about this opportunity to talk to young people. It is important to move the groups on after 10 minutes maximum, so students meet a range of people and careers. It would be useful to provide short biographies of the STEM Ambassadors and other physicists for the students before the event, so they could prepare some relevant questions for each person they meet. Students were very positive about this part of the day.

The responses from both students and teachers were overwhelmingly positive. One teacher wrote, *"Yes we met our learning objectives as students found today very useful, learning new information and different ways of working within the world of science".*

Students' written comments included: *"It was more challenging and we were able to see how physics is used in real life",* and *"We get to see a more advanced part of science and how it is relatable to real life".*

Evaluation

Teachers and students were asked to complete a short questionnaire at the end of each day to give feedback about the event. Workshop leaders were asked to respond via email to their experiences of the event.

Teacher evaluation: The form for teachers asked them to state their main objectives in attending the event and then asked if the objectives had been met, and if so how. All the teachers wrote down their objectives and offered an explanation of how they had been met. One physics teacher, for example, responded that her main objectives had been to:

Figure 2: Meeting a Medical Physicist

1. Encourage students to consider taking physics at a higher level.
2. Have an understanding of how physics impacts on the real world.
3. Allow the students to experience a university environment.

This teacher said her objectives had been met, particularly when students were encouraged to ask questions, and that her students had gained *"better understanding of what physicists do in university and the real world".*

Teachers were asked to rate the event overall on a scale from:

1 = not at all useful to 10 = extremely useful

50% responded with 8 on this scale - 38% responded with 9, and 12% with 7.

All the teachers had positive comments to make even when they may have been unsure about part of the programme; for example, one teacher responded that the most useful part of the day was *"the speed-date period – far better than I had anticipated!"*

Suggestions for improvement included: *"We brought a mixed ability group – some of the students struggled to grasp the concepts and/or needed an alternative way of looking at the subject/topic in some of the workshops".* This was apparent in comments from students, who had most appreciated and enjoyed the more interactive workshops with strong personalities as presenters.

Student evaluation: Over half the students who took part in the event completed a short evaluation form at the end of the day. They were asked if they were *'… more likely to want to continue to study science after your visit to this event?'* The response asked for was *'YES'* or *'NO'*:

73% responded YES, 24% responded NO, and 3% wrote 'MAYBE'.

Many of the students wrote that they would like more interactive activities and less being talked at. They were asked to rate each workshop they attended on a scale from 1 to 4 for, separately, both interest and enjoyment, where 1 = not very interesting/not very enjoyable and 4 = very interesting and very enjoyable. Most of the responses rated workshops highly with a majority of 3s and 4s. The networking session was also mostly rated as 3 or 4.

Figure 3: 'Anarchy: the Science of Arches' workshop.

Some of the students wished they could have attended all the workshops and one suggested *"more time to go round and see more people with different jobs".*

Students were also asked to suggest improvements to the event and the overwhelming response was to have more practical hands-on activities.

Physicist evaluation: One of the network participants summarised the event:

"The STEM event went very well from my perspective. All the groups I had responded positively and it was very satisfying to see some of the children change their views on studying science. They probably had as much interest in my RAF flying as they did my current medical physics job, but it was nice to show that you are not limited with a physics degree! As usual most of the children had not heard of a medical physicist before and they were quite surprised when I went on to talk about the many different roles we have in the hospital. Rather than just talk it was nice to get feedback from the Year 9 kids. Most of them had no idea what they wanted to do and felt physics was quite difficult and a bit geeky! Maybe we will never lose that image but encouraging children into science could still be improved."

Future Development and Sustainability

The positive response from students, teachers and the workshop leaders encourages us to look for further funding to repeat this event during the next school year. The format seemed to work well in the time constraints of a school day and allowing for travel time. Many of the physicists involved volunteered their time and expertise and the event could not have run without their invaluable help, but it would be good to be able to also provide more interactive workshops from experienced science presenters, and this does have cost implications. Next year the University will be able to offer a workshop in their observatory and involve more members of their Physics Outreach group.

There was a lot of interest from schools unable to take part this year, and it would be useful to increase the numbers attending. The original intention was to aim the event at Year 10 students, but many of them were still involved in exams or out on work experience placements, so we included several groups of Year 9 students. Although some of the work was challenging for them many of them appreciated being stretched.

In summary, we plan to run the event again but to take more time to plan, contacting both schools and potential workshop leaders at least six months ahead of the event. We also plan to ensure that we include more practical hands-on workshops that are accessible to mixed-ability groups. It is useful to try and timetable workshops physically close to each other so time is not lost moving around the campus, but this is not always possible. The keynote addresses were a good starting point, but were curtailed as schools were held up in traffic and missed this vital introduction; so we might timetable these slightly later, but would mostly keep the same format for each day.

Key points for future sustainability:

- Funding for administration and coordination and workshop costs, after discussion with potential partners including The Ogden Trust, Institute of Physics and Institute of Physics and Engineering in Medicine.
- Six months minimum planning time, including booking schools and speakers.
- Promote the event to new contacts, STEM Ambassadors and others to provide networking session for participants.
- Research new workshop ideas.
- Encourage the Physics Outreach Group to develop new workshops, providing them with training and perhaps in-school pilot scheme with a small group of students to test their ideas.

References

[1] http://www.york.ac.uk/physics/

[2] http://www.nybep.org.uk/

Examples of the Transfer & Embedding of Activities from the Royal Academy of Engineering's 'London Engineering Project'

Gender Awareness Training

Lynn Moran, Department of Physics, University of Liverpool

Abstract

The *Gender Awareness Training* workshop from UKRC was run for postdoctoral researchers and staff across all departments of the Faculty of Science and Engineering at the University. The attendees were a mixture of Admissions Officers and outreach organisers and deliverers with representatives from other universities present which led to lively discussion. In particular, for those new to outreach, there was the discovery that many school pupils, particularly widening participation cohorts, may have a completely different concept of science and engineering in terms of its importance and relevance than the staff themselves. Since this event, the Department has run a Women in Physics event for AS-level students (July 2011), and its success has led to the development of Young Women in Physics (Feb 2012), WiP 2012 (June 2012) and involvement in all-girls science events in schools.

Background and Rationale

The under-representation of girls in the physical sciences and engineering is a topic of concern high on our list of priorities. The Physics Outreach Group has run events for a few years, but find difficulties attracting participation (on or off campus) from all-girls' schools particularly difficult. Combined with this, the high-ability classes, with whom the schools usually select for us to interact, tend to be male-dominated approximately 70-30%. It is difficult to assess our success in interesting girls in science, in particular physics, with such a small sample.

We had encouraged a group of undergraduate and postgraduate female students to plan some events to address this with staff support. They had applied (successfully) to the Ogden Trust for funding to run a 1-day all-girls' event for A-level students in June 2011 as this is a model run successfully in Germany. However there was no experienced support to help develop the events, and in particular to successfully market it to all-girls' schools. If running girls-only events is appropriate, we would then be in a position to develop all-girl inter-disciplinary events across the STEM subjects.

Most importantly, we would like to build elements, which encourage girls into STEM subjects, into all of our events.

Implementation

The *Gender Awareness Training* presenters from the UKRC were booked for the 26 May in order to suit as many potential participants as possible. The workshop was advertised throughout the North-West, with attendees from the Schools of Physical Science, Engineering, Environmental Sciences, and the Science Communication Unit, including 2 University of Liverpool admissions officers. The admissions officer from the University of Lancaster also attended. Where no contact was known, the Heads of Departments, Schools and Faculty were contacted via email, who kindly forwarded the details to the relevant person, or nominated an attendee. The event was run in the Physics Department of the University of Liverpool.

Evaluation

UKRC requested that attendees complete an evaluation form from which the feedback was unanimously positive. More specifically, in response to open questions, attendees commented on:

- *"Hearing overlapping ideas/alternative perspectives of issues from different people."*
- *"Documentation about laws etc. will be handy when I get to read it."*
- *"Discussion sessions. At the moment, the items that were most applicable to undergraduate admissions were most useful. However, the other stuff will probably prove to be useful the future."*
- *"Discussing barriers to women in STEM was very useful. Some items are things I'd heard before – but it's really useful to discuss them in a focussed and evidence-based way. I feel better informed and more aware."*
- *"Understanding what causes women to have confidence issues about studying physics."*
- *"Getting (hearing and discussing) practical ideas of what can be done."*
- *"Learning to distinguish gender from role bias."*
- *"It was very useful and I learned a lot. The best bit was the discussions and how much you learn from the others."*

Discussion, Learning and Impact

It is clear from the evaluation responses that all attendees found the day beneficial for varying reasons. Those attending each had a particular focus which enabled the trainers to lead discussions on specific topics, giving specific examples and pieces of evidence and to develop deep level of discussion in some areas. Due to the small size of the group, there were opportunities to hear responses to questions from other people with a different perspective (outreach, admissions, student supervision), which was enlightening.

The key lessons were why female students can have confidence issues and through discussion how similar effects can be seen in students (both male and female) from non-traditional backgrounds (both socio-economic and ethnicity).

The main goal of obtaining this training for Liverpool was the development of the Women in Physics event, specifically for female, Year 12 students in July 2011. The event was designed based upon the information from the training day, incorporating previously unthought-of elements such as the promotion of female staff and students at Liverpool as role models by integrating personal histories of their academic studies and successes into their short research talks. A bespoke questionnaire showed clearly that the girls felt that participation in the event had improved their confidence and *'made me realise how much physics I actually know.'* Due to the success of this event the Physics Outreach Group (POG) was approached to run a similar event for Year 11 girls to encourage the uptake of physics at A-level, which was adapted and run in February 2012. The Women in Physics event will run again, with small improvements in June 2012 and is already fully booked. Finally, the POG has been approached to participate in new all-girl science events which have been launched this year.

If this event was run again, it would be beneficial to find a time of year which maximizes the possible number of attendees and I would focus on teaching staff this time as I believe the revelations experienced by those who attended would be even more extreme for the male-dominated environment in the School of Physical Sciences.

Further Development and Sustainability

Running this event has established a legacy. At a simple level we have more HE staff across several Schools and Institutes in Liverpool who are better prepared to integrate good practice in encouraging girls, (and potentially those from a non-traditional background) into science both in terms of admissions and outreach. Many of these practices will actually improve events in general.

Perhaps most importantly, as many of the attendees were currently lecturing staff in the physical sciences at universities they may integrate such good practice into their lecturing and teaching (this was discussed by attendees as their aim). At the very least awareness of problems potentially faced has significantly increased.

Gender Awareness Training

Caroline Lambert, Faculty of Engineering and Computing, Coventry University

Kusky Makota, Faculty of Engineering and Computing, Coventry University

Engagement and Target Audience

The initial target audience included female members of staff within the whole of the Faculty of Engineering and Computing (EC) and female student advocates. Through further thought and development of the invite list, this was expanded.

The roles of the 10 delegates who attended are listed below:

- Project Co-ordinator and Associate Head of the Department of Aerospace, Electronic and Electrical Engineering (AEE).
- 2 undergraduate programme managers (Electrical courses and Aviation Management).
- Senior Lecturer (Aerospace).
- Lecturer (Aerospace).
- Teaching Assistant (Aerospace).
- Research Assistant (Disparity in Student Attainment project).
- 2 student advocates (Final year Aerospace and a postgraduate in Engineering Management).
- Part time final year student (Aerospace).

Background and Rationale

Between 2004 and 2007 EC received over £20,000 of funding from the UKRC to establish a mentor scheme and online support network for our female undergraduates. Many factors meant that further development from the Faculty was minimal after the final report was submitted to the UKRC and the funding ceased. However, there were a number of members of staff and industrial partners interested in this issue that would have been very keen to see it develop further.

Hosting this event was designed to reignite that enthusiasm and interest from colleagues and bring the gender issue back to being an important area of concern for us as a Faculty, especially in the new context of working towards joining the Athena Swan charter. As with many workplaces nowadays, it is widely presumed that the gender gap and inequality is no longer apparent. The framework that was set up in 2007 needed support and development from interested and committed staff and students alike. It was believed that by raising awareness again through this workshop, EC could finally expand upon some really good ground work undertaken before.

Implementation

A suitable location, time and list of delegates were all identified: Coventry University Technology Park is specifically designed for outward facing conference style events and was booked once a suitable time had been established. This provided the relevant physical spaces, IT and AV support and refreshments. The mutually agreeable time was determined using a number of factors. As the delegate list consisted of members of staff and student advocates the day-long event needed to happen outside of term time (to minimise the disruption on staff timetables) but near to the end or start of a term (to maximise the ability for the students to participate).

The identification of the delegates was a really interesting learning curve. The initial assumption was that this would be most suited to female colleagues and student ambassadors within EC. Although over 40 people were identified, with 3 weeks to go only had 5 confirmed (maximum was 15). In discussion with the UKRC and the internal Strategic Partnership Unit, the invite was extended to external contacts, for example, business contacts that would have a workplace view on the issues, the other Faculties and Schools within the University working on similar projects such as diversity and student disparity, and male colleagues. To be able to educate the workplace in gender and diversity issues you need to reach the whole community you work in, not just the minority concerned. Without that, you are in danger of perpetuating the problem.

Evaluation

As this event was delivered and facilitated by the UKRC, their evaluation approach was adopted. All delegates were asked about their expectations and concerns about the course at the beginning of the day and these were revisited at the end of the training. This was a very good tool to use for a quick feedback session for the delegates and trainers alike. It gave the delegates confidence that

their concerns were taken seriously and gave the trainers an insight into the direction the workshop should go for this particular group of people. Additionally at the end, each delegate was asked what they will do with what they had learned i.e., what their action plan was.

All delegates were then asked to complete a paper questionnaire at the end of the day and return it to the trainers. The results of this were then transcribed into an electronic document and sent back to the Project Coordinator for further analysis. Nine out of the ten delegates provided this information.

Discussion, Learning and Impact

At the start of the programme the delegates were asked what their expectations and concerns were in regards to workshop. Highlighted responses were as follows:

Expectations:

- *"Having disparate people share ideas/thoughts."*
- *"Finding out about other experiences and ideas to help resolve issues in the future."*
- *"Find out about barriers/issues and how to overcome them."*
- *"Learn techniques to use in the workplace."*
- *"Look at how the agenda has progressed over the years."*
- *"How to address concerns."*
- *"Opportunity to discuss it/think."*

Concerns

- *"Barrier of 'women's rights' can put people off – balance."*
- *"Not just another Equality & Diversity course…."*
- *"Not get practical ideas for change."*
- *"Low numbers of females on courses."*
- *"Applying this!"*

It was noted by the external facilitators how fantastic it was to have such a disparate group of people. This resulted in some extremely thoughtful discussion and helped to inform and educate all of the delegates on the issues and concerns that are still present regarding gender disparity. A bullet pointed summary of the discussions that were undertaken is available along with a student delegate's personal viewpoint [1]. This helps to show that the main outcome of the workshop was awareness – not trying to stereotype or 'pigeon-hole', but a general understanding that different people respond in different ways to different communication and to recruit effectively from all minority backgrounds, this is something a higher education institution must be aware of.

The discussions, gathering of ideas and the opportunity to work with people from diverse backgrounds within the organisation was seen as the most positive aspect. Some had been worried (predominantly the male delegates) that this was going to just be a 'male-bashing' session and were pleasantly surprised. The heightening of awareness and the ability to discuss action plans showed real progress. A follow up session on dealing with gender/female and cultural issues for lecturers working with students was requested, as well as a colleagues and working environment focus.

The main feeling about the overall experience was that it was very good and enjoyable. A lot of useful information was shared and imparted. The notes provided were excellent. Delegates left feeling very positive 'with a big 'to do' list'.

The individual responses as to what the delegates were going to do next, as a result of this session are below. It confirms that the majority of the expectations set out at the beginning of the session were met, that concerns were addressed and that positive action is being undertaken:

- *"Use brilliant resources provided to update my notes on the law in my teaching in relation to discrimination."*
- *"Get some more information about our outreach evaluations to identify impact."*
- *"Get involved as a student advocate to promote female recruitment."*
- *"Formalise our schools activity – ad hoc at the moment."*
- *"Review our course content, open day, and assessment process to ensure inclusive to girls."*
- *"Engaging women in open days."*
- *"Spend more time helping on open days and particularly encourage women to go on work placements/encourage employers to put female staff forward for open days."*
- *"Raise awareness in my day-to-day work to attract/ retain women/particularly look at induction."*
- *"Look at my module statistics/content and see how I can review to include women also in class delivery."*

Further Development and Sustainability

Identification of needs/issues: The University's gender equality events will be based on the most

pressing and existing potential needs and issues that students and staff are likely to face.

Mentors: There is a view to establish a mentoring scheme for staff and students beyond recruitment and extending the pool of mentors throughout the University. It helps to create an environment that encourages a healthy level of social, professional and academic interaction. Furthermore, it assures fair and equitable recognition of all staff, including the recruitment, promotion and advancement, retention, and upward mobility of women at Coventry University through the utilisation of role models.

Development of the Athena Swann Charter: A research project being carried out to examine any gender specific trends, and monitor impact. It is a mark that will show that Coventry University and all of its SET departments have reached a standard of achievement with its gender equality policies.

Targeted Workshops and Open Days: Are being planned to encourage female school pupils to attend a 'taster day' at the University to get them interested in selecting A-levels for engineering careers. The structure of the open days is also under review and there is much more information being shared about the demographics of the applicants attending. Already, since the event, a Facebook page has been set up for all applicants to Aerospace and Electrical courses, where communication on the students' level can take place. Previously, access to applicant details has been held centrally.

Dissemination to other HEIs: The learning curve that Coventry University has embarked on could help inform and develop other HEIs concerned with the same issues. It is intended that a dissemination event is held at Coventry to share our experiences with other local HEIs about what has been learned and what is being implemented to address the gender disparity.

References

[1] http://www.hestem.ac.uk/activity/gender-awareness-training-0

Gender and Diversity Workshop

Geeta Uppal, Marketing and Communications Service, Southampton Solent University

Background and Rationale

Southampton Solent University received support for a one-day interactive training workshop on gender and diversity which was delivered by UKRC in September 2011. The training was aimed at academic, support staff and student ambassadors as part of our continued efforts to develop and deliver outreach materials and activities with local schools and colleges.

The training was intended to help inform key staff about issues surrounding females in STEM subjects. With this training the delegates will be in a position to further disseminate their knowledge not only to university colleagues but further afield. Trained individuals will work closely with college and sixth form staff to pass on their learning and help to support gender recruitment into STEM subjects. As a University we were particularly interested in developing some new initiatives to promote key STEM subjects that struggle to recruit female students.

Implementation

An interactive workshop on gender equality issues in STEM subjects, with a focus on raising awareness of gender-based attitudes and knowledge amongst staff to improve recruitment, progression and retention of women, was delivered by UKRC on the 21 September 2011. Its main emphasis was to highlight, and work through, issues around the lack of female students progressing onto technology based subjects and to find practical ways to engage the main stakeholders to address this issue of gender imbalance.

Deans and Heads of School at Southampton Solent were approached in the first instance to identify appropriate academic staff from engineering, science, and sports science disciplines for this training. This approach was taken to ensure senior management support for the project. In total ten members of staff including academic and support staff attended the training workshop. The academic staff came from Engineering/Engineering Science and Maritime & Coastal Studies. The academic staff who attended were at a fairly senior level consisting of academic leaders for external development and operations, and senior lecturing staff. The support staff were from the University's student recruitment, educational liaison, and widening participation and outreach teams, and are collectively known as the Solent Partnerships Team. The Team works externally and internally to deliver recruitment and widening participation activities with schools, colleges and the wider community.

Since the training, we have seen an increased number of activities in the Maritime and Technology faculty as well our Sports Science faculty. The main aim has been to encourage the academic staff to take ownership and deliver a combination of aspirational and curriculum led activities in partnership with the Solent Partnerships Team to school pupils and prospective college students with the aim of increasing participation amongst female students; some of these activities have targeted a female only cohort. Below are some of the examples of the various activities that have taken place since the training workshop.

Enterprise Systems Academic Exchange (January 2012): This event was held at the University for academics from computing, ICT and business IT related disciplines as well as careers and advisory staff, who were invited to meet and network with their peers from FE institutions and Southampton Solent University lecturers to make meaningful contacts for the future. Discussions during the Exchange focused upon supporting student progression, sharing common practice and ultimately how Solent can help better support local college students (for example in relation to specific skills, taster sessions, masterclasses, and portfolio development). Proposals for follow up include further Exchange meetings, electronic networking, as well as the provision of other CPD opportunities.

Live Radio Broadcast Project with Outside Broadcast Unit (January/February 2012): As part of our outreach and recruitment activities the Solent Partnerships Team, in conjunction with the Outside Broadcast Unit of the Technology faculty, developed a live radio link project to air a discussion programme with college students and staff. The project was undertaken in partnership with a local Community Radio Station *Unity 101* with whom the university has a robust long-standing working relationship. The project aim was to provide prospective students with an insight into university life and the benefits of higher education study through a range of discussion themes during 'Community Hour'. Community Hour is a discussion programme aired between 15:00 and 16:00 Monday to Friday.

The project provided a physical presence at pre-identified colleges to raise the University's profile and also to offer a multi-facetted dimension to recruitment activities in technology related subjects. We aimed to promote our courses and provide our students with the necessary work experience by:

- Providing mini-tasters/talks using the outside broadcasting truck to promote subject related courses that aligned with the Community Hour discussion.
- Providing relevant work experience for current students on the Outside Broadcast course by linking this with their curriculum and thereby using it as part of their assessed work.

British Computer Society (BCS) Women Hampshire Schools Symposium – Girls into IT Conference (March 2012): In partnership with the BCS Women's IT group the University hosted this Girls into IT conference for female students from local colleges. The purpose of this activity was to help address the woefully small percentage of women who are in the IT profession. We believed that by showing girls and young women the jobs that are available, and enabling them to have conversations with women working in IT, we can encourage more young women into IT. Students were mainly from Year 12 within local colleges. The programme consisted of short presentations from IT professionals and a carousel activity. The carousel activity involved a host, a woman working in IT, who gave a short overview of her career and then invited questions from the participants with a view to stimulating discussion.

Computer games development and web design taster days (May 2012): As a follow up from the links made through the Enterprise Academic Exchange in January 2012, two taster workshops in computer games development and web design were hosted by Maritime and Technology faculty academics for Year 12 students studying BTEC Nationals from a regional college. As a result of this liaison, the college has requested to work more closely with the University in offering their students on the BTEC National Computing course, a more cohesive structured pathway to university.

Engineering and maritime careers Day (May 2012): The University hosted an engineering and maritime careers day for Year 12 students studying a range of engineering and maritime BTEC National courses at various local and regional colleges. The students participated in a number of subject tasters from Electronics, Yacht and Power Craft Design, Mechanical and Manufacturing which reflects the University's course portfolio. As part of this event, engineering graduates from local and national employers were invited to talk about 'life and work after university'. This focus on employability provided students with a clear insight into career opportunities after graduation.

Evaluation

The purpose of the Gender and Diversity training workshop was to gain a better insight into the issues affecting the progression of females into STEM subjects. The training helped staff to reflect on our current practices and activities, to identify barriers, and find working solutions to increase participation and progression of females into STEM subjects. An action plan was developed by members of academic and support staff following the training with specific goals identified for the future.

The action plan includes, amongst other items: reviewing the images used throughout the faculty on the online portal; developing taster days, including a day with an all female focus; enhancing STEM Ambassador recruitment amongst female students; exploring the implementation of Athena Swan Charter; and, organising a conference for teachers and employers to promote gender equality and enable networking. Many of these have now been implemented and continue to be developed further.

Solar Car Challenge

Graham Sparey-Taylor, Centre for Solar Energy Research, Glyndŵr University

Engagement and Target Audience

The Glyndŵr *Solar Car Challenge* race day saw 82 pupils representing 6 different schools going head-to-head on a number of STEM related tasks allowing them to demonstrate the knowledge they had gained over a number of weeks. These tasks included presentations regarding technical aspects of the work together with aesthetics and design with further challenges in entrepreneurial skills and racing the school built solar cars.

Whilst 82 high school pupils took part on the final race day the impact on stakeholder numbers is much greater. The delivery team started each school engagement programme with an overview of the surrounding and connecting technologies concerning 'renewable energies' and 'sustainable transport'. These first presentations ranged from 30minutes to 2hours, with pupil numbers as high as 179 (a whole year group in a Welsh media school). Further, it is known from feedback that most schools encouraged their solar car teams to present to peers, year groups and school assemblies. Quantifiable data as to the wider reaching audience numbers is unavailable, however the school pupil numbers are given in Table 1. It seems fair to note that mums, dads and grandparents became award of their children's activities; this became apparent by the number of adults attending the Welsh Eisteddfod in Wrexham this year who visited the Gwawr solar car stand to see their children's work first hand.

Table 1 is used to provide an indication of the wider context that this solar challenge had impact on in terms of stakeholder. It is understood there are some 70 high schools across North Wales:

With a thematic approach considering renewable energy and sustainable transport, each school was led through a 12 week/hour programme taking into account topographical subject matters as: Solar cell technology, gearing and power transfer, renewable energy, aerodynamics and transport of the future.

Each of the subject sets was delivered as a one hour section, so allowing time for the pupils to implement ideas gleaned from these sections to design their own car and structure race day presentations. Primarily the university student ambassadors were Beth Hughes, Steve Collins, Ynyr Lloyd, Jack Davies and Georgina Lacey.

School	Area	Pupil Numbers	
Ysgol Alun	Mold	10/24/1731/2	(English Medium)
Ysgol Glan Clwyd	St Asaph	18/179/950/2	(Welsh Medium)
St Joseph's Catholic and Anglican High School	Wrexham	0/15/693/1	(English Medium)
Ysgol Maes Garmon	Mold	15/17/560/2	(Welsh Medium)
Ysgol Morgan Llwyd	Wrexham	12/12/803/3	(Welsh Medium)
Rhosnesni High School	Wrexham	9/16/1051/1	(English Medium)
Rhyl High School	Rhyl	18/18/ 803/1	(English Medium)
Ysgol Darland	Gresford	0/30/612/1	(English Medium)
Ysgol Dinas Bran	Llangollen	0/0/997/ 1	(English Medium)
Total		82/389/8200/14	

Table 1: List of schools involved at some level in the *Solar Car Challenge*, listed by school, area, pupil numbers and delivery language of school. The 'Pupil No indicates the number of pupils ***directly*** involved with the final race day / number of pupils ***attending*** the 12 hr program / number of pupils ***in the school*** / number of staff involved with the delivery team.

Other parties involved included the Techniquest Glyndŵr (TQG) team headed by Scott Owen providing secondary ambassador work and significant support on logistics via the National Science Academy on race day. Andrew Clayton from The Centre for Solar Energy Research provided a hands-on solar cell workshop during the race day, which was balanced with interactive workshops from TQG and the Institution of Engineering and technology (IET). Further support was provided by Sarah-Lou Gaffney from the University's widening participation team and an interactive prize was given by Professor Richard Day which invited 2 of the teachers from each school to attend a flight simulator day at the

University. The judging panel incorporated the chairs of both North Wales chapters of the Institute of Mechanical Engineers (IMechE) and IET, along with members of the CREST HE Guild and the National HE STEM Programme. Furthermore prizes were awarded by the Mayor of Wrexham Ian Roberts and Professor Stuart Irvine.

During the programme of delivery the Members of Parliament and the Assembly Ministers for each of the wards visited the schools, allowing the pupils to discuss and ask deep and probing questions of the dignitaries.

This program of activity was aimed at Year 8 pupils aged 13 to 14 of mixed abilities. To ensure the team met this target adverts were placed in local papers and on websites across North Wales. Information letters and emails were also sent directly to a number of Head Teachers. It was initially hoped that we might attract school right across from Wrexham to Anglesey, however, it became apparent that the logistics of moving the pupils on the final day made it impractical for schools that far afield to attend. Nevertheless the team attracted interest from 10 schools across four counties and engaged fully with 8. The eight came down to practicalities on timetabling for the schools. Further due to the bilingual nature within Wales, it was of great importance to us that we had a balance in English and Welsh medium schools. Due to the numbers expressing interest the balance fell by natural order.

Background and Rationale

The Centre for Solar Energy Research, Hybrid Electric Vehicle Laboratory, Glyndŵr University hosts Gwawr, the award winning Welsh solar car. As a group we see a fundamental need for sustainability in generations to come and therefore already participate in a large number of events demonstrating solar vehicle technology to the general public. The group has a particular interest in running the *Solar Car Challenge* aimed at high school aged participants, as such an event would clearly impact on the engineers and scientists of the future.

The experience would expose the participants to a host of technologies and practices in one package: renewable energy generation, sustainable transport, automotive technology, civil engineering, project management and teamwork. But possibly more importantly, would provide hands-on experience to the pupils. We have already produced NOS[Gwawrll] our ½ scale educational solar car. This car is capable of being driven by the youngest member of our team, aged 9, although older team members have been known to have a go too. The car has led to a new dynamic leading to wider discussions during public and schools engagements. It is envisaged that the 'wow factor' will only be increased when school pupils can produce their own solar cars.

Implementation

A delivery team of ambassadors were sought from within the STEM subjects at Glyndŵr University. In the main ambassadors who came forward were already members of the University Gwawr Solar Car Team. It was felt that the cost involved in sending the student ambassadors to London for a half hour training session was unreasonably inhibitive so training was provided in house. Ambassadors were assigned to particular schools, matching necessary skills, so for example the ambassadors with a good grasp of the Welsh language were assigned to the Welsh speaking schools. One of the ambassadors had previously attended one of the target schools, so she became their ambassador, providing a good role model to the current pupils. Ambassadors were encouraged to interact thereby enabling the cross-sharing of ideas between the schools.

Whilst the general programme had been described as suitable for 8 school teams each consisting of 6 to 8 pupils, the delivery team decided that more pupils from within school year groups (consisting of up to 200 pupils) would be able to participate if they desired, as with the additional activities described below, it was agreed there would be ample work to occupy between 15-20 pupils.

Meetings with the pupils at the schools took place during the school days and in the main were assisted by a teacher. The initial presentation was delivered by Graham Sparey-Taylor as the team member with the greatest background in the solar car field. Often, these initial presentations were to the whole of the Year 8, with pupils then able to make the decision if they were interested in the project. It was hoped that the diverse nature of the presentations pupils were asked to prepare for the final race day would attract those who would consider themselves non-technical along with perhaps more STEM minded pupils. Graham Sparey-Taylor was generally assisted in these meetings by one or two of the student ambassadors. Over the next few weeks PowerPoint presentations on general background information were made to the pupils by the student ambassadors covering solar cell technology, gearing and power transfer, renewable energy, aerodynamics and transport of the future. These presentations were delivered in Welsh and English.

The school teams were split into groups, each consisting of about 4 pupils, with each considering a different aspect of the car – aerodynamics, power and drive, solar array and steering. Each group fed data to a co-ordination team who collated all the information whilst sourcing and researching the background information to bring it all together. Pupils were able to build their cars through the week (without ambassador presence) as well as at the arranged meetings with the ambassadors, building upon the knowledge gained through the presentations.

When the solar car kits arrived the general consensus of the delivery team were that they were very basic, and not sufficient of a suitable challenge for Year 8 pupils to build. It was considered that a single pupil would be able to build the car in just a few hours. The cars were designed to just be able to move forward in a straight line, with a simple on/off switch to make them move. To add more challenge to the product it was decided to make the cars radio controlled along with the addition of a steering mechanism. To this end the team purchased a number of radio controlled model Subaru Impreza cars at a price of £7 each to become parts donors. The Subaru was chosen as the donor model as the car is generally considered to be a high performance petrol car used in World Rally championships, but due to petrol supplies due to run out in the future it provided a good talking point. The modification to the original cars was an easy transplant and allowed the pupils to design suspension and steering systems.

On the race day pupils and teachers were coached in from each of the 6 schools who had completed their cars, to the main site of Glyndŵr University in Wrexham. This meant for some a 45 mile journey. Transport was laid on by the National Science Academy, organised by TQG. Pupils were given a brief welcome with 'rules for the day' before Helen James, Pro Vice Chancellor, introduced Glyndŵr University. The schools were then split into 3 sets. Each set rotated through the three sections – presentations, hands on workshops and race car scrutineering.

Throughout the 12 week 'build time' the pupils had been invited to work on 3 presentations broadly covering entrepreneurial skills, product design and technical information. The five minute entrepreneurial presentation was based on the BBC Dragon's Den style theme, with pupils attempting to gain financial backing for their company who wanted to upscale production to 5,000 full size cars of solar cars sale per year. The rationale behind this presentation was that pupils would understand that STEM activities have a very big impact in business, along with having fun working out how they would run their own company. In the technical talk pupils were asked to present the technical information about their own car and aspects of sustainable technology. They were asked to overview and focus upon the individual sections of the car that each sub-group had worked upon. Presentations were made using PowerPoint to a judging panel, and also in front of one other school and could be in their choice of English or Welsh medium. The product design presentations were judged throughout the day with judges circulating through the teams looking for each team's 'wow factor' in their car design or innovative flair of product design.

Pupils shared a collective picnic lunch, after which all the packaging and waste was collected to help form the obstacle race circuit. As the cars had been modified to be radio controlled and steerable the cars were more dynamic than the original solar cars so teams could do more than just a straight sprint race. Along with a sprint race an obstacle course was also constructed to test the cars stability and the drivers' control. This course included the 'Garbage Run' where pupils had to navigate their car through the waste collected after their lunch, Temperature Rise (a seesaw bridge) and Climate Change Corner (a banked corner). Navigating this course, along with the sprint races, added to the discussions that had been held through the previous weeks and so proving to dispelling the myth that electric cars involve dull, slow, boring technology.

Each pupil received a Gwawr Certificate of Participation, with 4 main prizes also being awarded at team level for each of the 3 presentations and the overall race winner. Each of these awards comprised of a Total Solar Certificate and a trophy. The certificates were provided by Glyndŵr University, with the trophies, Figure 1, provided by Web Whales and Gwawr, two companies which were associated with the original solar car Gwawr.

Figure 1: The Mayor of Wrexham Councillor Ian Roberts, Dr. Helen James Pro-VC, Professor Stuart Irvin, The Mayoress Mrs Hillary Roberts standing over the school solar cars and trophies. Right to left

Evaluation

Engagement: The project outline suggested that eight teams of 6-8 pupils should be covered by this programme. Through the presentations made to the schools, 311 pupils had some form of direct interaction with the delivery team; with 89 completing the full 12 week/hour build to race day experience. Further, it is understood that most school teams presented to their

peer/year groups or whole school thereby increasing indirect engagement to several thousand pupils. Had the full 8 schools finished the entire process and come to race day a total of 136 pupils would have had the full experience. The team felt that only presenting the activity to the suggested 64 pupils had insufficient merit for the time input. On balance we consider that 15-20 pupils per team a good number, especially considering the alterations made to the original car and the presentations required on the race day. With some indirect contact of 8,200 pupils plus friends and family, together with highlighting such activities to local MPs, Assembly Members and councillors engagement stepped far outside of working with Year 8 pupils in STEM activities.

To enhance the pupils thinking and learning the team put on a final race day which included a series of events designed to test the pupils understanding and engagement in the process and allow latitude to less STEM type ideas. The four main events included a sprint race and obstacle race, presentation of product design, a technical talk and an entrepreneurial pitch. In terms of STEM directly, the race and tech-talk held main focus whereas the entrepreneurial pitch and product design was used to amplify how STEM subjects cross into other areas such as the world of business. A panel of judges was invited from industrial societies and STEM groups. These judges were asked to gauge the pupils understanding of what they had learnt. The feedback from the judges was that in the main the standard was high although some schools had spent more time than others and also that it was good to see schools could present in their first language. The delivery team was surprised at the volume of paperwork the school teams produced.

The student ambassadors feel it of great benefit to bolster and underpin their own thinking and knowledge so that they can learn new skills. When asked if they would do it again one reply was *"when do we start?"*

Whilst the numbers engaged was higher than suggested for the activity the team agree it was not more work having larger numbers in each team and allowed for small focus groups within each team. This actually made delivery easier as tasks could be set to a group. It was found to be easier to maintain a small number of pupils on a task rather than 8 on one central idea.

The team did provide feedback forms for the pupils to fill in on route home which were meant to be posted back by the schools. However in the main most pupils did not return a form. Where they did respond there were some strong comments both positive and negative.

Discussion, Learning and Impact

Whilst it was disappointing that not all of the schools who started building the solar cars were able to participate in the final race day due to time constraints of other extra-curricular activities, for the schools which did finish, the pupils were able to achieve the intended outcomes. The teams each had a workable solar car, enhanced from the original designs, and were able to present their work in an informative manner, showing that they understood some of the STEM technologies behind the cars.

Directly targeting schools to participate in the activity led to a good mix of English and Welsh speaking schools. Presenting the activities to an entire Year 8 cohort leaving them to choose whether they wanted to join the team led to a good mix of abilities on each of the teams. The addition of the entrepreneurial and product design presentations increased the dynamics of the groups as they also involved pupils who would have considered themselves to be non-technical affording them a stepping stone into STEM subjects.

A number of key lessons were learned from the work:

- Make sure there is a good infrastructure to run such a project.
- There needs to be a strong champion of such cross-platform ideas.
- An academic is generally not in the position to orchestrate the schools' interface for such a project.
- Ensure that the product/kit arrives in good time prior to needing to use them in the schools, as there was a long delay time in the arrival of the kits after ordering them, which lead to at least one school pulling out.

By using the model solar car and relating it to the full size car, it provided significant impact on tangible reality for the pupils balancing real with imaginary, STEM subjects with life. For instance, one of the main comments we hear as a team are that solar cars are fine in hot countries like Australia, India or Africa, but not much use here in Wales. By conducting simple experiments with solar panels it was easy to demonstrate that light, no matter how little, can produce some energy.

In future we will use a kit based on one of our own designs, thereby giving a more visual impact to the large-scale vehicles that we already use. These kits could be produced for a cheaper price than the supplied kits, and have more functionality. We would advise others to consider the target audience and ask if the kit is appropriate to their age level. Be ambitious and have the confidence to be so. If you do not believe that it can be achieved the target audience will pick up on that. Give your target audience more credit than the norm.

Accessing the schools as an academic in the first case proved a challenge; we found the use of advertising via the media limiting. This was overcome by more direct contact means and use of the TQG and widening participation network at the university. We found that the schools generally did not want an hour a week, but preferred to work in longer blocks, for example one school we visited every day for a week, whilst another we fitted into their science timetable. Due to the constraints of the grant and the timetabling of the pupils, together with the timetabling of the university students and mapping around lectures and exams, it became difficult in times to ensure cover was completely provided by ambassadors; to get around this TQG staff and Graham Sparey-Taylor were utilised when necessary.

Further Development and Sustainability

Sustainability of this delivery programme has a high personnel cost. This is the predominantly prohibiting factor. To sustain a programme of this scale, funding needs to be sought via the Widening Access Groups and outreach programmes, although following the success of this past year funding has in part been potentially offered via the industrial societies. The new kits have in part been designed but need some refining, and it is hoped that in this next year it will attract 10 schools.

Solar Car Challenge

Helen Ward, Department of Postgraduate Initial Teacher Education, Canterbury Christ Church University

Engagement and Target Audience

Institutions involved:

- Canterbury Christ Church University
- Kent and Medway STEM
- University of Kent - School of Engineering & Digital Arts

Duration of activity: April 2011 to July 2011

Target age group: Secondary - Key Stage 3

Maximum number of pupils: 60

Canterbury Christ Church University, who hold the contract for Kent and Medway STEM, and the University of Kent, School of Engineering and Digital Arts, have collaborated on this activity as part of the National HE STEM Programme. *The Solar Car Challenge* is set up to engage local schools to take part, with support from university student ambassadors.

The challenge was run as a 12-week project for school teams in Years 8 and 9. It was run during the spring and summer term. Initially 10 schools from Kent and Medway Region attended the twilight session. Each school team is provided with a solar car construction kit plus instruction/guidance sheets for teachers, pupils and ambassadors. The Royal Academy of Engineering provided top-up training for student ambassadors who acted as mentors for this event. The student ambassadors visited their teams weekly or fortnightly to guide them, supported the pupils to complete their activities. They also encouraged teachers and pupils to enter their project work as a club to show at their local Big Bang Regional Fair and encourage them to gain CREST Award accreditation.

The challenge culminated with a competition finale, hosted at the University of Kent – School of Engineering and Digital Arts, which involved the pupils and their parents.

Background and Rationale

This activity was developed to engage and inspire pupils in Kent and Medway schools to consider future careers in engineering and raise awareness of what engineering design actually involves. We also wanted to get the school pupils to work with engineering undergraduates, of different, backgrounds, ethnicities, and genders to overcome the 'engineer' stereotype. It was actively inclusive by setting challenges which would hopefully appeal to both male and female students. A secondary benefit was to develop the experience and skills of student ambassadors by actively involving them with schools in the local community.

Implementation

Teachers and ambassadors were invited to attend a twilight session which included top up training run by Royal Academy of Engineering. This helped to build confidence of the ambassadors to work with schools, talk about engineering and to do so in a positive light. We aimed to help break down stereotypes so that everyone regardless of gender or ethnicity could view engineering in a positive light.

The top up training is designed for participants to:

- Have increased confidence.
- Understand the support resources available.
- Have some practical ideas for activities (tried and tested).
- Be able to effectively engage pupils from all backgrounds .
- Be clear on the engineering 'message' and how it links to the wider STEM community.
- Have information on how to talk about engineering and your own career.
- Be involved in the development of an engineering activity.

The challenges were set for Key Stage 3 students (age 11-14 years). The schools were requested to enter one or more teams to design a Solar Car to a specified brief. The challenge was undertaken in a school on a weekly basis for 12 weeks with STEM student ambassadors from the University of Kent, School of Engineering and Digital Arts assisting the team during design/build stages of the activity and testing their prototypes with guidance from the STEM ambassadors during the lesson time or as a lunch time or after school activity. All schools were provided with at least 1 Solar Car Kit, but as the challenge progressed

several schools were provided with extra kits as they formed additional teams to take part in the challenge.

Whilst more than 22 teams took part in the challenge, the final was held at the end of the summer term at the University of Kent. This final event involved 12 teams from 5 schools including a group of children from Kazakhstan who were visiting the Langton Boys School and were delighted to participate in this practical project. All teams displayed the product of their efforts and prizes were awarded to the three designs best meeting the challenge.

Professional engineers judged the cars in three different competitions: speed, performance on an incline, and design innovation, with prizes being awarded to the winners of each category. Gifts and certificates are given to all students who took part (including the student helpers). During the judging process, the students and teachers were given a brief tour of some of the facilities in the engineering faculty.

The final competition was not only a great success but a fun and engaging activity for young engineers of the future with more than 20 heats taking place. The activity helped to expand the pupil's scientific knowledge as well as help them to learn about renewable energy concepts. Each team had customised and adapted their car to make it unique in style and appearance.

The judges looked at the cars, the heat results and assessed each team's abilities to communicate, their teamwork and presentation skills. There were prizes awarded to the winners of each category. The judging team included:

1. Ajay Sharman, STEMNET Regional Director.
2. Kostas Sirlantzis, School of Engineering and digital Arts, Univeristy of Kent.
3. Jenny Young, National HE STEM Programme (Royal Academy of Engineering).
4. Peter Kean, Instro Precision Ltd.

Evaluation

The schools tat took part reported (with 50 students providing feedback at the final event) that it was a very positive experience and particularly appreciated the input made by the University students who also thoroughly enjoyed the experience of undertaking the activities.

The feedback comments from the STEM ambassadors included:

"…happy to be a part to motivate them. See the engineering world from a different point of view, as a game rather than just some equations, maths and so on."

"…since I helped 4 schools, with SLGS as my main school, it helped me gain confidence, understand how students think, communicate and understand engineering as a field."

"I have benefited immensely from my association with the pupils. The way they think, approach challenges and solve problems. It has really been an exciting programme."

The feedback comments of teachers from the participating schools included:

"…provides opportunity to provide engineering examples. Pushes the most able to develop complex problem solving skills."

"…recognition that the competitive element helps motivate pupils. Girls were anxious before they came that their efforts would be insufficient."

"…joining together DT [Design and Technology] department at the school to physics department."

The Feedback comments from students included, for the best thing about the day:

"Involvement with other schools."

"Race of cars was very interesting."

"Learning how to model gravity with 2 objects."

"Race cars in heats."

"Teamwork and being the best and nice free food."

Discussion, Learning and Impact

Despite the close proximity between the two Universities, no previous collaborative activities had been undertaken within STEM Outreach projects. Canterbury Christ Church University are the current STEMNET contractors for Kent and Medway Region and utilised the funding from this project to enhance their current provision through a targeted event - *The Solar Car Challenge*. At this event teams from local school science clubs, supported by the student ambassadors, competed to construct the fastest, most efficient and reliable solar powered miniature car.

As a result of this activity:

- Closer links have been established between participating schools and the Universities.
- The pupils gained engineering design skills and team-working/project skills.
- The University of Kent student ambassadors developed mentoring and communication skills.

- Closer links have been established between participating schools and the Kent and Medway STEM, Canterbury Christ Church University .
- One ambassador has continued their activity and is now engaged with the Big Bang Event in Birmingham, March 2012.
- International relationships have also been fostered through the programme. A group of pupils from Kazakhstan visiting Simon Langton Grammar School For Boys, Kent joined the club and entered into the *Solar Car Challenge*.
- The *Solar Car Challenge* is running for a second time in collaboration between the two universities and a twilight session is booked for the end of April.

Engineering Pick 'n' Mix

Baljinder Rana, Schools and Colleges Liaison Office, Aston University

Engagement and Target Audience

The event was held at Aston University and a number of local schools were invited to bring two teams of five to the University and take part in the interschool competition. In total, 45 students participated in the activity.

There were 2 teams (comprised of 10 students) from Holy Trinity Catholic Media Arts College, 2 teams (10 students) from Hamstead Hall, 3 teams (15 students) from Smiths Wood College and 2 teams (10 students) from Bordesley Green Girls School.

The Outreach Office has a strong record of widening participation, and is experienced in engaging with under-represented groups. The team has developed a relationship with a large network of local schools, including particularly hard to reach schools, through projects such as mentoring, student tutoring, summer schools and enrichment days. All of these are targeted specifically at learners from under-represented groups as part of the University's work in widening participation and diversity.

"This was run very professionally, students engaged and enjoyed the day. It made them think of engineering, some students they would like to pursue their career in this subject." Teacher, Participating School

For the *Engineering Pick 'n' Mix* day the Student Volunteering and Outreach Department worked closely with the school contacts to ensure they were targeting learners that: a) would most likely benefit from participation in such an activity and b) matched the criteria for under-representation in higher education and STEM disciplines. All four schools that were entered into the project are inner city comprehensive schools where there is a large mix of ethnic minority groups and the students are from the traditional Aimhigher backgrounds.

Background and Rationale

The *Engineering Pick 'n' Mix* event took place at Aston University, and was delivered as an interschool competition. Schools were asked to submit teams of five, who would then compete against each other. It was decided to run the event on campus as opposed to within a school as we felt inviting students on to campus gave the event a different dynamic with the opportunity for students to see a university campus, as well as competing against other local schools.

The *Engineering Pick 'n' Mix* event compliments the heritage and history that Aston University holds in regards to excellence in engineering. It was considered that by hosting such an event it would build on the University's reputation for developing strong engineers as well as attracting a diverse group of Year 9 students to consider engineering as a future career option.

Implementation

The *Engineering Pick 'n' Mix* day was re-branded at the University to be called Engineering Enterprise with the event itself taking the form of a full-day interschool competition. Each team was given the same brief to develop/design and then pitch, a new product to a panel of 'dragons'. The product itself could only be made from the items that were on sale within the engineering shop. The winning idea was the one judged to be the most creative, made use of the materials available to the groups and was accompanied by a dynamic and confident pitch.

The day started with a welcome talk and short introduction to engineering; this was undertaken by a member of University staff and was followed by University STEM ambassadors introducing themselves and their interest in engineering.

Each team was assigned a STEM ambassador (Aston University students) to work with them for the whole day. We asked the school students to form their teams and then paired each group up with an Aston University student. Each group was asked to build a chair made solely from balloons and Sellotape, prepare a presentation for their design and be prepared for a member of University staff to test their design in front of the wider group. We found that by introducing this activity it enabled the teams to feel at ease with their ambassadors.

The morning session was followed by a break and then we introduced the main activity of the day (developing/designing and building a product). It was considered important to keep the students motivated and engaged, and so the teams were moved to a different room. In the first part of the session the students were asked to think of ideas, design their product and plan for the materials that would be required. The shop was then 'opened' to allow the groups to begin building their products. By allocating specific time to the design of the product it encouraged students to think carefully about how best to use the materials that were available effectively.

After lunch the students were given 30 minutes to complete their product before developing their presentation. We found that while some students had already thought of their presentation, other groups had given this task little thought and therefore they were able to use this time to think constructively about the selling points of their developed product.

Each team was given 3 minutes to present their product which was then followed by questions asked by the 'dragons' (made up of Industry STEM ambassadors and Aston University staff and students.) Whilst final decisions were made, a short presentation was given by one of the STEM ambassadors addressing the idea of engineering and the different avenues it holds in terms of career prospects.

Every student was given a certificate to thank them for participating in the activity and the winning team was presented with an individual prize and a trophy to take back to their school.

The day itself was run by University staff but facilitated by current Aston University Engineering students. This enabled school students to speak openly and ask questions to their ambassadors about studying a STEM/engineering subject at university. In the future we will continue to follow this format of a team building exercise followed by the main activity, however we will also look to incorporate a full tour of the University's engineering facilities.

Evaluation

When evaluating the event it was felt it would be best to ask the students who took part in the activity about their thoughts and options. Each student was asked to complete a short evaluation form which was collected after the event had finished. The form was simple after a long day at the University; school teachers also completed the form.

Overall, the evaluation showed that many of the students who attended the day enjoyed the activities on offer. However, not all commented on it being a focused engineering day so in the future the activity will be restructured to incorporate a guided tour of the engineering facilities at Aston. By evaluating the event we have been able to see how positively it was received and has confirmed our decision to embed it within the University activity programme offered to schools.

"Great day to offer to local schools. Helpful to give opportunity to pupils to visit a University and take part in a subject focused stimulating activity." Teacher, Participating School

Discussion, Learning and Impact

When taking on an activity like this it is imperative that you have someone in the team that has engineering knowledge. We were lucky that we are part of a University that has a strong heritage in terms of producing engineers. As the activity was part of the outreach work the University undertakes it was important that we worked collaboratively with the School of Engineering and Applied Sciences to access their expertise. The STEM ambassadors facilitated most of the day and received very positive feedback from the school students and teachers. By ensuring students are trained and have a strong understanding of what they are doing helps to ensure the success of such activities.

Although the materials the students used to develop their products were simple, the activities needed the input of an engineer to see how the materials could be used and if any other items needed to be purchased in the future in order to develop the challenge.

"I enjoyed the designing process, encouraging students to question their designs and reconsider and redesign." Student Participant

From the positive feedback received, the activity has definitely had a high impact on the students involved; it was considered that it could have an even greater impact if accompanied by a regulated activity. Aston University students could perhaps work with the school students for a number of weeks in the run up to the main event, and the students then be given the opportunity to explore engineering in depth particularly by exploring possible careers attached to the field.

Further Development and Sustainability

After the success of the day it was decided to embed the Engineering Enterprise day into the programme of activities we offer to schools. To move the activity forward, the on campus competition will be further developed as part of a longer running scheme within the participating schools whereby Aston University students will work with the school teams on a number of different activities in preparation for future activity days.

"I enjoyed presenting our pitch and our product because it gave us a chance to show off our skills." Student Participant

Embedding the Engineering Enterprise day into our programme of events will have a cost implication. We are currently looking at the idea of the STEM ambassadors taking part in the schemes on a voluntary basis therefore cutting the cost of salaries. In the future the department will develop, train and maintain a network of STEM ambassadors who will be able to support activities such as this.

By making this event into a regular activity as opposed to a one off event it means:

1. The school students will gain a wider understanding of engineering.
2. As students may already be working on ideas it may possibly free some time during the day for students to participate in a full tour of our engineering facilities.
3. More 'weight' will be provided to the scheme as students will be engaged in regular activity and will therefore have a greater impact.

Engineering Pick n Mix

Jenny Hann, School of Design, Engineering, Fashion and Technology, University of Wales, Newport

Engagement and Target Audience

This project engaged Year 9 Ysgol Gyfun Cwm Rhymni Comprehensive School pupils in a design technology class. The school is a Welsh medium secondary school and so attracts pupils from Community First areas. Identification of the target school was undertaken by Teresa Perry, First Campus Coordinator, who liaised with the school and accompanied the children throughout the day.

The 21 children arrived at 10:00 and stayed until 14:30. Their form teacher and design technology technician accompanied the class.

Background and Rationale

The University is keen to encourage schools to participate in university activities. The project aligns with First Campus which is an initiative that brings young people into contact with University. The aim of First Campus is to raise awareness, aspirations and motivation to Higher Education from areas of low participation with a particular focus on Communities First areas.

Implementation

The Head of School of Design and Engineering led this project supported by Teresa Perry from First Campus and Adam Martin, programme leader of the BA Hons Interactive Media Programme. Several students from the BA Hons Interactive Media final year and BA Hons Advertising Design programme were engaged to support the project. These students acted as guides and consultants in the production of a business proposal for a new product. The class was split into 5 groups of 4 or 5 and each group had one or two 'helpers'. The class arrived at 09:30 and was led through the building to a room dedicated as a base. The Head of Design and Engineering introduced the proceedings by assigning the groups – each sat at a table with different colour chairs.

A PowerPoint presentation outlined the day's activities. The students first had to give their team a name and then brainstorm ideas around activities associated with the morning in order to come up with a product that would meet a need. A range of materials were supplied. Participants then proceeded with an intensive practical activity day, developing and refining concepts. Final concepts included devices for waking, including a Jaffa cake dispensing alarm clock.

The participants had a morning snack break and a lunch break. In the afternoon each team presented their design and business proposal to each other and the student helpers, their teachers and the project leader. Each team gave a short presentation of their final design proposal outlining its features as well as the costs and the development process. The presentation took place in a fully equipped lecture theatre and the students used the visualizer, PowerPoint presentations, posters and models to illustrate and explain their concepts. Each group presented for 5 minutes and the student helpers judged the winners in each category and identified an overall winner. Categories included most creative concept, best teamwork, best business idea, and best presentation.

Each participant received a certificate and goody bag including a USB memory stick, water bottle and information about the University. The winning team,

comprising 2 girls and 2 boys, were awarded Newport University hoodies. The pupils went away having had a thoroughly enjoyable experience at the University where they had developed new skills and also an insight into design, engineering and business and also had a taste of university life through the visit itself, by working and presenting in a university environment and by taking lunch in the student canteen.

Evaluation

As this was a one off activity, formal evaluation was not collected in the form of feedback forms. General comments were made during the day from pupils and teachers in terms of feeling that the day was worthwhile and successful. The adults that accompanied the pupils felt that this was a good opportunity for pupils to experience education in a different setting from school and allow them to understand what a university is like by spending time on a campus and mixing and having an opportunity to be part of the student experience.

On returning to the school an email was sent by a teacher who was the original contact for the:

"Just a small message to thank you for arranging the day for our students last Thursday. They thoroughly enjoyed themselves and have come back with a new found outlook on engineering.

Once again, Thank you very much and remember us if you have any other events planned for the future."

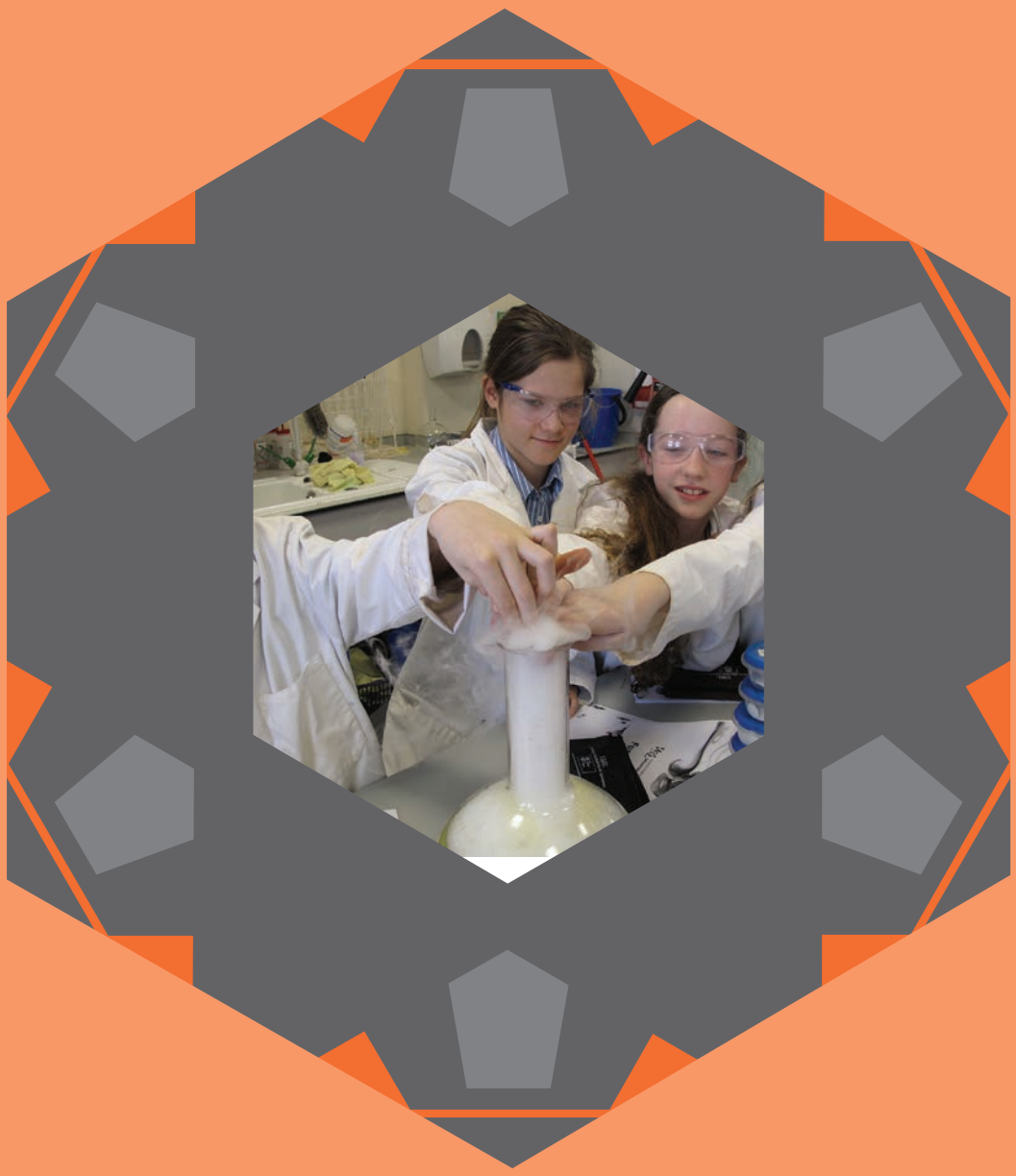
Discussion, Learning and Impact

No formal feedback was obtained from pupils during the day, but this in itself is a lesson that has been learnt from the event. Even if the activity does prove to be a one off activity, gathering information from the group in written format should be incorporated in future activities. This will allow us to plan future approaches, either repeating one off activities or for us to develop links that would allow pupils to take part in follow on activities and access the University again.

It was clear on the day that involving current students provides pupils attending with role models, and they can gather information about being a student much easier from them. The use of current students in activities involving pupils from schools should be something that the University builds in to as many activities has possible. As well as working on a specific subject area during their visit, it gives pupils the opportunity to find out about student life in general, which allows pupils to be better informed about studying in higher education.

A very positive outcome of this event is it has enabled different departments within the University to better understand one another and how they can forge future links to promote the University and meet targets that have been set. Due to the good working relationship that was established during this event, links have now been made to undertake further higher education awareness raising work with other colleagues, with both parties able to use each other's strengths to make the new workshop effective and successful.

Examples of the Transfer & Embedding of Activities from mathematics community led 'More Maths Grads' initiative:



Pop Maths Quiz

Liz Maddock, Outreach and Widening Participation, Keele University

Engagement and Target Audience

Three events were offered to 144 Key Stage 3 and 4 students:

22 March 2011: Norton Canes High School – 51 students (Key Stage 4)

13 May 2011: Ercall Wood Technology College – 45 students (Key Stage 4)

27 May 2011: Southlands High School – 17 students (Key Stage 3)
Clough Hall Technology School – 19 students (Key Stage 3)
John Port School – 12 students (Key Stage 3)

Keele has an active schools and colleges partnership programme, called *Keelelink* [1], coordinated by the Outreach and Widening Participation (WP) Section. Upon joining all partners are ranked for WP status according to a number of criteria, including postcode, NS-SEC (National Statistics Socio-economic Classification), GCSE/A-level scores, and government indices of multiple deprivation. A number of our existing projects are only available to schools and colleges with a high WP ranking. For other activities, schools and colleges with a high ranking are given preferential booking or, if there is a cost, funded 'free' places. This information on our partner schools allowed us to target those with a high WP rating for this activity.

The geographical location of the University consists of a mix of rural and urban areas, with high levels of economic and social deprivation. Using the Indices of Multiple Deprivation (ODPM, 2007), 1 (most deprived) to 149 (least deprived), Stoke-on-Trent is ranked 19. There is also low local progression to higher education. Between 2000 and 2003 only 23% of Staffordshire-resident 18-year olds progressed to higher education. In Staffordshire the increase in UCAS applications over the last three years has been less than half the national average of 11% (at 3%).

This data shows the need for targeted work in the area local to Keele. For each activity run via *Keelelink*, data is collected on every learner taking part which enables us to confirm whether they are classed as belonging to a WP cohort.

Statistics:

22 March 2011:

- Percentage of WP Learners: 88%
- Percentage Male Learners: 50%
- Percentage Female Learners: 50%

13 May 2011:

- Percentage of WP Learners: 68%
- Percentage Male Learners: 55%
- Percentage Female Learners: 45%

27 May 2011:

- Percentage of WP Learners: 72%
- Percentage Male Learners: 53%
- Percentage Female Learners: 47%

Background and Rationale

This activity complemented the existing STEM Mentoring Scheme run by Keele University's Outreach and Widening Participation Section. The undergraduate mentors have a range of subject specialisms, however, many of them are studying for either mathematics or physics degrees. The most popular mentor sessions are the *Stardome* (inflatable planetarium) and *Make it Molecular* (molecule building kits). Previously mentors have also offered regular support to local After School STEM Clubs, tutoring for individual learners, and activities at drop in sessions at local community events.

Prior to gaining support from the National HE STEM Programme, mathematics was not an explicit focus of the mentoring scheme, but Keele is strong in both mathematics and science and we get significant interest in mathematics sessions from schools.

Implementation

Recruitment of schools: At the start of the academic year all *Keelelink* schools were informed of the activities and events on offer through the partnership. Several mathematics campus-based events were included in the offering. Schools were able to sign up for these

events; schools with a high WP score were allocated a higher quantity of free places on the event.

Session delivery: STEM mentors are current students of the university studying a STEM subject as part of their degree programme. STEM mentors are employed on a casual contract and are notified of all work opportunities available to them; they deliver interactive sessions both on Keele campus and in the community. Information about the *Pop Maths Quiz* sessions was emailed to STEM mentors and appropriate mentors were selected to deliver the session. All STEM mentors have completed a full programme of training including child protection training and are CRB checked.

Activity preparation and delivery: *Pop Maths Quiz* questions and answers were provided by Sheffield Hallam University through the National HE STEM Programme. There were two sets of questions provided: one set for Years 7 to 9 and one set for Years 10 and 11.

The questions provided were transferred onto a PowerPoint presentation with a separate slide for each question. STEM mentors were required to read out each question twice and learners were allocated 3 minutes to answer each question. In order to ensure that the 3-minute allocation was adhered to the PowerPoint presentation was set up to change to the next slide after 3 minutes; an alarm sound was also added to the presentation to ring when the slide changed. This alerted learners and STEM mentors that it was time for the next question. A 3-minute break was provided in the middle of the session, any questions which required repeating were done so during this break.

Teams comprised of 2-3 learners, with one answer sheet provided per team. At the end of the quiz all answer sheets were handed in, and while STEM mentors were marking the quizzes, learners were given a campus tour and attended various other mathematics based sessions throughout the day. At the end of the day a presentation was held to award prizes to the winning teams; prizes were given to every member of the winning teams, prizes awarded were as follows:

1st Prize:

- Framed certificate
- Amazon Voucher
- ' *Keelelink* 'branded Star key-ring and bendy pencil

2nd Prize:

- Framed Certificate
- ' *Keelelink*' branded bendy pencil

3rd Prize:

- Framed Certificate

Answers were not provided at the end of the quiz however teachers were given the questions at a later date so that they could work through these with students during their classroom sessions.

Changes required for subsequent sessions: Following the completion of the first event it was clear that the questions provided for the quiz were too difficult with the winning team answering only 30% of questions correctly; this event was a Key Stage 4 event so the Year 10 and 11 question set was utilised. To overcome this problem a new question set was created for later events incorporating a combination of the Year 7 - 9 questions and the Year 10 and 11 questions. This question set proved to be more successful with a greater range of results being achieved.

Evaluation

The aim of the evaluation was to detail:

1. The effectiveness of the WP targeting of the students.
2. The effectiveness of the operational aspects of the events and their impact.

Evaluations were completed by all members participating in the *Pop Maths Quiz* session: Teachers, learners and STEM Mentors, and all evaluations gained feedback on the *Pop Maths Quiz* session.

As part of the learner evaluation information was obtained to ascertain WP eligibility. The information collected was:

- Gender
- Ethnicity
- Date of birth
- Post Code (for social deprivation)
- School or college of attendance
- Who the student lives with
- What their parent/guardians occupations are (male and female) utilising NS-SEC guidance
- Parental higher education experience
- Gifted and talented status

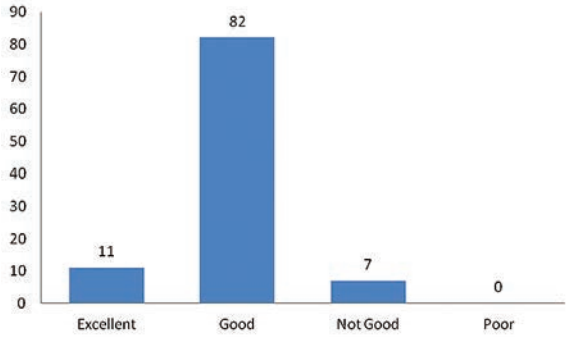
To assess the success of the event from an operational perspective, learners were asked questions on the following areas:

- Plans post school or college
- Prior consideration of university
- Main concerns about higher education
- Whether these main fears been addressed?

- Impact of the event on the likelihood now to attend university
- Session rating
- What was most enjoyed?
- What could be changed?
- Any further information the student would have liked to receive
- Any additional comments

Results:

22 March 2011
Learner feedback:



Comments:

"Very good, helpful and fun, a little hard."

"Awesome."

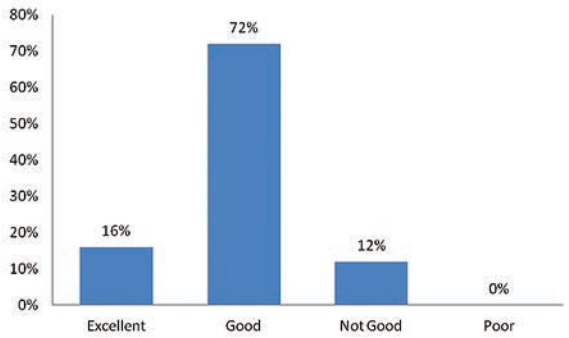
"Too Hard!"

Teacher feedback:

"Quiz was too hard."

"Make the maths session a lot easier." There were many comments similar to this one.

13 May 2011
Learner feedback:



Comments:

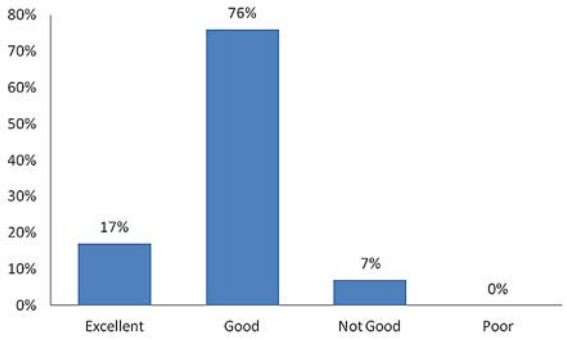
"I enjoyed seeing the university and doing the things. The maths quiz."

"Maths quiz, it was very enjoyable.."

Teacher feedback:

"Less questions on the quiz."

27 May 2011
Learner Feedback:



Teacher feedback:

"We have a new STEM club in school and it was a good activity to do as part of this club."

Higher education statistics

Overall HE Considerations (prior to events):

- 45% said that they were definitely considering HE as a viable option.
- 24% were confident in their ability to enter HE.
- 10% of the attending students thought that they would definitely fit in at HE.

Overall HE Considerations (post events):

- 52% of the attending students said that they were now planning to attended university.
- 48% stated that they were more likely to attend university as a direct consequence of the event.
- 81% said fears such as their ability to enter higher education and financial concerns had been broken down as a direct consequence of their experience on the event.

Summary: In summary the activity was successful in meeting its objectives with most people rating the session good or excellent. The only negative issue that was raised being that the questions of the quiz were too hard. In addition 48% of learners said that they were more likely to attend university as a direct consequence of the events.

Discussion, Learning and Impact

Outcomes: The main goals of the sessions were:

1. To raise aspirations of learners with respect to higher education.
2. To raise the attainment of learners in particular in the subject of mathematics.

The statistics in the evaluation show that the aspirations of the learners were raised with 48% of leaners stating that they were more likely to attend university as a direct consequence of the event. Whether the attainment of leaners was raised as a direct result of the event would be more difficult to measure however the feedback received from the session was good but not excellent.

Approach: The approach was successful as the schools were targeted via the *Keelelink* Partnership which allowed WP rating to be taken into account. As the Outreach and WP Section at Keele already employs a team of STEM mentors the recruitment of deliverers was not an issue. All deliverers were fully trained and CRB checked. Evaluation is a key part of all *Keelelink* Projects so feedback was taken from all parties involved.

Lessons learned: The key lesson learned from this project was that more time needed to be spent in ensuring that the questions are pitched at the right level for learners. When all questions are too hard for learners they lose interest and the desired impact was not achieved.

Key benefits: The main benefit of the activity was that it was held on the University campus which helped raise the aspirations of leaners by providing them with a taster of the university experience. Another effective part of the activity was that it was delivered by current Keele students who were closer to the age of the learners than teaching staff or academics. Learners related to student mentors more which meant that they were more inclined to ask questions about the session, the subject and university life in general.

Further Development and Sustainability

To ensure future sustainability of the activity it will be incorporated into our current *Keelelink* offering to schools and colleges as part of the STEM mentoring project. STEM mentors will deliver the session to *Keelelink* schools both on campus and in school. It can also be incorporated into the *Keelelink* campus events programme.

References

[1] http://www.keele.ac.uk/ *Keelelink*/

Pop Maths Quiz

Nicolette Rattenbury, School of Computing, Mathematics and Digital Technology, Manchester Metropolitan University

Engagement and Target Audience

Manchester has 8 out of the country's top 10 deprived super output areas. This means that many of the students in the local area come from very low-income families. This is one of the groups of students that have been a focus of the widening participation initiatives being run by government. We were lucky to get some publicity through Aimhigher; this enabled us to target many of the schools in these areas, following on from our initial mail drop. In our publicity we tried to portray the quiz as a fun activity that was about taking part rather than winning.

In total we had 130 students participating.
There were 23 teams from 13 schools:

- Abraham Moss High School
- Alder Community High School
- Broad Oak Sports College
- Burnage Media Arts College
- Canon Slade School
- Loreto High School
- Manchester High School for Girls
- Philips High School
- Reddish Vale Technology College
- The Barlow RC High School
- Thornleigh Salesian College
- Whalley Range High School
- William Hulme Grammar Academy

Of these schools, 6 have a larger than average number of students receiving free school meals, and English is a second language for a larger than average number of students at 5 of the schools. Many of the schools have a high proportion of students from minority ethnic backgrounds; in some cases this is 4 times the national average. Finally, 5 of the schools have a higher than average proportion of students with special educational needs and/or disabilities; in one case this is twice the national average.

Background and Rationale

It was intended that the *Pop Maths Quiz* would expand our current schools liaison programme. To date, our liaison programme has been very lecture based, with academic members of staff giving lectures at local schools. The *Pop Maths Quiz* was intended to be much more hands-on, allowing the students to 'get their hands dirty'. It was an opportunity for students to visit one of their local universities and meet some real-life mathematicians. Some of our undergraduate students were given a chance to get involved and improve their science communication skills.

Our overall aim was to get more young people involved in mathematics and see it as a fun, interesting and relevant subject. The goal of the activity was to encourage more students to study mathematics at GCSE level and above.

Implementation

Before we started to organise our *Pop Maths Quiz* staff from Sheffield Hallam University and the University of Leeds were contacted who have already successfully run such events; we were given invaluable advice on how to proceed. Sheffield Hallam University have also generously shared their questions with us, on the understanding that we provide a few questions for their quiz next year.

A team building their Menger Sponge.

In November of last year we put together a glossy information brochure to send to schools in the area. Due to a delay in printing, it was not possible to send these out until just after Christmas. We had intended on sending email reminders to schools about a month after the initial mail drop but we had such a great response that we didn't need to do this. We asked teachers to

register using an online booking form. This enabled us to capture all the information without having to type it in. We limited the number of teams from each school to three, to allow as many schools as possible to participate. We had a limit of 24 teams, due to the size of the venue.

Another team hard at work.

We followed a very similar format to the quiz run by Sheffield Hallam University, although on a much smaller scale. We had the teams arrive from 10:00, with the quiz starting at 11:00. While the teams were waiting for the start of the quiz they made Menger Sponges out of train tickets. The students were having so much fun with this that we started the quiz slightly late. We had 20 questions, which were read out at a rate of one every 3 minutes. The teams were asked to write their answers down twice on an answer sheet. At the end of the quiz they submitted one copy of the answers and kept the other copy to mark. The answers were read out and the schools marked their own answers.

Once we had determined which school had the most points we checked the sheet they marked against the sheet they submitted, to make sure no answers had been changed. The prize was then presented to the winning team, who were from Manchester High School for girls. Each of the members of the winning team was presented with a trophy to take home and keep. The team was presented with a large trophy to put on display for the coming year, along with a £50 book voucher. Each student who participated was given a participation certificate.

We provided a buffet lunch for the teachers and students before the public lecture started just after 13:00. This was given by Stephen Lynch, from MMU, who spoke about 'Fun with Maths'. We strongly encouraged family members to join the students for this talk.

On the day we had 8 people helping out; there was myself and 2 other members of staff. We did most of the setting up and organisation. We also had 5 student ambassadors; these were final year mathematics students. They helped take the teams to the correct tables and reread questions to any team who requested it. They also helped the teams get started with their Menger Sponges. Although instructions were left on each table, the students learnt more quickly from the ambassadors. They also helped record the day by taking photos and helped with tidying up afterwards.

We asked teachers to fill in feedback questionnaires at the end of the session, to let us know what they liked, what they didn't like, and how we could have improved things.

During the week following the quiz, the Head of School and I attended a special assembly at Manchester High School for Girls, to formally present the trophy to the winning team.

Evaluation

After the quiz we asked all the teachers to fill in an evaluation form. We received 11 completed forms. In total we had 22 teachers present from 13 schools. This means we only had a 50% return rate. Overall the results from the forms were positive. We did get some constructive criticism though, which we will use to help us improve the event in future years.

We asked the teachers to rank a variety of statements from 1 to 5, where 1 is completely disagree and 5 is completely agree. The results are in Table 1.

Statements	1	2	3	4	5
I enjoyed the event	0	0	1	5	5
I thought the activity was interesting	0	0	1	5	5
I thought the activity was well presented	0	2	2	7	0
I would bring my students to other similar events	0	0	1	1	9
The event was well organised	0	0	0	7	4

Table 1: The number of responses of each type for each statement

It seems that the majority of teachers enjoyed the event, thought it was interesting, would bring their students to similar events and thought the event was well organised. The statement we didn't achieve such positive feedback for was about the event being well presented.

There were three questions that allowed free text. The first of these asked what the most enjoyable part of the event was. All 11 forms mentioned building the Menger Sponge in this section. A couple of teachers commented that this was a good team building exercise.

The second question asked what the least enjoyable part of the event was. The third was asking for any other comments. Many of the teachers answered these two questions together. A couple of teachers commented on not being able to hear properly. Although we had a PA system, it seems it didn't cope very well with the large number of children in a confined space. We will need to ensure this is fixed for next year. Another recurring comment we had was that the questions were

too hard or too complex for the age group. Although some of the schools did struggle with the questions, achieving 8 or 9 correct answers, the winning team got 18. We will need to look at this carefully for next year, so that all the schools participating feel they are getting something out of the day. Several teachers suggested changing the format of the day. That is, rather than having a quiz, running it more like a relay quiz. They commented that it was unrealistic asking for the students to be quiet through 2 readings of the question. It was also commented by several of teachers that the questions were read too slowly. The final comment we had was that having the event on a Saturday means some students were unable to participate due to other extra-curricular activities.

Many of the teachers had already submitted their forms before the public lecture, so we had no formal feedback on this part of the event. I did, however, receive verbal comments from both the student ambassadors and some of the teachers that although the lecture had been enjoyable, it wasn't appropriate for the year groups involved. We will need to make sure this doesn't happen again next year.

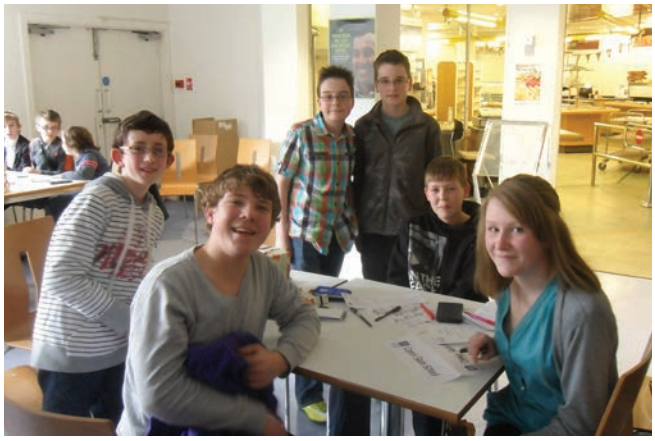
Discussion, Learning and Impact

Given the feedback above, I believe the event was a success. Both the teachers and their students enjoyed the day. It is impossible to tell at this stage if this has encouraged more students to study mathematics at GCSE and above. The student ambassadors also found the event enjoyable and rewarding.

We have learnt a lot from running the event this year. Both the students and the teachers really enjoyed building the Menger Sponge. This had only been intended as an activity to keep students entertained while they were waiting for the other teams to arrive. The students enjoyed it so much that the start of the quiz got slightly delayed. Given how successful it was, we will definitely ensure that we have a similar activity for next year's event.

There are a few things we will change for next year's event. We will need to rethink the venue. This year we held the quiz in the student refectory. This had some advantages, in that the tables and chairs were already set up. The disadvantage was the low ceiling. This made it noisy and hard for some of the students to hear the questions, even with the use of a PA system. We may be able to continue to use this venue if we can display the questions for the students to read, perhaps using a projector.

We need to improve our classroom management for next year. We found it difficult asking the students to stay quiet for two readings of the questions. If they heard the question properly the first time, they automatically wanted to get started on it. If the questions are displayed after they have been read we could just read the question once. We will also need to find a way to get their attention to read the next question, perhaps using a hooter or something similar. Speeding up the reading of the questions slightly could also help retain the students' attention.



The runners up.

Presentation at Manchester High School for Girls.

I know that many students were unable to make this event, as it was on a Saturday, but we will continue to host the quiz on a Saturday in future years. There are several reasons for this. We don't have the room to host it during the week, unless we make it outside of term time. I believe students would be even less inclined to attend if this were the case. Also, we have timed it to coincide with the Science and Engineering Week. Students can attend other activities that are being run on campus after our event. I also think teachers would be reluctant to take students out of school for a whole day for such an event.

Our Head of School very kindly funded the lunch for this event. Even for a relatively modest number of students this becomes quite costly. Unfortunately our refectory is closed on the weekends, so we are unable to ask students to purchase their own food. In order to make this event financially sustainable we will need to think about how to arrange this for future years.

The final change we would make for next year is to include some acknowledgement for the runners up. This could just be a runner up certificate.

Further Development and Sustainability

Both our Head of School and Head of Division have been very supportive of this event. They wish to see it continue in future years and have agreed to financially support it. There were some one off costs that we have had this year, as we have got the event off the ground, such as purchasing a trophy. This will make the event slightly cheaper to run in future years.

We would like to run the event once more with the same age group and iron out the few problems we have had this year. The following year we would like to expand the quiz to other age groups.

A Note from the Editors

The *Pop Maths Quiz* ran again in 2011/2012; details are available [1].

References

[1] http://www2.docm.mmu.ac.uk/STAFF/N.Rattenbury/PopMathsQuiz/

Pop Maths Quiz and Hands on Maths Workshops

Bryan Fryer, Academies and Trusts Unit, University of Wolverhampton

Engagement and Target Audience

In these two National HE STEM Programme supported activities (*Pop Maths Quiz* and *Hands on Maths Workshops*) a total of 76 school students participated, along with support from 10 teachers, 3 STEMNET representatives, and University staff and students.

Pop Maths Quiz: The participating schools for the quiz on the 14 March 2012 were as follows:

- High Arcal (1 team of 4)
- Kingswinford (2 teams of 4)
- Holly Lodge (1 team of 4)
- Ormiston Sandwell Community Academy (2 teams of 4)
- Highfields Science Specialist School (1 team of 4)
- Ridgewood (2 teams of 4)
- Dormston (1 team of 4)
- Redhill (1 team of 4)
- Wolverhampton Girls High (had to withdraw)
- Ellowes Hall (had to withdraw)

Each team of 4 consisted of 1 student each from Year 7, 8 and 9 plus one other student from Key Stage 3.

Hands on Maths Workshops: The participating schools for the Year 10 Maths Team Challenge on the 27 March 2012 were:

- Harbourne Academy (1 team of 4)
- King Edward VI Camp Hill School for Boys (1 team of 4)
- Queen Mary's High School (1 team of 4)
- Edgbaston High School (1 team of 4)
- Queen Mary's Grammar School (1 team of 4)
- Sutton Coldfield Grammar School for Girls (1 team of 4)
- King Edward VI Camp Hill School for Girls (1 team of 4)
- King's School (1 team of 4)

We worked closely with the individual schools to identify appropriate widening participation students and to encourage them to participate.

Background and Rationale

For many years the University has been involved with the Science Focus Group [1] which was established to bring together key STEM practitioners in the University, regional STEMNET and schools. It meets regularly to support STEM activities in various ways including sharing information on STEM developments, supporting regional STEMNET Hubs in the delivery of enrichment and enhancement activities, supporting STEM clubs and STEM ambassador recruitment, supporting bids for STEM activities, and developing STEM resources.

The University, in collaboration with the Science Focus Group, has facilitated a science quiz annually for a number of years. We wanted to broaden the appeal of this quiz, encourage greater take up by schools, and incorporate other subjects, and so we set out to develop a STEM quiz. The Pop Maths Quiz format and Hands on Maths activities and questions were therefore used to develop and enhance our current practice.

Implementation

Engagement with the University consisted of the following activities:

- Booking a room to host the quiz. We used a lecture theatre, as many school students will not have used one before. As one teacher commented: *"I think the venue was inspiring for the Year 7-9's most of whom probably haven't experienced a lecture hall before."*
- Catering. Refreshments (drinks only) were provided for arrival and the short break while the results were collated. However, one teacher commented: *"In the past there have been nibbles for the students to keep them going until 18:30. Totally understand that budgets change from year to year but if I'd known there wasn't to be any them we could have ensured the students had something to eat beforehand."*

The Quiz ran from 16:00 to 18:00, and the winning team received a trophy for their school and high street vouchers for each member of the team. The runners-up received a University pen, pencil, ruler and writing pad.

The roles of the staff involved in the project were as follows:

- University academic staff provided suggestions for questions.
- The University project manager liaised with schools and STEMNET, ordered the trophy, vouchers and other prizes, provided paper, pens and pencils for each participant, booked room and refreshments.
- STEM Focus Group member (a Director of Science specialism from a local school) wrote the questions and created the quiz.
- STEMNET/Education Business Partnerships staff advertised and promoted the quiz to schools and helped out at the event.

Evaluation

The purpose of the evaluation for this project was to assess the quiz itself such that amendments could be made to future events. Rather than asking the teachers and students at the end, feedback was sought a couple of days later to allow time for reflection. Following the event, an email was sent out to all of the teachers asking for qualitative feedback. At the time of writing this case study, three teachers responded to the feedback email, and the following are typical some of the quotes that were received:

"Timing was good, rounds were varied and kept the interest of the students, also it is better to run these activities out of school hours as this avoids disruption to other curriculum areas."

"We really enjoyed attending the quiz and we would be happy to bring students to a similar event in the future."

"I think science and engineering week is the ideal time to run this event."

Although not a major focus of this project, a follow up email was sent asking for feedback from the students, and how the STEM Quiz may have had an impact, or potential impact, on the students themselves. To date, no teachers have responded to this second email.

To evaluate the *Leeds Mechanics Kit* we setup the activities with some of our first year undergraduates along with a member of staff who supports the Further Maths Support Programme. We gave them the kit, a copy of the teacher's guide and let them try it out. At the end we asked them to complete an evaluation sheet. The students tried the following activities:

- Forced Oscillation (which they could not get to work).
- Conical Pendulum.
- Car on a loop track.
- Friction on a plane.
- Spinning pennies.
- Exploring Simple Harmonic Motion.

In general the undergraduate students felt that the activities did not help to improve their understanding of mechanics as they already had a fairly good understanding of these topics. However, they felt that had they done activities like these whilst studying for their A-levels, it would have helped to improve their understanding at that level. They also commented that the activities took a long time to set up so in a classroom situation it would be best to have them set up before the lesson starts. Also the teacher guide was found to be unclear at times as some of the equipment shown in the diagrams and picture is not the same at the equipment in the box, and there is limited guidance as to how they are supposed to work; this might be fine for someone who is used to teaching mechanics as they would know what they were aiming for with a particular activity.

Discussion, Learning and Impact

These National HE STEM Programme projects were undertaken to broaden and enhance the University's enrichment offer and in particular, its mathematical activities. The *Pop Maths Quiz* was undertaken to enable the enhancement of a current event, the Science Quiz, and create something new that would be based on a successful format. In this respect the project was successful, and the feedback from teachers seems to confirm this.

The second objective was to use the Quiz as a way of engaging the University with local schools and STEMNET. The quiz was designed with a capacity of up to 80 pupils, and so 44 (down from an initial 56) would suggest that for future events we need to engage better and earlier with schools. For future events the following modifications will considered:

- Set the date and communicate with schools much earlier in the year, ideally at least 3 months in advance.
- Encourage more schools to participate through earlier engagement and enhancing the marketing/promotional materials (perhaps setting up an online booking system).
- Investigate the longer-term impact on students engaging with the event.
- Encourage more input from university academic/subject staff.
- Ask for feedback from teachers and students at the end of the event, rather than just via a follow up email.

Further Development and Sustainability

As part of an established network between the University, schools and STEMNET, the STEM Quiz will be sustained as a scheduled output of the network. Timing it to coincide with Science and Engineering week is useful as many schools are looking for external activities that they can engage with. Engagement with an organisation like STEMNET is mutually beneficial, as they rely on others to deliver activities but in return provide a way into every school in a particular region.

The University's Mathematics department are organising a future Key Stage 4 Enrichment event taking place in July 2012. There will be multiple workshops, with one using the Fun Maths Roadshow CD activities and another will use the *Leeds Mechanics Kit*. Further events will make use of both resources, however the Mechanics Kit is physically too large and heavy, generally, to take out to schools. The *Leeds Mechanics Kit* with not be used in Further Maths support sessions due to the length of time needed to setup the experiments and the time constraints of each session. The lessons are only an hour long and it is only one lesson a week. However, discussion with STEMNET and the STEM Focus Group have highlighted that there may be opportunities for STEM Ambassadors and schools to borrow the kit.

References

[1] http://www.wlv.ac.uk/default.aspx?page=26515

Mathematics Challenge Competition

Debra Croft, Centre for Widening Participation and Social Inclusion & Institute of Mathematics and Physics, Aberystwyth University

Roger Morel, Centre for Widening Participation and Social Inclusion, Aberystwyth University

Engagement and Target Audience

The *Maths Challenge* Packs were made available to 26 schools (listed in Table 1). Of these 26, 11 took part in the *Maths Challenge* and submitted 386 entries overall. We invited our most local Community First (CF) schools (one of the Welsh Assembly Government's targets for Widening Participation (WP)), as well as Welsh speaking schools. By translating the Challenge we were able to target this WP group. Roger Morel (Science Officer) visited many of the schools to deliver Challenge Packs, particularly those schools we wished to target on a WP basis. These were then followed up and encouraged to take part.

School
Aberaeron Comprehensive; Penglais Aberystwyth; Penweddig Aberystwyth; Brecon High School; Builth Wells High School; Ysgol Uwchradd Aberteifi; Crickhowell High School; Lampeter Comprehensive School; Llandrindod High School; Ysgol Dyffryn Teifi Llandysul; Ysgol Uwchradd Caereinion; Llanfyllin High School; Llanidloes High School; Ysgol Bro Ddyfi; Newtown High School; John Beddoes School; Gwernyfed High School; Tregaron Secondary School; Welshpool High School; Ysgol Maes-y-dderwen; Ysgol Bro Gwaun; Pembroke school; Ysgol y Preseli; The Greenhill School; Ysgol Dewi Sant; Tywyn Secondary School.

Table 1: Schools receiving *Mathematics Challenge* Packs

The other part of this project was the celebration event, where we were able to attract over 120 pupils, parents, teachers and Heads. Some travelled up to 2 hours to get to us. The rural nature of our area informs the way in which we deliver projects, particularly the timings of events, and we also had some funds available for CF schools to assist in travel.

Background and Rationale

Aberystwyth University, through the Centre for Widening Participation and Social Inclusion (CWPSI), has considerable experience in outreach activity [1] – in primary and secondary schools, and in public/community contexts. These have recently included science based out reach such as: *Science Circuit* Phase I (adults) and Phase II 'Skilling the Future' in schools, the Gwyddfan/Science Van Physics National HE STEM Programme project, a Maths Challenge National HE STEM Programme project and various out-reach and in-reach schools which concentrate on science. There is major expertise in delivering science in innovative and exciting ways, working with the departments and specialists, the STEM Physics Buskers, the Wales-wide *Hands on Science* programme and the Reaching Wider Partnerships.

Having worked extensively with the Physics School in the joint Institute of Physical and Mathematical Sciences (IMAP), we knew there was capacity to build on the mathematics outreach and piloted a number of specific half-day masterclass visits with Year 12 students from local schools. We knew we wanted to do more and the opportunity to pilot the *Maths Challenge* (developed by Leeds and Liverpool, & *More Maths Grads*) seemed the place to start. We have a number of annual events – for example, National Science and Engineering Week, Salters' Chemistry Festival, Expanding Horizons GCSE revision (core subjects) and the schools know and like the regularity of these. The *Maths Challenge* could become one of these in a project to engage, enthuse and inspire school and college pupils, particularly those from a widening access background.

Implementation

The National HE STEM Programme *Maths Challenge* project had support from the Faculty of Science and work was started in January 2011 to obtain the questions from Liverpool and get these translated and printed into bilingual booklets. Twenty-six schools in four counties were targeted, namely Ceredigion, Powys, Pembrokeshire and South Gwynedd, initially by outline letter about the *Challenge*.

In early February, *Challenge Packs* were made up including instructions, entry sheets and bilingual booklets for the two age ranges: below Year 8 'Challenge 2011' and below Year 10 'Senior Challenge 2011' [2].

The majority of the *Challenge Packs* were then hand delivered to the heads of mathematics in the schools, particularly the schools in our Community First areas [3]. This gave us the opportunity to discuss the *Challenge* in detail and outline process and the celebratory prize-giving event to be held at the University in May 2011.

Those packs not delivered in person were posted to be at the schools well before the spring term half-term holiday (21 - 25 February). A deadline date of 15 March 2011 was set for return of the completed *Challenge Packs* and answers to be returned to us, so that the pupils undertook the challenge over the half term holiday. Most were received by this deadline although a number continued to 'trickle in' for a week or so afterwards.

Markers: As with most of our projects we use undergraduates and postgraduates as role models and also employ them to enhance their employability skills. The markers were recruited from IMAP and allocated approximately 50 scripts per person at a face-to-face marking meeting, where the marking guidelines were distributed and discussed. The markers were also invited to attend the prize-giving event which was booked for the 9 May. Roger Morel moderated the marked scripts to ensure correct marks had been allocated.

Results: The results were tabulated and, in order to encourage and reward schools and pupils for participating, we looked for the three highest marks initially in each school – or more if there were tied numbers. We used three categories – School Winner(s), School runner-up(s) and Special Mentions. We used a cut-off for a low mark – so not all schools had a 'winner' if the top answer mark was poor – but they did get 'Special Mentions' in those cases.

Schools were phoned and e-mailed with the results (for their school only) as soon as the marks were compiled and agreed, and invited to the prize-giving event.

Prize giving event: This was held on 15 May 2011 (17:00 – 20:00) in the Medrus Mawr conference suite at Aberystwyth University. Over 120 guests were hosted (pupils, teachers, parents and siblings), together with 14 staff from Aberystwyth University.

Debra Croft hosted the event, with a welcome talk from Professor John Gough ('Maths and Your Future'); medals were awarded by the Vice-Chancellor of the University (Professor Noel Lloyd) and a thank you speech was given by the Director of IMAP (Professor Manual Grande).

The Physics Buskers and Phys Chic provided suitable entertainment during the proceedings with maths themed games, tricks and demonstrations. Tea, coffee and light refreshments were available from 16:45 before the event, and a cold buffet was served at 18:30, with more entertainment, fun and games.

After prize-giving event: All schools have been provided with details of prize-winners, the celebration event and photographs, regardless of whether they participated. This was done in three groups – those not entering, those entering but not attending the evening event, and those attending the evening event.

Evaluation

Of the 26 schools contacted with *Challenge Packs*, 11 had pupils taking part (42%). Given that this was our first year and the diverse and rural spread of the schools contacted we feel that this was a good response. We had aimed for 1/3 in our initial discussions.

Universities in cities (for example Leeds and Liverpool) have reported around 1500 entrants. We had 386 in this first year. It is hard to evaluate 'success' or 'failure' - we would have liked more but it is a 'benchmark' that we will be able to build upon. We had a number of extended conversations with teachers, pupils and parents to ask about whether they would value this kind of event on an annual basis and overwhelmingly this was a 'yes'!

We also evaluated using a school/teacher questionnaire sent out after the event. Of those returned, the feedback was:

- Junior Challenge questions
  rated 4 on a scale of 1(poor) – 5 (very good)

- Senior Challenge questions rated 4 on a scale of 1– 5
- Overall organisation rated 5 on a scale of 1– 5
- Celebration evening rated 5 on a scale of 1– 5
- Prizes, etc. rated 5 on a scale of 1– 5

Discussion, Learning and Impact

Overall we are very pleased with this pilot. We would like to attract more schools and more entries next year and make this an annual event on the schools' calendar.

A number of learning points were identified:

- Set a deadline and stick to it.
- Have markers in place early on so that the schools and pupils/parents have more notice of the celebration evening.
- Delivering complete packs (that the schools didn't need to copy and were bilingual) was an absolute 'must'.
- Schools that are contacted regularly are more likely to encourage pupils; especially those in the WP target group.
- We need to capture more feedback, both quantitative and qualitative.
- Analyse why the schools that didn't take part felt unable/unwilling to.

Further Development and Sustainability

Externally: In the future, we hope to embed this event in the schools' calendar of regular STEM activity. It will be advertised earlier in the school year and with the marketing materials available from this pilot.

The typical teacher reaction was effusive, for example:

"… excellent to see such a good turnout, especially from schools that had a long way to travel. The Vice Chancellor was particularly kind to find the time in such a busy day. Thanks also to Professor John Gough for an entertaining introduction which gave us all something to think about." **Head of Maths, Penglais School**

And parents:

"We were so proud of [C], the whole family came. It's good to see the University doing this kind of thing." **Parent of a Student Participant**

Several Year 10 pupils were unhappy that they wouldn't be allowed to compete next time! Others thought that it was good to have maths skills valued – often they don't get enough attention where there is a lot of emphasis on lower end achievement at that age: getting people up to a basic standard. It seemed that they enjoyed being challenged.

Internally: We hope to gain more involvement from the Department, having successfully piloted the event. They have seen the value of it and the interest from our local schools, so this will be fully possible. A case will have to made for the allocation of funds based on the costings of this pilot. One of the things to consider will be the increase in numbers if more schools take part and how/where to host them at a celebration event.

A Note from the Editors

The mathematics Challenge Competition ran again at Aberystwyth in 2012. Further details, including the materials used are available [4].

References

[1] http://www.aber.ac.uk/en/widening-participation/schools/stem

[2] http://www.aber.ac.uk/en/widening-participation/schools/stem/maths-challenge/

[3] Communities First is the Welsh Assembly Government's flagship programme to improve the living conditions and prospects for people in the most disadvantaged communities across Wales: http://wales.gov.uk/topics/housingandcommunity/regeneration/communitiesfirst/?lang=en

[4] http://www.aber.ac.uk/en/widening-participation/schools/stem/maths-challenge/challenge12/

Mathematics Challenge Competition

Phil Ansell, School of Mathematics and Statistics, Newcastle University

Tom Nye, School of Mathematics and Statistics, Newcastle University

Engagement and Target Audience

Upon receiving the questions from the host institution, we sent copies to all local schools (we decided that 'local' comprised schools that were located in certain postcode areas across the North East). In doing this, we ensured that not only schools already involved in events hosted by the School of Mathematics and Statistics were invited to take part but also schools classed as in low participation neighbourhoods and schools with whom we had no current links would be covered.

After contacting schools across the North East, the following schools sent in completed challenges:

- Dame Allan's Schools
- Cramlington Learning Village
- Sacred Heart
- St Thomas More
- Durham School
- Monkwearmouth Sixth Form College
- Walbottle Campus
- St Bede's Peterlee
- St Mary's RC Comprehensive

Over 300 students returned work to us and we awarded 16 prizes between the two challenges. The standard of responses was variable and mechanisms to improve the quality of submitted work have been considered.

Background and Rationale

The School of Mathematics and Statistics has always had strong links with local schools through events such as masterclasses, revision days and conferences, but as part of a recruitment and engagement strategy review we made a decision to try and involve younger students. As a School we see the importance of engaging these year groups as a way of promoting our subject and improving recruitment into AS and A-level classes. In turn, we hope this will improve what is already excellent recruitment into our degree programmes. The idea of a challenge which allowed students to work in their own time on challenging problems was something that we had been looking to do for a while and the opportunity of breaking down the barrier of coming to the University and seeing what is was like here appealed to us greatly.

Implementation

We sent the questions, suitably amended to reflect our institutional branding, in time for students to be able to try them during the February half term break. They were to return them to us a couple of weeks after this date.

We then held a 'celebration event' in May where we provided some enhancement activities, a bookstall and of course, a chance to look at the Challenge solutions. Students, parents and teachers were then given a 'fun' lecture by Professor Robin Johnson and we held a prize giving ceremony hosted by Tom Nye and Professor Rob Henderson (Head of School).

Soon after the celebration event, and with the permission of the students, a website [1] was created which contained information about the event and also pictures of the winning students.

Evaluation

Although feedback at the event wasn't formal, anecdotal responses suggested that the event was a success. All of the prize winners attended along with parents and teachers. In hindsight we should have obtained more detailed feedback at the event and this is something that we will do in the future.

Discussion, Learning and Impact

The aims of the project were to run to a mathematics challenge event that:

- Engaged a variety of local students, particularly in a younger age group than we catered for in previous outreach events.
- Improved links with local schools.
- Provided those students with an opportunity to visit the University.

In part all of these objectives were met. A variety of schools took part in the event including schools

with which we already had links and those that we had not had involvement with in recent years.

The School of Mathematics and Statistics has committed to running the Challenge event again in 2012 and we will make a number of changes to try and increase the uptake, improve the celebration event and ensure that relevant evaluation takes place.

In the first instance, we hope that the School of Mathematics and Statistics engagement strategy, which has already improved links with local schools and has led to an increase in the number of named teachers that we can contact in each school, will have an impact in the number of responses that we receive. This in itself will provide its own problems. In 2011, two academic members of staff undertook the work, including the marking and hosting of the event. If numbers increase we will have to re-evaluate the marking procedure and probably have to include (as those in other institutions do) other academic colleagues and/or postgraduate students in assessing the responses.

In terms of the variability in the quality of the responses, we will be providing more detailed guidance to teachers in how they manage the challenge from the school perspective. It was clear from some responses that students had, as we had expected, taken the paper home and spent some time working on the solutions whereas others seemed to have been given the paper in a lesson and whatever they managed to complete in the hour that they had was submitted.

Further Development and Sustainability

Overall, we see our first running of the Mathematics Challenge Competition as a success, we intend to improve a number of features of the process this year and hope that we can build upon and learn from the positive and negatives to ensure its success for the future.

A Note from the Editors

The competition has run again in 2011/2012; details, including the questions and materials used are available [1].

References

[1] http://www.ncl.ac.uk/maths/outreach/resources/challenges/

Maths at Work Day

Ceri Pugh, School of Education, University of Wales, Newport

Kerie Green, School of Education, University of Wales, Newport

Engagement and Target Audience

This project was delivered in collaboration with Careers Wales Gwent at the Caerleon Campus, University of Wales Newport. It provided a one-day opportunity for sixty Year 10 learners from four local schools to undertake workshop activities presented by four local employers. The activities were based on the core activities of the employers and involved the application of mathematical skills to the working environment. Activities were chosen that, although challenging, would present mathematical concepts already familiar to learners in a real-life context.

The University's geographical location is in a region with low participation in HE and it attracts the HEFCW funding Widening Access premium for recruiting from *Communities First* areas, i.e. the most disadvantaged communities across Wales. The secondary schools that were targeted are based in some of the most socially deprived areas of Wales. Accordingly, the schools invited to attend were Abertillery Comprehensive School, Blaenau Gwent; Hartridge High School, Newport; Lliswerry High School, Newport; Newport High School, Newport.

Background and Rationale

This event was designed to promote a number of aims consistent with the aspirations of the Newport School of Education and the wider University. Outcomes were either intended to support work already being undertaken, or to add a new dimension to existing practice, and are outlined below:

- building links with employers in the region.
- working with school teachers so that they can demonstrate to their own learners applications of mathematics in the world of work in South East Wales.
- raising student teacher awareness of careers in mathematics so that they become facilitators in their first teaching appointments.
- giving student teachers the opportunity to observe learners' reactions to mathematics as it is used in industry and hence adapt their mathematics curriculum to respond to learners' perceptions of the subject.
- encouraging learners who have not been well represented in higher education to go on to study mathematics and related STEM subjects at A-level and beyond and to see the relevance of their studies to the world of work.
- exploring applications of mathematics in a different and fun way hence increasing learners' confidence.
- introducing a higher learning environment to learners, to which they may not have previously been exposed.
- developing a range of resources for the classroom and careers centres.

Additionally, in 2008 the Welsh Assembly Government issued statutory guidance designed to prepare learners for the world of work but recent research indicates that there has been low impact on practice. Experiences of, and resources developed for this activity were intended to support integration of the framework within the undergraduate Initial Teacher Training curriculum for STEM subjects.

Implementation

A preliminary meeting was arranged within the School of Education. In addition to the project overseer, four members of staff were involved and responsibility for employer contact, school contact, materials preparation and document completion were assigned. Careers Wales Gwent were contacted to assist in approaches to businesses, resulting in the recruitment of three local employers. A fourth employer was secured through contact from one of the University team.

Further support was elicited from eight student teachers from within the School of Education who acted as

ambassadors on event day. Initial Teacher Training degrees in STEM subjects, at University of Wales Newport, provide training opportunities for individuals who would not have entered teaching by any other route and have enriched the teaching profession by bringing a greater diversity of backgrounds into the classroom benefiting learners and teaching colleagues through exposure to different ways of working. The involvement of some of these student teachers, on the day, presented excellent role models to learners as they are traditionally under-represented learners themselves. The ambassadors were involved in small-group activities during sessions and their input was invaluable. For future events it is anticipated that their number would be increased to provide a higher ratio of ambassadors to learners.

The Programme (Figure 1), posted to schools before the event, is shown below and indicates the organisation of the day.

Organised through the National HE STEM Programme and hosted by the tutors and student mentors from the Secondary Initial Teacher Training programme, University of Wales, Newport in collaboration with Careers Wales Gwent.

9.45 am Arrive at Caerleon Campus via Lodge Road Gatehouse. Parking reserved in Felthorpe Way. (Straight ahead, top of slope turn right). Report to the main reception under the clock tower. Student Mentors will greet and accompany schools to their first workshop.

	Workshop 1 Architecture Room 102/3	Workshop 2 Manufacturing Room 106/9	Workshop 3 Finance Room 111/2	Workshop 4 Construction Room 117/8
10.00 – 10.45	Newport High	Lliswerry	Hartridge	Abertillery
Morning break. Free drink and snack vouchers will be provided.				
11.15 – 12.00	Abertillery	Newport High	Lliswerry	Hartridge
Lunch. Free lunch vouchers will be provided.				
12.45-13.30	Hartridge	Abertillery	Newport High	Lliswerry
13.30 – 14.15	Lliswerry	Hartridge	Abertillery	Newport High
14.15 – 14.30	Online evaluation. Depart.			

The University and Careers Wales would like to thank the following organisations who have kindly participated in delivering Maths at Work;
Mike Little, Leadbitter; Sally Colcombe Architectural Services; Richard Hill, Monmouthshire Independent Financial Services and David Evans, InBev

University of Wales, Newport | Prifysgol Cymru, Casnewydd | GyrfaCymru Careers Wales

Figure 1: Programme for Maths at Work Day

Future changes to this aspect of the work include the addition of an introductory session, based in a lecture theatre, where all presenters are introduced and decreasing the number of sessions. The positive engagement of learners meant that more time could have been allocated to tasks, suggesting that three sessions of at least one-hour duration would be preferable; this would then allow time for a tour of Caerleon campus. Additionally, a later lunch is envisaged with more activity focused earlier in the day.

Evaluation

Evaluation of this project was centred on the six broad themes outlined within the National HE STEM Programme:

- building partnerships - internally between the groups involved in the Programme and externally with the broader STEM community within the HE sector, among HEIs, employers and other stakeholders.
- sustainability - ensuring that successful approaches are sustained within the HE sector beyond the lifetime of the Programme.
- employer engagement - engaging employers in HEI activity and particularly in relation to workforce development and higher level skills.
- the transferability of activities and practices, for example, between HEIs and disciplines.
- widening Participation amongst groups of learners traditionally not well represented within the STEM disciplines at university level.
- impact on institutions - in encouraging wider changes in practice across subject areas, faculties, departments or amongst individuals.

To this end, three questionnaires were devised targeting employers, accompanying teachers and learners respectively. A hardcopy format was adopted for employer and teacher responses, whereas learners were asked to complete an online evaluation made available to them at surveymonkey.com. Additionally, a discussion session was conducted immediately after the event, where the views of staff and ambassadors were recorded.

Employer responses: All four employers completed the questionnaire, which asked for their extent of agreement with a number of statements. Mean average responses are shown in Table 1:

Question	Average response
The pre-course organisation was good.	4.0
The organisation of the day was good	4.0
I had realistic expectations of learners' abilities	4.0
I was able to establish a good rapport with the learners	4.0
The programme met my expectations	4.0
I would consider being involved in a similar event in the future	4.25

Table 1: Mean average scores for employer responses

Question	Average response
The programme supported the development of STEM skills	4.75
Involvement in this programme assisted learners in the development of STEM knowledge & understanding	4.5
The programme supported your school/department improvement plan	3.67
The activities contributed to delivery of National Curriculum: *Careers and the World of Work*	4.0
The programme met your expectations	3.75
The content of the programme was practical and useful for the learners with a good balance between activity and instruction	3.75
The quality of the materials was good	4.0
The pre-course support and organisation was good	4.0
The organisation of the day was good	4.25
The presenters were clear in their delivery	4.0
The presenters established a good rapport with the learners	3.75
The presenters had realistic expectations of learners' abilities	3.5
I would consider bringing learners to a similar event in the future if required to make a financial contribution	3.5

Table 2: Mean average scores for teacher responses

Improvements suggested by employers included their being fast-tracked for lunch and inclusion of an initial session for all participants.

Today I understood the sessions a lot and I extremely enjoyed the construction session. Also I thought that the student teachers were very helpful and kind.

Teacher responses: All four teachers completed the questionnaire (Figure 2), which again asked for their extent of agreement with a number of statements. Mean average scores are shown in Table 2.

Learner responses: The response rate was 100% and the use of an online survey aided significantly in processing of learner data. A question-by-question breakdown of responses is given in Figure 2.

Question 1. Before today I was thinking of a career in science, engineering or mathematics.

Question 2. After today's events I am more interested in a career that involves mathematics.

Question 3. I know more about the types of careers that involve mathematics as a result of today.

Question 4. I am more likely to choose an 'A' level in the future involving mathematics.

Question 5. I am now more likely to study mathematics at college or university.

Question 6. The presenters made me think that studying mathematics-related subjects could be important in getting an interesting job?

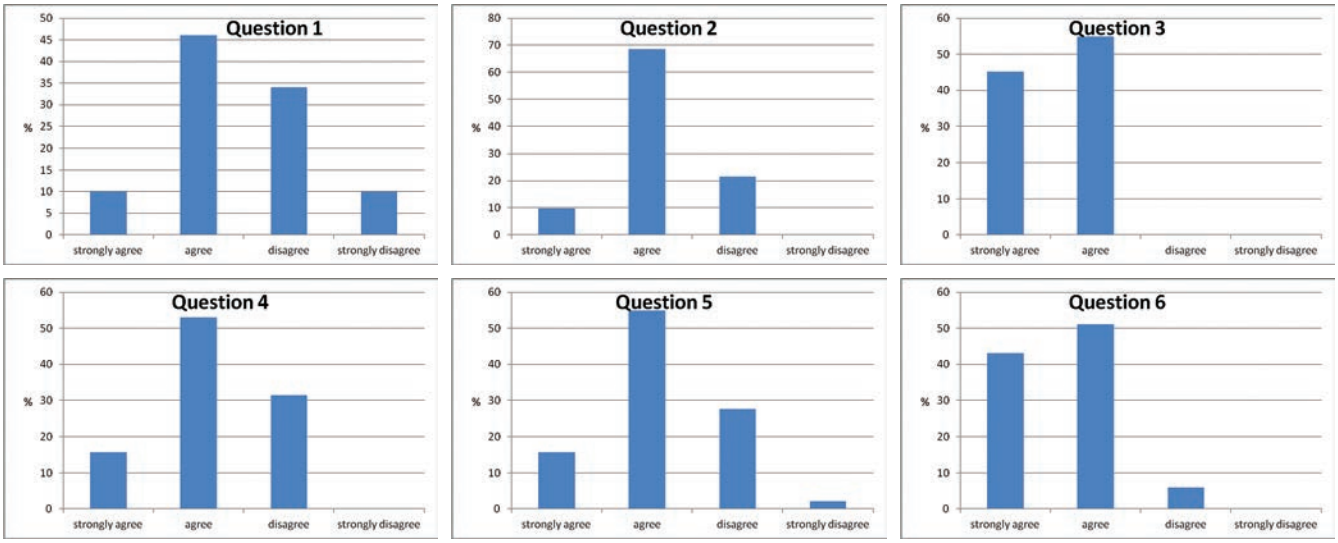


Figure 2: Analysis of student questionnaire responses

Discussion, Learning and Impact

It is evident from analyses of questionnaires from employers, teachers and learners that the event was considered an overwhelming success. Briefly, presenters felt that the day was well organised, that learners engaged with the activities, and all would wish to become involved in any future similar events. Teachers supported strongly the notion that the event had supported STEM skill development, as well as furthering learners' STEM knowledge and understanding. Careers Wales, Gwent commented: *"It's been a pleasure to work with members of the University of Wales Newport, in delivering such a worthwhile event for the pupils of Gwent. We look forward to working with them in the future in organising new events, perhaps including the other STEM subject areas."*

There was more information in maths told today which was very interesting.

Organisation was considered to be good, with an appropriate choice of activities. One activity was highlighted as being less engaging than the others which has led to the idea that, for any future events, presenters should be required to submit their session plan to the University team so that any unrealistic expectations of learners abilities can be resolved in advance.

The analysis of learner questionnaires indicates, again, an overwhelmingly positive response to the activities provided and to the day in general (apart from University jelly that was not well received!).

In evaluating the extent to which the event fulfilled the objectives set beforehand, strong support is given to indicate promotion of the six broad themes discussed above:

1. Partnerships were built between the university and Careers Wales Gwent, local employers and the schools that attended.
2. Sustainability was considered to be embedded into the event and is discussed in further detail below.
3. Employer engagement was particularly noteworthy, with a strong desire from presenters to continue the partnership with further events.
4. The transferability of activities and practices, for example, between HEIs and disciplines was seen to be more likely as a result of the day, with other STEM subjects being considered for future development.
5. Widening Participation amongst groups of learners traditionally not well represented within the STEM disciplines at university level appears to have been promoted as a result of the day. Almost 80% of learners agreed that they were now more interested in a career involving mathematics than previously. Almost 70% of learners agreed that they were now more likely to consider an A-level in the future involving mathematics, with a majority agreeing that their studying mathematics at university was now more likely. A strong indication of the success of the presenters in connecting the study of mathematics with an interesting job was given by the over 90% agreement to this statement.

I enjoyed looking around the uni during my day here and the staff were really nice.

6. The impact on University of Wales, Newport was also evident, as further activities are now more likely to be planned, involving different STEM subjects, and more student teachers are expected to participate in future activities.

Further development and sustainability

The University, working with Careers Wales Gwent, has developed closer links with local employers and will now embed work-based activities in the undergraduate ITT STEM curriculum. The perceived success of the

Maths at Work day will now influence future practice in a number of areas. These include continued working with Careers Wales Gwent to support other STEM/ curriculum enrichment projects such as an introduction of science, ICT and D&T work days. We will now embed an annual *Maths at Work Day* into the curriculum, which, it is anticipated, will provide an opportunity for local employers to engage more readily in the learning process and enable student teachers to develop employability skills and prepare effectively for professional practice. It is then hoped that, in turn, further awareness will develop of STEM skills in demand in the locality.

Learnt about all the different types of jobs which involve maths and student teachers were brilliant!

Additionally resources developed for use on the day will be built upon followed by development of a resource area on Moodle in future years. STEM student ambassadors will work with/train new cohorts of student teachers and student teachers will be supported in meeting the 'out-of-class' national standard for the award of qualified teacher status. It is believed that this event has been the first stepping stone to developing strong links with future partners and should enable future engagement in, for example, developing STEM Foundation degrees. Future annual events will enhance and strengthen our partnership with local secondary schools.

Hands on Maths Workshops

Chris Marchant, Department of Mathematical Sciences, University of Liverpool

Michael Jones, Department of Mathematical Sciences, University of Liverpool

Engagement and Target Audience

The workshop was designed for Year 6 or 7 pupils, and we will have seen approximately 900 pupils from 30 different primary schools when we have run our event at the four High Schools across Ellesmere Port and Neston, all of which are Aimhigher schools in an area of high deprivation, child poverty and low engagement with higher and further education.

We plan to have follow-up events next year as part of the Ellesmere Port STEM festival, and to offer the workshop to other schools for an internal event, as an aid to transition from primary schools or as an outreach event to other high schools.

Background and Rationale

The idea for BIG Maths came out of the Maths Knowledge Network we established with the Ellesmere Port and Neston schools using funding from the National Centre for Excellence in the Teaching of Mathematics (NCETM). The idea was to help to improve the teaching of mathematics in schools, to enhance the pupils' experience of mathematics, and to aid transition to the high schools.

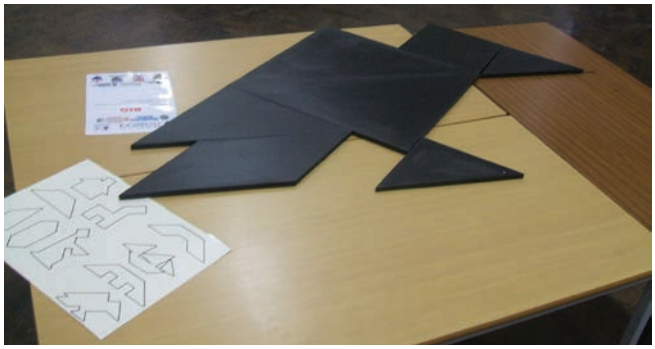
Ellesmere Port and Neston is an area in which a third of adults have no qualifications at all and 47% have literacy below level 1. The importance of schools and universities working closely together has never been greater, and the partnership we have with these schools is a very close and extremely productive one.

Implementation

After securing additional funding from the National Lottery in order to make the project viable, we brought together 6 gifted and talented Year 8 pupils from each of the 4 high schools: The Whitby High School (Whitby), Neston High School (Neston), Ellesmere Port Catholic High School (EPCHS) and University Church of England Academy, Ellesmere Port (UCEA).

After a 'getting to know you' event, we held a 'writing day' in which the pupils had input into the activities to be included in the BIG Maths event, as well as writing the questions for an inter primary school quiz, which is the second half of the overall project.

Despite some supplier issues, we were able to hold events at 3 of the high schools during the first week after the October half term holiday (the event at UCEA has been postponed until after Christmas due to an OFSTED inspection). The gifted and talented pupils, now in Year 9, acted as staff for the event, supporting the pupils on the activities, as well as helping to host them by guiding them to toilets, and in and out of the school.



Giant Tangram

Evaluation

The events were a roaring success. All of the pupils from the primary schools enjoyed themselves, and the primary staff were very impressed with the attitude and aptitude of the Year 9 pupils. We did find that some of the bigger groups did not get as much time on some activities as we would have liked. Most of the activities were set out with 2 sets of equipment, however due to supplier issues we only had 1 Soma Cube and 1 Towers of Hanoi set.

We also felt that time was very tight, and so we decided that for future uses of the workshop, we would allow 10 minutes for each task, with an additional task. This

would mean that the teams would be smaller: the whole workshop would then last for 90 minutes.

Crazee Diamond

Discussion, Learning and Impact

We found that the session succeeded in helping to bridge the gap between high schools and primary schools, brought the pupils' attention to a wide range of mathematics and continued to build the relationship between the staff from all of the schools and ourselves. We were very pleased with it.

Were the goals/intended outcomes at the start of the work were successfully achieved?

- Yes, we introduced the primary pupils to a range of mathematics and to the high schools. We facilitated the Year 9 pupils having a peer leadership role and helped them to develop a great resource.

Giant Pentominoes

Was the approach successful and why?

- Yes. The concept proved to be sound; however, more resources for the Soma Cube and Towers of Hanoi activities, and more time for the pupils to complete all of the tasks, would make the sessions more fulfilling for them.

What the key lessons are that were learned from the work?

- Pupils actively engaged with these activities because they were able to work with pupils from other schools and the resources were interesting, stimulating and highly interactive.

What was effective or beneficial about the work with particular attention given to impact on the target audience (i.e. those who the activity was originally aimed at)?

- The pupils were able to visit the high schools in a challenging, but not threatening, situation and engage in activities which were clearly designed for them.

What would you do differently if you were to undertake the activity again (and why?), and what advice would you give to others wishing to undertake similar work?

- We have commissioned additional resources for the two tasks mentioned above, and would market the workshop as a 90 minute session.

Barriers and enablers: What were the key threshold points that made implementing the activity difficult (barriers), and how were these subsequently overcome (enablers)?

- Some schools were unable to participate due to OFSTED; we have arranged additional sessions to ensure that they do not miss out.

Further Development and Sustainability

We intend to use the workshop as part of the Ellesmere Port STEM festival in 2012. It will also become another option for schools booking an outreach visit.

Hands on Maths Workshop

Ruth Edwards, Southampton Education School, University of Southampton

Abstract

In 2009/10, Southampton's primary and junior schools were ranked as the third worst performing in the country. With a view to increasing widening participation and raising standards in mathematics the secondary mathematics PGCE trainees ran *Hands on Maths Workshops* as enrichment days involving gifted and talented Year 9 pupils from a number of local secondary schools.

Background and Rationale

Historical and anecdotal evidence has shown that trainee teachers continue to support and promote enrichment activities in which they have been involved during their PGCE year. The secondary mathematics PGCE course at the University of Southampton is structured in such a way that the trainee teachers have the opportunity to run a Year 9 enrichment day following the end of their second school placement. This involves pupils identified as gifted and talented from local secondary schools. To date eight different schools have been involved with twelve pupils invited from each. The support obtained through the National HE STEM programme to run *Hands on Maths Workshops* enabled the faculty to extend and enhance this provision by increasing the number of schools and pupils targeted.

In addition it has been found that many secondary mathematics trainees are eager to maintain links and work in partnership with the University once they have employment in local school. There is potential that by using the *More Maths Grads Hands on Maths Workshops* materials as the source of activities for an enrichment day, these materials will be more widely disseminated into schools and colleges.

Implementation

The event was held on the 16 and 17 June June 2011. Twelve schools were each invited to bring twelve able Year 9 pupils to participate, with six schools attending on each day. The day consisted of a series of workshops for pupils planned and delivered by the current cohort of PGCE trainees. The workshops were Mathematical Trickery, Codes and Ciphers and the Fun Maths Roadshow.

The menu of activities suggested by the National HE STEM Programme listed a range of resources developed by the *More Maths Grads* project: Mathematical Trickery, Maths in Real Life – Classroom Challenge, Paper Imagination, Air Miles, Fractals, Cryptic Challenge (Codes and Ciphers), The Golden Curve, Mathematical Quiz as well as the Fun Maths Roadshow and Practical Mechanics. The University uses the virtual learning environment Blackboard to support many of its courses. A copy of each of these activities and associated resources was placed on Blackboard to allow easy access for the trainees. The secondary mathematics tutor team chose which three different sessions were to be used and the trainees were divided into six groups (seven trainees per group) and allocated a topic and a day.

Teachers were asked to provide name labels for pupils which were colour-coded so that pupils could be split into three groups Red, Yellow and Blue. In this way pupils could easily be arranged to work in three mixed-school groups.

Schools were responsible for transporting the pupils to and from the University at the start of the day, and for any supervision required at these points. Supervising teachers were asked to ensure they had carried out the required checks regarding pupils' medical needs, any allergies and medications and gained relevant permissions from pupils. They were also informed that as the enrichment day was being supported by the National HE STEM Programme photographs would be taken at the event and they should obtain permission for this and return the attached permission form provided by the University.

Pupils were asked to bring a packed lunch and a drink, a calculator and their usual maths equipment. A sandwich lunch was provided for staff and a drink and biscuits for the pupils during the morning break.

A week prior to the event the activities were introduced to the trainee teachers and they devised in their groups how they would allocate the time to different aspects of the sessions and which resources they required. Photocopying was completed by one of the course tutors as were the room bookings and organisation of refreshments and purchase of any equipment required for the sessions.

On arrival at the University all the pupils were taken to the lecture theatre where they were given an introduction

to the day and a competition crossword was distributed for them to complete during the course of the day. A prize of a £15 gift voucher was awarded to the pupil with the most complete solution at the end of each day.

During the session before lunch all the pupils returned to the lecture theatre for a talk entitled 'Why Study Maths?' In this session pupils were selected and asked what careers they would like to follow. The rest of the audience was challenged to identify where they might need to use maths in that particular job. This was followed by the DVD *'What's the point of maths?'* which can be found in the *More Maths Grads* 'Maths in a box'. At lunchtime the trainee teachers took the pupils on a short tour of the University.

Liverpool Fun Maths Roadshow: Boxes 5 and 6 were used for this activity and pupils worked in pairs to answer the problems. A University mug was awarded to each of the best pair within a session.

Figure 1: Students working on Fun Maths Roadshow activities

Cryptic challenge: The trainee teachers used 'save the special agent' and 'who was the assassin' as themes for these sessions. They dressed in suits with dark glasses to add an element of excitement to the session. Pupils worked in teams of four to complete the challenge and a prize of a wooden puzzle was awarded to each member of the winning teams.

Figure 2: Students tackling the Cryptic Challenge

Mathematical Trickery: In addition to the card tricks supplied by the *More Maths Grads* team the trainee teachers supplemented this session with tricks and other algebraic problems of their own.

Figure 3: The Cryptic Challenge

Evaluation

At the end of each day evaluation forms were distributed to the pupils. Pupils were asked to evaluate the content of the day as a whole and each of the sessions on a scale of 1 to 4 with 4 being the most enjoyable. The results of the evaluations are shown in the Table 1.

Questions	Average Rating Thursday	Average Rating Friday
1: The content of the day as a whole	3.9	3.4
2: Mathematical Trickery	3.3	3.4
3: Cryptic Challenge	3.4	3.7
4: Fun Maths Roadshow	2.7	2.8

Table 1: Evaluation ratings for the individual activity sessions

Pupils were also given the opportunity to comment on the activities. A summary of some of the responses are given below:

The content of the day as a whole:

"Makes maths fun", "Fun, like to come again", "Entertaining", "Awesome", "Lecture could be more interesting", "Better than normal school maths", "It was nice to learn new things".

Mathematical Trickery:

"Very entertaining", "Fun, interesting", "Exciting", "Cool!" "I'm going to use them", "most of it was good", "amazing", "clever and made you think", "bit boring", "could have had more tricks", "was fun, but not my type of maths", "Good to learn

new tricks", "different side to maths", "Working out how the tricks worked was interesting".

Cryptic Challenge:

"I have learned more about coding", "Increased my knowledge of binary in a light hearted way", "Fun", "Funny, challenging", "Exciting and funny", "EPIC!", "enjoyed it", "really good", "cool, good, catchy", "helps me understand", was fun and I enjoyed the hard work", "interesting way to learn and think".

Fun Maths Roadshow:

"fun fun fun!!!", "challenging + variety", "fun and hard", "fairly challenging", "not very interesting", "bit boring", "not much actual maths, but we got sweets :)", "Working as a pair to solve little puzzles with the motivation of a prize was fun", "Similar to a fun maths lesson", "Bit too much maths", "Not as good as everything else".

What do you feel that you have learnt from the day?

"cool codes and tricks", "I have learnt more about coding", "more teamwork skills", "not much, but better than school", "that maths isn't all boring" "that maths can be fun and used in everyday jobs", "that maths is an essential part of your life", "…Binary?" "to solve problems, etc.", "maths isn't just for school!", "cool things to do with maths", "maths is very important in a lot of concepts and life", "logic skills", "maths is used in different ways", "Loads of awesome stuff".

Would you recommend this Enrichment day to other students?

All pupils that answered this question (two did not) answered *"yes".*

Please detail any suggestions for improvement to this day and give any other comments that you would like to make:

"add an extra activity because everyone loves it", "more tricks on the trickery", "mathematical roadshow more entertaining", "have laptop and electronic devices, etc.", "football at lunch break and make it more funny", "more puzzles", "have more time", "no improvement, the place is outstanding", "we could have got rid of the why do maths thing", "goody bag and to do more real life maths".

Discussion, Learning and Impact

The pupil evaluations clearly indicated that they had enjoyed the day and the activities. Their comments show they did not only feel that they had learned more (and new) mathematics but had a better idea of the pervasiveness of mathematics in the world of work.

It was interesting to note that on both days the Fun Maths Roadshow was not rated as highly as other sessions. This was an unexpected result as trainees have used these activities in the past and they have been well received. From the responses given many pupils found the activities in the Fun Maths Roadshow to be hard however it is possible that the pupils were making comparative judgements about their enjoyment of the sessions when completing the evaluation forms as opposed to rating each session on its own merits.

Approximately half of the teachers accompanying the pupils had previously trained for their PGCE at the University. This confirmed the anecdotal evidence that trainee teachers continue to support and promote enrichment activities in which they have been involved during their PGCE year. The teachers were keen to discover where the activities had originated and some contacted the tutor for further information after the event.

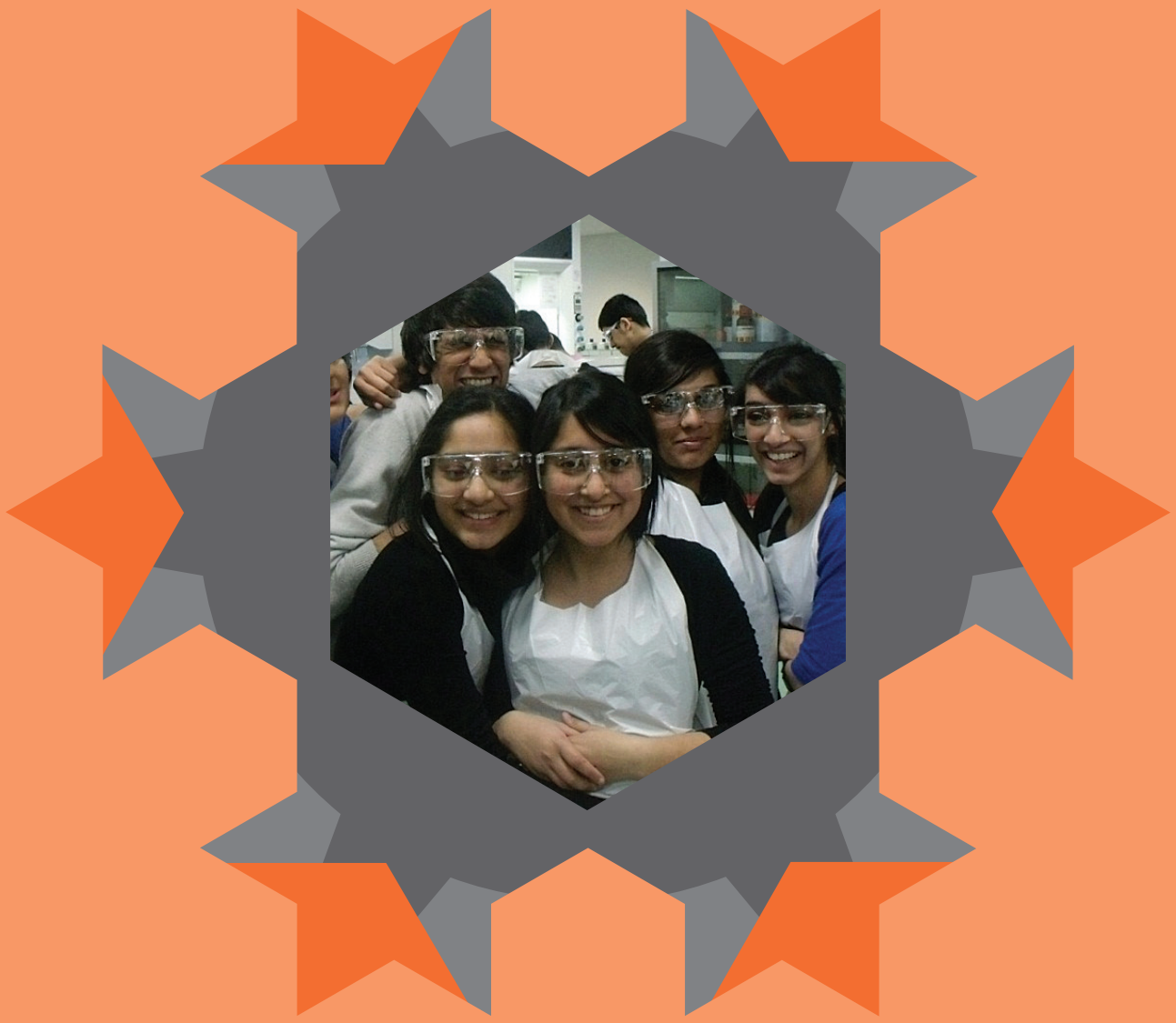
Whilst twelve schools had registered for places at the enrichment day one school was unable to attend on the Friday. The timing of the day was suitable for most schools however two schools had to leave fifteen minutes before the end of the day in order to return the pupils to school in order to catch their buses home. Consideration will need to be made for this in future years.

Further Development and Sustainability

Two of the activities were highly successful and well rated by the pupils. It would be worthwhile looking at the problems in the Liverpool Roadshow boxes that were used as a number of pupils reported these as being 'hard'. This activity may be replaced in future years by a different, more interactive one.

Sustainability will be increased through identifying each year, particular trainees as 'specialists' for each activity. They will subsequently be involved in the training of the new cohort in the use of the resources and running the sessions the following year. In subsequent years the faculty will aim to seek sponsorship from local businesses to support the running of the workshops.

Examples of the Transfer & Embedding of Activities from the Institute of Physics 'Stimulating Physics' project



Ashfield Music Festival

Lynn Moran, Department of Physics, University of Liverpool

Engagement and Target Audience

The Ashfield Music Festival was run by the Physics Outreach Group at the University of Liverpool as an all-day activity on 3 dates (7 December 2011, 14 December 2011 and 23 March 2012) in 3 different schools in the Merseyside area. In total 138 pupils (59 girls, 79 boys), 126 from Year 9, and 12 from Year 8 (Gifted & Talented) participated in the events. Teachers, student teachers on their PGCE, teaching assistants and careers teachers all participated in the events. The running of the events involved undergraduate and postgraduate students from the School of Physical Sciences and the School of Engineering, many of whom had never been involved with outreach before. These students were trained and supported by staff from the Physics Department and the new Central Teaching Laboratory, who have since collaborated on further outreach activities based on the success of these events.

The schools (except one) have an above average percentage of pupils on free school meals. The host schools were also encouraged and supported to invite schools from their area. At Hillside High School the 36 participants were 12 Year 9s, 12 Year 8s, and 12 Year 9s from Archbishop Beck Catholic College (AB). At Gateacre Community Comprehensive (GCC) the 54 participants were all Year 9s, 30 from GCC, 12 from St Francis Xavier's College (SFX) and 12 from Childwall School (CS). The final event was hosted by The Mosslands School (MS) and was again entirely for Year 9s, with 24 from MS and 24 from Weatherhead High School (WHS).

Details of the participants, including the percentage of pupils at the school on free school meals (FSM) [1] are provided in Table 1.

Background and Rationale

Our previous outreach events were aimed at increasing the uptake of STEM subjects at A-level, but evidence indicates that by Year 11 many pupils have already made their decisions. Targeting Year 9 pupils would allow us to have an impact on their decision making for GCSE options. We are often asked to provide activities for Year 10 students with relevance to careers, but we have struggled to demonstrate how the skills they are developing in science are relevant in the real-world. The *Ashfield Music Festival (AMF)* activity is particularly interactive.

The purpose of this funding was to run the *AMF* 3 times in the academic year 2011/12 for Year 9 students about to make their GCSE options choices. The intention was for the schools to host the event in order to reduce costs for the schools involved, but also to emphasise the links for the pupils between the science they study in school and the real-world applications of science.

This activity (*AMF*) will then be available for us to deliver in the future, with experienced staff and trained students, and will inform our development of new workshops.

Implementation

All 3 events were run in close collaboration with the staff at the schools, though the University of Liverpool staff took responsibility for providing risk assessments, booking buses, as the costs were covered by funding, and providing the materials, prizes, etc. The undergraduate and postgraduate students who would help run the event were trained at a Physics Outreach Group weekly meeting, by briefly outlining the event

School	Fsm	Year 9		Year 8	
	%	Girls	Boys	Girls	Boys
Hillside High School (HHS)	38.2	6	6	6	6
Archbishop Beck Catholic College (AB)	28.5	5	7	0	0
Gateacre Community Comprehensive (GCC)	23.8	12	18	0	0
St Francis Xavier's School (SFX)	13.2	0	12	0	0
Childwall School (CS)	38	6	6	0	0
The Mosslands School (MS)	43.3	24	0	0	0
Weatherhead High School (WHS)	29.5	0	24	0	0
TOTALS		**53**	**73**	**6**	**6**

Table 1: The participant schools, their percentage of pupils on free school meals and the breakdown of girls v boys and level

and assigning roles to pairs of students, clearly defining the leader who would have the final word on any small decisions which needed to be made on the spot. As the students read through their documentation, such as the 'expert brief' they shared their understanding and they were led through a discussion of what may happen or be asked by the pupils.

After the first event, everyone met again to feedback details of how it was run in a session that doubled as an opportunity to train some new recruits. The newer people were assigned to work with someone who had undertaken that role previously.

Staff took a leading role on the day, presenting the general information to the pupils and overseeing the timing of activities and the judging. Staff at the schools were encouraged to engage but were not given specific roles as they often had other responsibilities which meant they slipped out occasionally.

In the first school, it was possible to take the pupils completely off-timetable for the day, and coffee breaks and lunch were provided for the pupils who were allowed to decide how and when they would work. This appealed to the pupils and made it seem more like a working day over which they had control, though not all pupils have the maturity to work well in this situation.

At the 2 other events it was necessary to stick to the school timetable, and otherwise the day was run in a very similar manner, except that due to the large number of teams involved, the presentation session was divided into 2 groups. The overall winner was decided between the winning teams of the two presentation sessions based on their responses to detailed questions about their proposal in a short final session with all participants.

Evaluation

A bespoke questionnaire was given to each pupil and each teacher at the schools to investigate the impact, if any, of running the event in terms of the pupils' interest in further pursuing science (i.e. by taking triple science) and their ability to see the applications of physics in the real world. In total 124 of a possible 138 completed questionnaires were collected: 74 boys/50 girls.

Pupils were asked 9 questions: they investigated their enjoyment of *AMF*, their opinion of the educational value *AMF* (in terms of physics and of the application of physics in the real-world), and their GCSE choices.

Discussion, Learning and Impact

The percentage of pupils choosing *'I enjoyed it/it was interesting'* or *'I really enjoyed it/it was fascinating'*: 77%

The amount the pupils felt they had learnt about physics and the applications of physics to the real-world varied between 70-80% from school to school. The slightly lower values corresponded to schools in which pupils believed they already had an excellent experience and understanding of the applications of physics in the real-world. The pupils who felt they had learnt *'Yes, quite a lot'* or *'Yes, very much'* corresponded to those who responded positively that *'I'm a little more interested than before'* or *'I'm much more interested than before'* (in physics) was approximately 75%.

The pupils were asked if they intended to study triple (separate) sciences at GCSE:

50% *'Yes'*

32% *'Maybe'*

When asked if the AMF had influenced this decision the results were:

26% *'Yes'*

27.5% *'Maybe'*

Most of the remainder indicated that they do not have a choice, but will automatically study triple (separate) sciences as they are in the top stream. The pupils enjoyed different aspects of the AMF including: the independent working style, the presentations, the poster, and the proposal. Other pupils did not enjoy giving presentations. Overall the event is effectively run according to the Institute of Phsyics documentation, but I would add 2 points:

1. The music in the video is considered 'uncool' by this age group (I have a better version if anyone wants to contact me directly for a copy).
2. At the start: although the pupils may know well each other from class, or may not, it is best to put the choice of name of their festival as their first activity together as it is a simple short task, and it is easy to get them started on it, then get their attention back.

Further Development and Sustainability

Many of these schools had not worked with us previously prior to running the National HE STEM Programme supported *AMF*, however all have asked for further talks, outreach activities or campus visits to the Department of Physics. Three schools asked for the activity to run again in their school for all (or a suitable section) of their Year 9 pupils at choices time. In addition to running these the Physics Outreach Group are advertising the *AMF* to schools with whom there has previously been little contact, in the hope they may have a similar reaction.

Physics Outreach Events have been developed over the years to be high impact and targeted, often involving pairs of students visiting pupils in their classroom on several occasions to run linked workshops. This is

based on research which indicates that pupils often perceive 'science' outside of their classroom/national curriculum (even Lab in a Lorry in their school yard) as different to and unconnected with 'school science' [2], [3]. Further, the impact of sustained contact over one-off events has been well documented [4].

Therefore, while *AMF* is very useful to attract schools new to working with the Physics Outreach Group to provide science/physics enhancement events, it has had little impact on the design of other outreach events. The Physics Outreach Group has always had far more positive feedback from pupils of the same age/level about their change in attitude to physics after our own events than *AMF*, with significantly less cost in terms of staff time in preparation (at both the school and the university), staff/student time and general expenses (printing/laminating, prizes, etc.).

References

[1] Department for Education http://www.education.gov.uk/areas-and-establishments

[2] Barmby, Patrick, Kind, Per M and Jones, Karen. 2008. Examining Changing Attitudes in Secondary School Science. *International Journal of Science Education*. June, 2008, Vol. 30, 8. Pp. 1075-1093.

[3] Osborne, J, Simon, S and Collins, S. 2003. Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*. 2003, Vol. 25, 9, pp. 1049-1079.

[4] Moran, L, 2001. The Physics Outreach Group: A How to Guide. *New Directions in the Teaching of the Physical Sciences*. 2011. Issue 7. pp. 63-68.

Developing a Physics/STEM Roadshow

Debra Croft, Centre for Widening Participation and Social Inclusion and Institute of Mathematics and Physics, Aberystwyth University

Engagement and Target Audience

A total of 43 people attended the Show and/or the training workshop. Of these, 16 were invited guests from our local Communities First (multiply deprived areas) youth group as part of their half term programme. These are particularly challenging young people and were aged between 12 and 16 years of age. They watched the show, had lunch with the full group and then left.

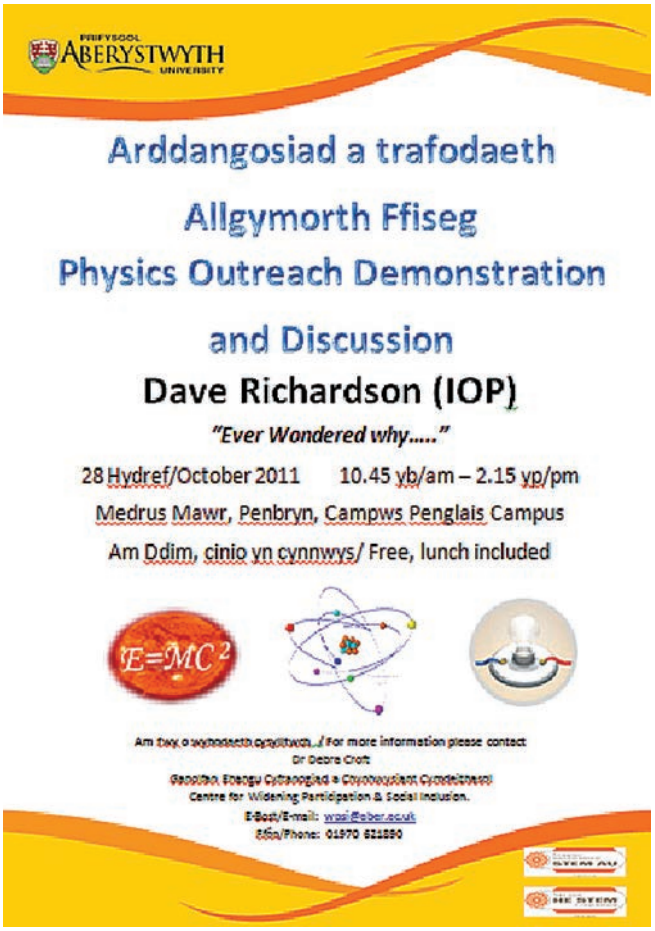


Figure 1: Flyer to promote Roadshow

The undergraduates (18 students) and postgraduates (5 students), and staff (4) attending were there to watch the Show and observe the invited guests and their interactions. They then attend the *Masterclass*, using the Show as a basis for discussion. The undergraduates, postgraduates and members of staff attended from a range of departments from Aberystwyth including the Institute of Mathematics and Physics, the Institute of Biological, Environmental and Rural Sciences, the Department of Sport and Exercise Sciences, the Department of Computer Science, and the Centre for Widening Participation and Social Inclusion.

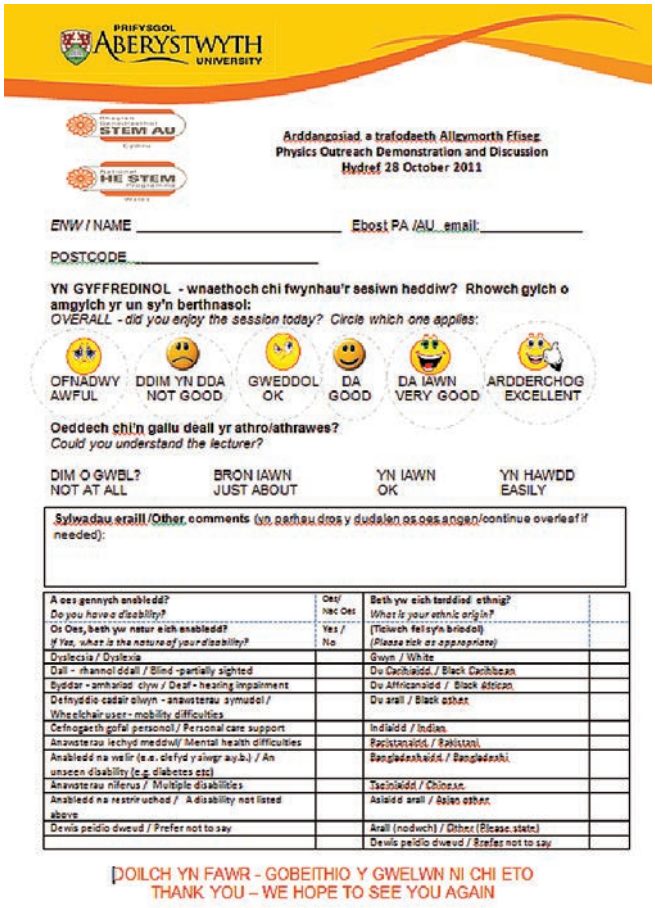


Figure 2: Evaluation form used at event

Background and Rationale

Having worked extensively with the School of Physics in the joint Institute of Physical and Mathematical Sciences, we wanted to improve the skills of undergraduates and postgraduates in designing and presenting a physics based road-show, using the Institute of Physics recommended presenter, David Richardson and his *'Ever wondered why …'* show [1].

Implementation

A Roadshow is not in and of itself a new and innovative idea. Dave Richardson has delivered this show for

the Institute of Physics in many locations and for many different audiences and it is finely tuned.

In this context, we chose a potentially difficult audience of young people from a widening access background, in holiday mood, with no teachers or parents present. The invitation to university students/staff was open to all who had an interest in physics and /or outreach. The Centre for Widening Participation staff also attended.

The format for the day was as follows:

10:30 Refreshments available

10:45 Guests arrive

11:00 Show starts

12:00 Show ends

12:10 Buffet lunch

13:00 Master-class for students / staff

14:15 Close

Evaluation

We wanted to collect information from the audience and also from the workshop participants and analyse these separately. All participants were evaluated using standard questionnaires (Figure 2).

Youth Group:
1. Overall, did you enjoy the session today?
87% rated the session Excellent or Very Good.

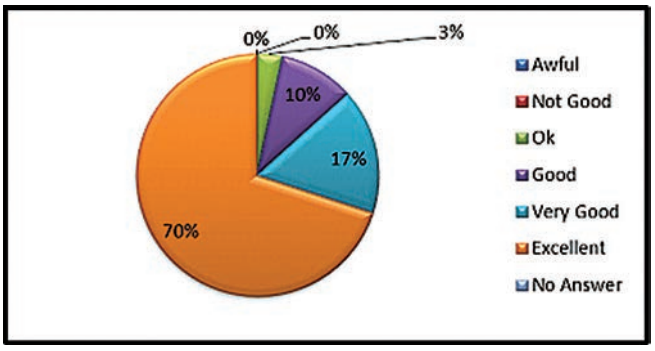


Figure 3: Student responses to the question: 'Overall, did you enjoy the session today?'

University Students: Overall these were extremely enthusiastic and the data supports this. We also asked for comments and the following are typical examples:

"Very enjoyable and excellently presented, the communication talk afterwards was very useful and really good advice. I will definitely adapt some of the advice to my presentations."

"Incredible, very good show, most excellent communication session afterwards, practically answered some of the hardest questions about being a teacher for me."

"The talk after was very useful about how to manage groups and how to change attitudes by changing the environment."

Discussion, Learning and Impact

Dave Richardson's *'Ever wondered why…'* show is already a proven success. This was our reason for using it as a Masterclass subject. As a result of the in depth session after the Show (feedback from some of those attending shown above), a number of follow up discussions were held with individuals and groups. It is apparent that this format worked well and the enthusiasm and outreach work coming from it is already being planned and honed.

If we were doing a similar event, we would like to have attracted a larger audience for the Show. Due to timing issues we were restricted to using the half term session and therefore access to larger school groups wasn't possible. In some ways, however, the nature of the smaller event enabled the student observers to gain a better view of the audience and gauge some of the problems and solutions with a challenging group.

Further Development and Sustainability

We are currently working with Biological Sciences to roll out a similar project for their students as this is an area which doesn't attract STEM funding, but where we can disseminate our expertise and knowledge from the physics based event.

We will continue to work with the students who attended and assist them in outreach work, as well as developing similar training for subsequent years coming through. This student led work, with older years training 'freshers', makes this a sustainable model with minimum support from our team and thereby enabling us to deliver more widely. To that end, we have also made a number of small grants for basic equipment (total approximately £300 in all) to enable the students to go out and deliver sessions in a variety of settings (schools, youth groups, scout groups, community settings and open sessions at local events).

References

[1] 'Ever Wondered Why…' playlist: http://www.youtube.com/playlist?list=PL562F42C2BB10C31C

Outreach Workshop: Doing Outreach

Lynn Moran, Department of Physics, University of Liverpool

Abstract

The *Doing Outreach* workshop from Graphic Science was run for postdoctoral researchers and staff across all departments of the Faculty of Science and Engineering. A mixture of those who volunteered, and those who were asked to represent their department, led to the dual outcomes of staff who are better prepared to organise and run outreach activities and, perhaps more importantly, those who are convinced of the importance of outreach. In particular, for those new to outreach, was the discovery that many school pupils, particularly widening participation (WP) pupils, may have a completely different concept of science/engineering in terms of its importance and relevance than the staff themselves. Since the event, all staff have been more enthusiastic about presenting and encouraging their postgraduate students and postdoctoral researchers to become involved with on campus events and consider the Researchers in Residence programme as an option. Further, running this event has led to collaborations which will have interdisciplinary events running in schools as early as October 2011, with a lot of ideas and plans for sharing of good practice and resources in the future.

Background and Rationale

The Physics Outreach Group, along with Mathematics Outreach and the SchoolsLab in Chemistry are in the process of merging to become the School of Physical Sciences Outreach Group. Although there is much experience and subject-specific expertise in these groups, it was felt that something external would be of great benefit to those Schools in the University looking to follow good practice by developing their own outreach activities.

The Physics Outreach Group's expansion means that much of the outreach activities of the Department, both on and off campus, are organised and run by undergraduate students. Although this gives our students excellent experience, it meant that no staff members were 'discovering' the reward of doing outreach by being 'needed' to help run events.

Implementation

The *Doing Outreach* presenters from Graphic Science were booked for 12 April 2011 in order to suit as many potential participants as possible. The workshop was advertised throughout the North-West, with attendees from the Schools of Physical Sciences, Engineering, Environmental Sciences, the Stephenson Institute and the Science Communication Unit, including 2 admissions officers. Where no contact was known, the Heads of Departments, Schools and Faculty were contacted via e-mail, who kindly forwarded the details to the relevant person, or nominated an attendee. The event was held in the Foresight Centre of the University of Liverpool.

Evaluation

Graphic Science requested that attendees complete an evaluation form. As the day had been long and the purpose was to change attitudes to positive, I didn't see the benefit of pushing participants to complete a second form. However, all who attended have approached me since (and have been positive when approached) to become involved with outreach activities.

There have been a number of specific outcomes post-event:

1. The 2 representatives from the Electrical and Electronic Engineering School have run the first (of several planned) outreach activities for a large group of Key Stage 2 pupils. They have informed me that they felt more confident after attending *Doing Outreach* and invited more schools than originally planned to their first event.
2. The Electrical and Electronic Engineering Department have agreed to collaborate to deliver the *Ashfield Music Festival* series to be run by the Physics Outreach Group between September and December 2011 (supported by the National HE STEM Programme).
3. One attendee has since obtained a lecturing post at Coventry University and is now determined to be involved/set up outreach activities despite no prior experience before the *Doing Outreach* event.
4. Another attendee has agreed to start with some outreach at her child's school and in particular has encouraged her postgraduates and postdoctoral researchers to participate in events on campus.
5. There are plans for the School of Physical Sciences Outreach Group (in development) to collaborate with a colleague from Environmental Sciences to develop outreach programmes (it

is unlikely we would have met if she had not heard about this event and registered).

6. Both admissions officers who attended (from different Schools) say they feel better equipped to discuss with A-level/Access to Higher Education students why they might choose science (in particular physics) over medicine or another oversubscribed subjects (for example dentistry or veterinary medicine).

7. All attendees discussed at the end of the day their new awareness of the different views of their subject and higher education present in school age children, particularly those with little exposure to higher education such as widening participation cohorts, compared to their own views (even at that age).

8. Many who could not attend were delighted to have made contact with others working on similar activities in the North-West and there are some early-stage plans to meet and share ideas.

Discussion, Learning and Impact

The goal was introduce those new to outreach to best practice in order to encourage them to participate; this has already begun. The idea of having external experts who came armed with data to support their claims and were willing to discuss the issues with the attendees was very important. As scientists (and engineers) the audience wanted to draw their own conclusions, but were previously lacking a lot of detail on student numbers in science (that those with the appropriate grades often chose medicine, finance or other subjects was quite a surprise to many who are dedicated to their subject!)

The main difficulty was choosing a convenient date to fill the places with attendees from a wide variety of backgrounds/locations. In the end, I did succeed somewhat in this, but there was interest from staff at the Universities of Leeds and Manchester who unfortunately could not attend. I would recommend a longer lead-in time to anyone planning to run such an event; I only allowed myself 2 months. It is possible people were not exactly clear what was on offer and who should attend as well, which I followed up on where asked, but in the future I would obtain a flyer/abstract from the deliverers well in advance for advertising and promotional purposes.

Further Development and Sustainability

Running this event has legacy. At a simple level we have more staff across several Schools and Institutes in Liverpool who are better prepared to organise and deliver high quality outreach (and in many cases more interested in doing so if sent as a representative of a School).

At a higher level it has initiated several collaborations through which we can spread existing good practice (and also experiences and connections) and what was learnt at this event.

Finally there is a basis for collaborations further afield and the sharing of ideas across subjects and locations as a consequence of running/advertising this event, even with those who could not attend. We are going to follow up on all of these possibilities between now and December 2011 as we have several examples of good practice to share.

Extending Your Outreach

Paula Martin, Department of Physics, Durham University

Engagement and Target Audience

The stakeholders who were invited to participate in the Extending Your Outreach one-day workshop were:

- Durham University staff and students.
- Staff and students from other local HEI's (Newcastle, Northumbria, Sunderland, Teesside).
- Other locally-based people with substantial experience in public engagement and outreach activities.

The workshop did not involve work with school or college age students. However, there will be on-going downstream benefits to them, and traditionally underrepresented groups of learners within the STEM disciplines who will be specifically targeted as and when appropriate.

Background and Rationale

Durham University has a wide variety of experience in developing and delivering public engagement and outreach activities, and regularly provides training for staff and students who would like to become involved in these activities. However, there are relatively few opportunities for those who already have substantial experience in public engagement and outreach activities to develop their skills to a higher level. We aimed to meet this need by offering the *Extending Your Outreach* one-day workshop run by The Training Group to those who have at least 20 hours of experience over the past three years of public engagement and outreach activities. We envisaged that the workshop would help us to support those who have already put a lot of time and effort into public engagement and outreach and would benefit from the opportunity to explore and develop new ideas, enhancing the variety of activities that Durham University is able to offer. In addition, those with similar levels of experience in public engagement and outreach activities from other local higher education institutions and elsewhere were also invited to participate in the workshop, to foster collaborations and encourage retention of highly-skilled workers in this field within the North East region.

Implementation

Paula Martin applied to the National HE STEM Programme to support the running of the workshop at Durham University, and received confirmation of the funding in May 2011. Paula Martin then liaised with The Training Group and Pete Edwards (Director of Science Outreach at Durham University) to identify an appropriate date and specific venue for Durham University to host the workshop. The workshop was advertised using existing communications networks targeting those who actively participate in public engagement and outreach activities, within Durham University and beyond (for example, via the North East Beacon for Public Engagement (Beacon NE) and the North East Science Alliance (NESA)). Anyone interested in participating in the workshop was invited to book a place using Newcastle University's on-line booking system, which provided automatic notification every time a new booking was made, and was set to limit the maximum number of people registered to 20, as specified by The Training Group. As part of the booking process, participants were asked to provide contact details so that further information could be sent to them directly, and to indicate what they hoped to gain from participating in the workshop, along with any special access requirements they had. Durham University hosted the workshop on Thursday 24 November 2011 in the Ustinov Room in Van Mildert College, Durham University (which can easily hold 20 active participants, and was set up 'cabaret' style for the day). The workshop was delivered by Wendy Sadler and Ben Johnson from The Training Group.

Evaluation

The workshop was evaluated quantitatively (in terms of the number of people booking places and the number of people actually attending) and qualitatively (in terms of gathering feedback from all participants and debriefing discussion between Paula Martin and Pete Edwards, who were both involved in the organisation as well as participating). The workshop was attended by 10 people (8 from Durham University, 1 from Newcastle University and 1 other) who all had over 20 hours of experience over the past three years of public engagement and outreach activities. Several other people expressed an interest in the workshop (with 5 others actually registering for the workshop, but then having to drop-out at short notice). Feedback was gathered from all participants using the relatively informal method of asking them to simply note the best thing about their experience of the day and any suggestions they had for improvements on different coloured post-it notes, which were then stuck up on

opposite sides of the room so that all participants could tick all comments/suggestions that they agreed with. All participants were also invited to provide feedback via a standard questionnaire on a single side of A4 used by The Training Group for all similar workshops that they deliver. All of those who participated in the workshop actively engaged with each other throughout the day and all provided extremely positive feedback:

"This was awesome - thanks, I'm inspired and raring to go!"

"Really enjoyed the chance to hear about new ideas, speak to professionals and develop new ideas of our own."

"A great opportunity to explore new ideas and find new people to collaborate with. Thank you."

Discussion, Learning and Impact

Contact details for all participants have been circulated to each other at their request, so that they can continue conversations started during the workshop and consider the practical possibility of future collaboration. The workshop successfully met the needs of the participants, supporting those who have substantial experience in public engagement and outreach activities to develop their skills to a higher level. We found it to be particularly effective to invite people from other local HEIs and elsewhere, and although these 'external' participants were few in number, their alternative experiences provided additional perspectives to many discussions. Although workshop was a great success, it is unlikely that we will repeat this training opportunity in the near future (i.e. within the next 2 years), as there will be little or no demand from the target audience. We gratefully thank the National HE STEM Programme for supporting this workshop.

Further Development and Sustainability

Based in part on our experience of organising and participating in this workshop, in future we intend to make any similar training opportunities open to a wide audience, including 'external' participants, as and when appropriate.

Extending Your Outreach

Wendy Brown, Department of Chemistry, University College London

Engagement and Target Audience

The target audience(s) of the engagement activities undertaken in UCL Chemistry are ultimately school children and the general public. However, in the short term, the training that was undertaken at UCL as part of this project was targeted at equipping PhD students with the necessary skills to plan and implement their own outreach activities.

The activities in this project were mainly targeted at 1st and 2nd year PhD students, so that the students could make use of the skills that they learned by performing outreach activities for the duration of their PhD studies. 20 students received the training, and they are now in a position both to design and implement outreach activities themselves, but also to pass on their skills to other students. The students all receive 'training points' for both attending the training funded by this project, and also for performing outreach activities. This serves as a further incentive for the students involved.

Background and Rationale

Although UCL is often identified in the press as one of the institutions least successful in attracting students from deprived/inner city backgrounds, UCL Chemistry has long been regarded in the College as being exemplary in this respect. The Department's long standing interest in outreach has led to strong connections with a large number of schools in deprived areas of London, and as a result a much wider demographic profile of our undergraduate body. UCL Chemistry's participation in the Aimhigher programme run by the Royal Society of Chemistry (RSC) allowed us to widen these links. However, with the new fee regime being introduced in the UK, the problem of widening participation may become more, rather than less, severe even when new bursaries and scholarships become available.

The UCL Chemistry Department has long had an active Outreach programme which uses both undergraduate and postgraduate students in supporting events in house at UCL (for example spectroscopy days for A-level students, Salters festivals for pre-GCSE students and more general open house type events), and travelling to schools and other events (for example primary school science clubs, Wellcome Collection evenings, Cheltenham Science Festival, Big Bang fair, etc.) to talk about various aspects of their research. While the students who participate in these events are all extremely enthusiastic, none of them have received any formal training in outreach activities and the aim of this project was therefore to empower our students to develop their own projects and ideas independently of the usual academic input and direct supervision. As well as these skills being useful in terms of providing outreach, they are also extremely valuable for the future careers of the students who undertook this training.

Implementation

A training course entitled *Extending your outreach* was run by the Training Group for a cohort of 20 students. The course took place at UCL on 12 December 2011. The event was an all day event and was advertised to all PhD students. Students were allocated places on the course, with priority given to 1st and 2nd year PhD students.

Evaluation

No formal (written) evaluation of the activity was undertaken by UCL, however all of the students who attended the course reported that they found it very informative and useful. Most attendees reported that they would have undertaken outreach activities if asked, but that the course had taught them how to design their own activities from the beginning. They particularly appreciated the ideas that they were given for how to obtain funding, how to plan an activity right from the beginning, and how to undertake effective evaluation of the activity. The success of this training event clearly speaks for itself, in terms of the planned activities by the students who attended (see below). A formal evaluation of the training event was performed by the Training Group themselves and the results were very positive.

Discussion, Learning and Impact

The activities funded by this project were clearly successful, as seen by the broad range of activities being planned by students who took part in the outreach training supported by this project. The activities being planned are mainly targeted at school children, with the aim of enthusing them so that they are interested in science in the future. It is not possible at the moment to evaluate the longer-term effect of this activity, in terms of maintaining the number of students from less privileged backgrounds who go to university

to study chemistry and physics, as the effects of the new students fees have still to be determined. However, there is no doubt that the students who participated in this training event have learned a lot of useful skills that they are now using to good effect.

Further Development and Sustainability

Many events coordinated by the students who attended this training event are now in the early or late planning stages. These include several events for National Science and Engineering week (9 - 18 March 2012) which include 4 new workshops designed by people who attended this training event. These workshops have been funded and are being developed in a form where they will be easy to run and have a 'user manual' so that anyone can run the workshop, thus ensuring the future sustainability of the activities. Students who attended this training event are also running junior masterclasses for Year 9 students over the next few months, with 5 events currently planned and more anticipated. Plans are also in place, again coordinated by students who attended this course, to develop amateur films on the Department's web site that are accessible to teachers. Finally, longer-term plans include opportunities for students to participate in science journalism, by writing about their own research work both on the web site and elsewhere.

Planet SciCast

Laura Roberts, Centre for Life Long Learning, University of Glamorgan

Engagement and Target Audience

Our target audience for this competition were young people between the ages of 7 and 18 from local Communities First schools, Youth and Community groups. These schools and groups were contacted with information and posters advertising the competition via the existing network of contacts First Campus (FC) have across South East Wales.

Schools that attended the competition launch event:

1. Whitchurch High School (3 pupils Year 9 and 2 teachers)
2. Howelll's School (teacher)
3. Darrenlas Praimary School (4 pupils Years 3,4,5,6 and 1 teacher)
4. Maerdy Primary School (32 Year 6 pupils and 2 teachers)
5. St Michael's RC Primary School (27 pupils and 2 teachers)

   (72 pupils in total)

Schools that entered the competition:

1. Tonypandy Community College (team of 3)
2. Whitchurch High School (team of 3)
3. Howell's School (team of 3)
4. Gwauncelyn Primary School (independent entry)

Number of participants (pupils):

- Number of participants (pupils) at the launch event: 72
- Number of participants that entered the competition: 10
- Number of participants that entered Planet SciCast Competition: 4

Number of activities held:

- Launch event (1 morning)
- Support sessions (2 days)
- Celebration event (1 evening)
- Development sessions (3 days)

Other organisations involved:

- Science Photo Library (sponsorship) www.sciencephoto.com
- Geek Pop (video resources and judging) www.geekpop.podbean.com
- Planet SciCast (advice and guidance) www.planet-scicast.com
- Institute of Physics (judging) www.iop.org

Pupils were invited from local primary and secondary schools with which First Campus (FC) have previously worked. These schools are in Communities First [1] (CF) areas or have CF catchments:

'Communities First is the Welsh Assembly Government's flagship programme to improve the living conditions and prospects of people in the most disadvantaged communities across Wales.'

Howell's and Whitchurch High School do not fall into Communities First catchments but had girls as part of their teams which supports the aim of encouraging more girls into STEM subjects at higher education level.

We also contacted CF Youth and Community Groups that FC currently work with, such as the Women into Science and Engineering, Education Business Partnership group, but no response was received from them.

Background and Rationale

First Campus work across the full range of STEM subjects but identified a need to deliver more physics-focused activities. This competition looked specifically at physics and so filled that current gap within our delivery. We also look for alternative ways of engaging young people who may be disengaged from education; this competition allows participants to be involved in a number of different activities with a focus on music and STEM.

The First Campus Hands on Science project chose to run a Science Rap Video Competition which would also lead into *Planet SciCast* [2]. First Campus ran a stand alone competition comprising of a lunch event, technical support, judging and a celebration evening with team and school prizes. The rules for the First Campus competition aligned with those of *Planet SciCast* so that

the winning entries could be submitted to the *Planet SciCast* competition with minimal additional work.

The Hands on Science coordinator had worked closely with Jon Chase (from CBBC's Space Hoppers programme), and a graduate of the University of Glamorgan, on a number of projects. Evaluation of these projects has shown that using 'rap' as a medium of communication in educational projects is a great way to engage young people. In addition to this Jon Chase has delivered STEM specific workshops through rap in secondary and primary schools which has been particularly successful.

Within the Faculty of Cultural and Creative Industries at the University of Glamorgan there was an existing pool of staff and students who could support the technical aspects of the competition (music production, video editing, etc.). First Campus also work in partnership with The Big Learning Company who offer education support and resources in media production, who were on hand to offer advice, guidance and technical support.

The STEM aspect of the competition focused on physics. The aim being that the development of the raps and videos would allow pupils to revise and reinforce their knowledge of physics.

Poster.

Implementation

The competition timeline for the First Campus video competition is shown in Table 1. The competition was launched with an event at the University of Glamorgan Students' Union which coincided with a mail/email shot of all of the First Campus Schools, Community Groups and through other publicity outlets such as Moodle, the University of Glamorgan Intranet and through the other First Campus partner institutions. The launch event was held to outline the details of the competition (to teachers) and to inspire the pupils who attended to participate. There were two performances at this event from Jon Chase (Science Rap) and Jonny Berliner (Science Songs) which gave pupils a taste of how science could be put to music; there were also a number of *Planet SciCast* video entries shown and images from the Science Photo Library as inspiration.

Competition Launch Event	24 January 2011
Technical Support	Throughout February 2011
Competition Deadline	10 March 2011
Judging	11 -14 March
Celebration Event and Awards	30 March 2011 (delayed from 14 March 2011)
Development workshops for Planet SciCast Submissions	18 -20 April 2011
Planet SciCast Submission date	1 May 2011 (extended from 27 April)

Table 1: Competition timeline

In the weeks after the launch event we registered interested schools/groups and received registration forms from the teams who were going to submit videos. During February half-term we ran support workshops at the ATRiuM where pupils could produce some original music and record their rap using University equipment supported by undergraduate music students and Jon Chase.

The deadline for the competition entries was the 10 March. Once all entries were submitted to YouTube the links were sent out with a judging proforma to all the judges (5 in all including representatives from the IoP & NGfLW, the Science Photo Library and GeekPop). Once the judging had taken place all of the teams and participants were nominated for a prize for different aspects of their work. The celebration and awards evening was held on 30 March at the University of Glamorgan Treforest campus and was supported by the Science Photo library (who sponsored the school prize) and Jon Chase, who performed a Science Rap written for the Science Photo library. After the awards ceremony, and during the Easter Holidays, two of the teams returned to the University of Glamorgan to

develop their videos further (removal of copyright images and improving sound and image quality) ready for their entry into the *Planet SciCast* competition by 1 May.

Discussion, Learning and Impact

Four teams submitted videos to the competition, two of which were developed further and submitted to the *Planet SciCast* national competition. Each team was from a different school; one pupil entered independently from their school but had support from their class teacher and Head Teacher, as well as his family, at the celebration event.

Whitchurch High School wrote an article about the event in their school newsletter and also commented that the activity was great for getting student science teachers involved in a project with pupils; this comment was also passed to the University of Wales Institute Cardiff (UWIC) PGCE Science Coordinator.

Key findings & lessons learned: Our planned future response to each of the findings is shown in italics below:

- Schools found it difficult to commit to the competition, even though additional support was offered, at the time of year if was running.
- Teaching timetables and workloads were a common factor in why schools chose not to participate in the event (as stated by teachers in their evaluation feedback).
  The time of the competition was dictated by the funding, however in the future this will not be a limiting factor and can be adapted to suit the schools year/teaching availability.
- Due to the nature of the funding and the specified time limit (the project had to be run by the End of March 2011 and funding was confirmed in December 2010) marketing and publicity was restricted to existing contacts and did not produce a very high return of interest.
- Some advertising was sent out through STEM emailing lists which reach a national audience and generated some enquiries from outside of the South East Wales region, unfortunately due to First Campus' remit we were unable to work with these groups.
  In the future (from 2011/12) specific groups will be targeted to take part in the competition rather than there being an open call for participants. This will negate the need for 'mass' marketing and should return a higher yield of entries.
- Many schools have restricted access to YouTube and this had a negative affect on them choosing to take part in the competition.
- YouTube was used as a submission tool so that the videos could be easily accessed remotely by the judges.
  This could be resolved by removing the requirement for videos to be submitted via You Tube. For example, schools could submit the video via DVD.

Analysis of event relative to its aims and objectives:

Aim: To run a successful Science Rap Video competition that engages a wide range of pupils from Communities First areas and girls in particular, with a multi-media, STEM focused project.

Achieved: *The Science Rap Video competition ran as planned but did not engage the number of participants desired. 50% of the participants were from Communities First Schools and 40% of the participants were female.*

Jon Chase (Science Rap) and Jonny Berliner (Science Songs) with pupils at the launch event

Objectives:

To be successful the competition should:

1. Engage a minimum of ten teams in the Science Rap Video Competition, 50% of which will be female participants.
   Achieved: The competition attracted 4 team entries; 40% (4/10) of whose members were girls. One team was made up of only girls.

2. Enable pupils to learn something new about science with the motivation to research it independently.
   Achieved: Pupils presented topics which were both part of the national curriculum (life cycle of stars & forces) as well as those which do not feature as prominently but are included as additional content for additional science and the separate science syllabuses (nanotechnology & nuclear fusion).

3. Allow pupils to access the University of Glamorgan campuses and gain a better awareness of University facilities.
   Achieved: Each pupil visited the campus on at least one occasion. Some of the pupils visited the campus for a number of consecutive days to attend development workshops. This gave them the opportunity to see two university campuses (Treforest & ATRiuM), visit the students' union and some of the teaching facilities.

4. Allow pupils to engage with academics and students from the University from both STEM and media discipline.
   Achieved: Pupils were able to work with STEM and Creative Media undergraduate students as well as Media Industry professionals during the development workshops leading up to the First Campus competition deadline and the Planet SciCast competition deadline.

5. Engage pupils and teachers in the competition and inform them of the aims of First Campus through a celebration event run during national Science and Engineering week in March 2011.
   Achieved: We had 40 parents and teachers attend the Celebration Event to support the four teams. At least one teacher attended from each school and all pupils had at least one family member with them. Only one pupil was unable to attend on the evening. The opportunity was taken to welcome the guests to the University and to explain to them the aims of the First Campus project, especially in the area of STEM outreach. Unfortunately the event was delayed because of school holidays and staff availability meaning that it did not fall within National Science and Engineering Week.

Student feedback & evidence of impact: Feedback from pupils and teachers after the launch event/ mail shot to schools included the following points:

"We learned new things when listening to the songs and raps performed by Jon and Jonny. We also enjoyed watching the videos created by other pupils." Pupil, Darrenlas Primary School

Feedback from schools on why they did not take part in the competition:

"Change the method used for judging the competition entries – use of "YouTube" because our LEA has restricted us from accessing this via the school intranet." Teacher, Darrenlas Primary School

"We have a number of activities taking place already and this time of the year there are a lot of controlled assignments taking place so pupils and teachers are not allowed to miss lessons. (Finish the start of May). We would prefer the time of year to be changed in order to take part in these sort of activities." Teacher, Bishop Hedley High School

Overall impact: The feedback we received from parents and teachers about the competition was very positive. They felt the project had given their children an excellent opportunity to focus on something creative and learn something new about science in the process. The awards gave the pupils confidence to take back to the classroom and also benefited the schools. Whitchurch High School published an article in their quarterly newsletter on the competition and also found it benefited their student teachers who were involved.

Further evaluation would be needed to gauge the level of impact over time of the competition and it was also be beneficial to go back to the winning school and see how the prize of one years free subscription to the Science Photo Library has benefited staff and pupils.

The competition was successful in engaging the pupils who took part however we were not as successful in gaining a large number of participants. This was due to three key factors:

- Schools feeling they did not have the time to devote to the competition, especially at the time of year the competition was taking place.
- Schools having limited, or no, access to YouTube in order to upload their videos.
- Publicity not reaching enough schools/groups to generate a large number of submissions.

The issues above mean that in future years the project will be run differently, for example:

- The competition will be rolled out to target groups in Communities First areas linked to local schools, rather than to schools directly. The groups will be involved in development workshops that will lead up to the competition. This will guarantee a higher number of entries.
- The entries to the competition will be submitted through YouTube, USB memory sticks or CDRs. All entries will then be uploaded to YouTube for remote judging if required.

Further Development and Sustainability

This event will be run in 2011/12 academic year as a specific Communities First project in an inner city Cardiff area. Young people, who attend community youth groups, will be invited to take part in rap science workshops, led by Jon Chase, which will then feed into the competition. They will have technical support from students from the University of Glamorgan's School of Cultural and Creative Industries and STEM support from the First Campus STEM Coordinator and undergraduate STEM students. To build on the participants STEM learning there may be the opportunity to develop a mentoring partnership between the participants and the STEM undergraduates. This would be conducted through their schools.

Targeting a specific group to run this competition negates the need for wider advertising and so cuts costs and makes the project more sustainable. It also allows the competition to be run with different groups across the South East Wales region that can then be brought together for the judging and celebration event. There is also the possibility that First Campus STEM may link up with UWIC PGCE course to deliver this activity through/ with their students, discussions will take place this coming year to embed it into their programme in 2012/13.

In addition to this work, First Campus is leading a National HE STEM Programme Practice Transfer Partnership during the 2011/12 academic year focused upon developing strategic partnerships with schools and colleges [3]. This will give us the opportunity to transfer the details and findings from running this event to other HEIs interested in delivering more STEM outreach work.

References

[1] http://www.communities-first.org/eng/home/what_is_communities_first/

[2] www.planet-scicast.org.uk

[3] http://www.hestem.ac.uk/activity/widening-participation-strategic-regional-working-schools-and-colleges

Video Entries:

- Tonypandy Community College – Winning Entry
  http://www.youtube.com/user/FirstCampusHOS?feature=mhee#p/a/u/2/14y74JXqG80
- Gwauncelyn Primary School - Runner Up
  http://scicast.org.uk/films/2011/06/nanotechnology.html - Planet SciCast Version
  http://www.youtube.com/user/FirstCampusHOS?feature=mhee#p/a/u/1/yuNZ1Davp_o You Tube Version
- Whitchurch High
  http://www.youtube.com/watch?v=vYmR77ba6_w – You Tube Version
- Howells School
  http://scicast.org.uk/films/2011/06/fusion-love.html - Planet SciCast Version
  http://www.youtube.com/user/FirstCampusHOS?feature=mhee#p/a/u/0/oXgLHUWRjJk - You Tube Version

Problem Based Learning Packages for Active Learning

Martin Loftus, School of Chemistry, University of East Anglia

Engagement and Target Audience

The University of East Anglia (UEA) does not have a separate physics department or a single honours physics degree. However, physics is offered within our natural sciences degree programme and is taught as part of many of our other degree programmes. Of our 80 Natural Sciences students, about 10% have physics as one of their main subjects. UEA also has a physics option within its Science with a Foundation Year degree programme. Of the 40 students taking physics about 10% hope to transfer to our Natural Sciences degree programme to study physics as a main subject. These two groups were the target audience for this case study.

Background and Rationale

Problem Based Learning activities are widely used at UEA by our health related degrees and to a lesser extent within the science faculty. Problem Based Learning (PBL) within physics teaching at UEA is rare. The main aim of this case study was to try out a proven package with a view to incorporating more PBL activities in the future. The topic of mechanics was chosen because it is an important aspect within the foundation year physics course and an important topic for Natural Sciences students to revise. Another aim of the activity was to use a PBL package with a mixed year group to see how it works and to get feedback from the students about working in this way.

Implementation

As Physics is a relatively small cohort at UEA, I am interested in mixed year teaching and peer assisted learning. For this reason, I invited all the natural sciences students with physics as a main subject and those foundation year students wishing to study physics further to join together for this activity. Joining together groups of students that don't usually meet meant arranging the activity for a Wednesday afternoon and so there was the possibility of clashing with sports matches.

In addition to myself the activity was overseen by two postgraduate students. The three of us worked through the activity separately first and then met together to discuss the activity before using it with our target students. I also spent an afternoon at the University of Leicester observing PBL activities in the School of Physics and Astronomy. This gave me the opportunity to discuss running PBL activities with technical and academic staff within the school.

Following a short introduction about PBL and the scenario being used, the majority of the two-hour activity was spent with the students working through the *Making Lead Shot* PBL activity. Time was allowed at the end for the students to provide feedback via a questionnaire.

Evaluation

All participants in the activity were invited to fill in a feedback questionnaire following the PBL activity. Drawing conclusions from small numbers of questionnaires can be difficult to justify, but for a number of questions all respondents gave the same answer, making it easier to conclude that their response is significant.

When asked if the student preferred to work as a group or alone, responses were about 50:50. However, when asked if they preferred to work in a single year group or a mixed year group, all said that following this activity they would like to do more work in mixed year groups.

All respondents agreed that this activity was a useful way to revise ideas and concepts already met in lectures and would like to take part in more of these activities to help with revision. However, there was a mixed response when asked if they felt confident that they could cover lecture material in this way. This is perhaps to be expected when carrying out an activity such as this for the first time.

Discussions, Learning and Impact

All the intended outcomes I had in mind at the start of this activity were achieved. The PBL approach was successful in this activity with a small group of self-selected students. Following this small case study I shall try the same thing again with a larger group in the future. I shall make it part of some mechanics teaching so that it is not just self-selected students.

The key lesson learned from this small case study was the way in which mixed year groups can work with each other to improve their understanding. There seemed to be real benefits for those relatively new to the topic and for those who were revising it. It was also very interesting to get positive feedback from the students about working in this way.

Further Development and Sustainability

I was very impressed with the way the mixed year group worked together and learned from each other. I was particularly impressed with the way the Natural Sciences students helped the Foundation Year students. This is something I will certainly follow up in the future. Foundation year workshops are usually supported by staff and postgraduate students, but following this case study I would like to see if Natural Sciences students could also help. This could be a good way to improve their understanding as well as helping others to improve.

The problem based learning activity itself worked very well. Many students reported feeling much more confident with the idea of terminal velocity and other aspects of mechanics after the activity than before. A significant number of others reported feeling more relaxed about asking questions because of the group working aspect of the activity, and also reported that getting help from their peers made it easier to explain exactly what they didn't understand.

Problem Based Learning within physics teaching at UEA will be more common in the future as a result of this case study. I shall investigate using PBL within my astrophysics teaching and mechanics teaching as soon as possible.


concept2

The Challenges of University - School Collaboration

Les Jones

The Menu of Activities initiative formed one of the key Programme activities to widen participation amongst students of school and college age by transferring and embedding of proven practices from four discipline based projects into the core practice of Higher Education Institutions. Three key desired outcomes were identified at the outset:

1. That universities adopt a range of proven activities and incorporate these within their current provision;
2. In adopting the activities there is a wider influence upon the practices of the department or faculty;
3. The activities are appropriately targeted at widening participation cohorts and in doing so a longer-term way of working is embedded within the sector to enable continued targeting of hard to reach cohorts;

Before considering the desired outcomes from a school perspective it is worth noting the scale of schooling in the UK and thus the available market being considered; the scale is big and it is an increasingly complex landscape. In this next section the number of schools is referred to and then there is a list of the top things to know about internal school organisation and why they exist. By knowing more about these, future planning can take them into account.

Top things to know about schools

Number of Schools

There are 3,446 state secondary schools in England. The vast majority (about 2,950) are comprehensive in intake. There are 164 selective grammar schools in the country and the rest are either secondary modern schools or 'high' schools, secondary modern schools that choose to use a different name to describe themselves.

Within the 3,446 figure, there are 1,300 schools that have now 'academised' meaning that they are more independent of local authority control, and so are known as academies. The difference between these and those that remain maintained by the local authority is that they have the same freedoms as independent schools to set their own curriculum, hire non-qualified teachers and run their own affairs. There are at least two types of academies. There are those set up under the previous Labour government which have sponsors (educational charities, private providers, independent schools and universities). There over 300 sponsored academies. Under the current government Coalition, some existing state schools were allowed to transfer to academy status (based on high Ofsted ratings). There are 981 transferred academies.

There are 16,884 primary schools in England.

There are 24 free schools of which have opened up for the first time last September. A free school has the same freedoms as an academy. The difference is that it is a new school started by a variety of parents', teachers' or faith groups, or an educational charity, such as an existing independent school or college.

There are 2,415 independent schools: 1,625 primary and 790 secondary. These educate about 7 per cent of the school age population.

In Scotland there are 372 secondary schools, all comprehensive in intake. Of these, 53 are faith schools (all Catholic). There are 2,099 primary schools.

In Wales, there are 1,435 primary schools and 222 secondary schools. All the secondary schools are fully comprehensive.

In Northern Ireland there are 832 state primary schools and 215 secondary schools of which 68 are grammar schools.

Variations that Exists Between Schools and their Organisation

1. School Capacity

The biggest difference between schools today is their 'capacity'. Capacity in this context is the ability of a school to be able to respond to new things and add significant value to a young person's education: to do the essentials but also to take on new challenges, enrich the curriculum and to go the 'extra mile' and succeed.

There are practical considerations which affect capacity. A good example is school funding as this varies according to location and intake of pupils. Many schools carry surpluses in their budgets, others have virtually no reserves. Available human resource for intervention work is a key capacity factor. General dynamism, leadership vision, ambition for pupils, Ofsted rating, deprivation factors, geographical location are also significant. The capacity a school

has to develop its wider vision and the availability of staff for outreach programmes is clearly crucial.

2. Targets

Schools are under pressure to deliver targets. In recent years it seems that the priority for schools has become the headline standards of attainment particularly in Mathematics and English and with the introduction of a new measure in the English Baccalaureate subjects; sciences, a humanity and modern foreign language will be significant. Therefore, any activities that impact on examination classes in these subjects can be viewed as potentially harmful to the examination results for the school and indeed student progression. The current headline measure is 5 good GCSE grades at A*-C including English and Mathematics.

The very tight margins that schools now work to are worth exploring. Consider an 11-16 school with 1000 pupils with 200 in each of five year-groups, currently performing at the national average level for GCSE. If the equivalent of one class of pupils (25 pupils) miss a C grade in Maths and obtain grade D or below then the headline results for the school (5A*- C grades including English and Maths) will be 12.5% lower than they might have been. This drop would be catastrophic for the school and very unhelpful for the students concerned as well. Even 10 students missing a crucial C grade or A* (5%) can have a major impact on how a school is viewed by inspectors and other bodies. Similarly in 11-18 schools and sixth form colleges, at A-level where A*, A and B grades are paramount. One or two topics that are not mastered by pupil cohorts are enough to create the dip in subject performance and trigger the downward trend in headline measures.

Releasing students for any activity, from the outreach interventions as reported in this publication through to other enrichments such as sport is therefore very carefully considered by schools, as missing crucial lessons makes it harder for the pupils and the school to maintain their top standard of attainment. Interestingly, the harder to reach pupils are often in the schools where any drop in attainment is likely to have the greatest impact on margins. Fortunately, many schools are now expert in ensuring that the impact of valuable enrichments avoids this problem.

3. School Calendars and Timetables

In schools there are really two timetables: the weekly timetable of scheduled classes - an internal document and the annual schedule of events or calendar *per se*.

The latter is normally published on the school website. Construction of school calendars normally begins in the autumn or spring term of the preceding academic year. A few UK schools have a two or three year view, but not many. Timetables normally begin as a concept in the autumn term of the preceding academic year and are 'firmed up' in the spring and summer. School days usually have two main timetabled sessions: morning and afternoon with some schools scheduling a third phase in the twilight, but this is rare.

Feedback from activities that took place in twilight time, for example, the Maths Challenge at Wolverhampton was very positive as there was much less disruption to normal scheduled classes in school. The downsides are a long working day for school staff and an extended day for the busy students, but the potential impact on both groups should be taken into account at the joint planning stage. So long as the same staff and students are not regularly engaged in this way any impact should be reasonable and acceptable to both groups.

Timetables run for one or two weeks. Even the latter tend to have a repeating pattern so planning events on different weekdays if the same year group is involved makes sense. Aligning higher education and school calendars is difficult but possible. Longer term planning is advocated but this is rarely undertaken because of funding and staffing uncertainties in higher education institutions. Regularising events has its plus points and there is evidence in the feedback from case studies that this is being thought about in relation to the Pop Maths Quiz and Hands on Maths Workshops.

Dates for key annual events like National Science and Engineering Week have become embedded. Therefore, in the same way, The Mathematics Challenge, the Ashfield Music Festival or the Solar Car Challenge Finale, set up for schools in collaboration with a local university, or cluster of universities, could always occur at a similar time each year.

There are at least two draw backs to be avoided: STEM overload in Science and Engineering Week in March and the possibility of too little long term impact by promoting STEM in this way in the spring term only as there is less opportunity for re-enforcement of messages and knowledge. By being aware of scheduling and regularising STEM outreach, other events being scheduled around this in the future could become a norm. For example, the adoption of a thrice yearly approach to STEM interventions may be the answer to deeper impact.

Therefore the projects reported here will only work if they are very carefully planned, preferably avoiding key examination preparation times, are of very high quality, and offer excellent value for money.

Universities and schools can maximise the impact of the higher education led STEM interventions by considering several events like this per annum. Coupled to this there is anecdotal evidence that what you do in the first week of term has a great impact on the tone of the rest of the year. Beginning each academic year with a STEM intervention might therefore be one good way of starting

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Year 7			National Big Bang Fair						New Intervention			
Year 8		Pop Maths Quiz					Solar Powered Car		New Intervention			
Year 9						Chemistry Outreach			New Intervention			
Year 10		Pop Maths Quiz	National Big Bang Fair						New Intervention			
Year 11									New Intervention			Revision pre/post exam
Year 12			National Big Bang Fair						New Intervention			
Year 13									New Intervention			Revision pre/post exam

Figure 1: The STEM Intervention Calendar: Holistic View. Schools can populate their Calendar from the Menu of Activities by agreement with universities. Examples are given in red and green. Year 11 and 13 could take part in specialised work. Invented new activities could start the year. Established events can be included.

the school year. The benefits include an academic focus for pupils, and exposure, and re-exposure to universities and those from within the higher education sector.

4. Health and safety

The safety of children and other young people in any context is, of course, paramount. Approaches and nomenclature vary but schools normally adhere to the statutory guidance on educational visits. There are four 'Categories' 0-3 and the number relates to a general type of activity: for example, a university visit with organised transport would be Category 1, and one using public transport Category 2.

A ratio of 1 teacher to 20 pupils is normally acceptable for non-international school visits, so for a class of thirty this usually means two members of staff. Schools also prefer to take at least one male and one female staff member if possible. A school normally requires staff leading the venture to complete a risk assessment document in advance of the activity.

School and college practices can vary significantly although group travel is often used. One advantage of communal transport is timing; a group arriving together in a punctual manner is advantageous when registering at larger events. Another advantage is to reduce costs as public transport can be expensive. Group travel is common practice in many schools even when students are 17 or 18 years old and very able to catch a bus or train safely on their own. Schools tend to be very cautious with all age groups. They see an increased risk when pupils are asked to make their own way to university venues, although the school will have discharged its general responsibilities by informing parents of the proposed travel arrangements and obtaining written permission.

The biggest difference in travel culture is seen between rural and urban schools and colleges. In urban areas it is more common to rely on public transport which is a way of life.

So long as the school has evaluated all the potential risks through the risk assessment process and followed the statutory guidance, there is no reason why pupils cannot attend universities under their own steam. This has cost advantages to schools as if the event is in the evening or at a weekend it would be expensive for schools to employ staff to provide care for the pupils.

5. Finance and staffing

In 2009 a statutory duty upon schools to use teachers only rarely for covering colleagues' lessons was introduced. A teacher may not be required to cover for a colleague when an absence is planned. Teachers working in school or attending outreach activities with students constitutes a planned absence so the full direct cost of

an outing normally has to include an element for supply teacher cover or for the use of cover supervisors.

Both methods have costs attached. £200 per day per is a standard supply teacher rate at the time of writing. Costs may be reduced by only having one teacher and then a support member of staff in which case there may be no direct second supply cost. There is a hidden cost in that the second person cannot perform his or her other duties whilst out of the office.

Teacher Supply 1	£200
Teacher Supply 2	£200
Coach Cost	£300
Total Cost	**£700**

Figure 2: Example Budget for a School Attending a Local University

This is not a large sum against a multi-million pound school budget but, on the other hand, £700 is about half of the annual capitation budget (money for books and consumables) of a History Department in a small school and so this is seen as a significant investment and cost by many schools.

Schools could possibly do more to target resources at higher education creating a healthier budget and allocating more staff, but this is a significant strategic decision for a school. As less funding will be available to schools in the future this thinking will have to take place to maintain and develop contact with higher education institutions.

6. Cancellation Penalties

Unavoidable and unforeseen problems do arise in schools. In several cases interventions through this Menu of Activities initiative did not take place due to cancellations; some of these were late notice communications. Some universities are starting to make up-front charges, so that they are not out of pocket should there be a difficulty, and others are considering this. An upfront agreed compensation arrangement is probably the best way to deal with logistical problems of this nature.

7. Communication

Communication is a challenge for any organisation and there are many good examples from the engagements reported here; however, there have also been some avoidable frustrations.

Simple and clear planning tools naturally work best. Creating a master document with simple nomenclature which everyone can refer to is best. This 'planning tool' will soon build into a fairly 'weighty' document including: the names and contacts of line/team members from each participating institution; presenters; resources lists; costing sheets; contacts for catering; coach companies; risk assessments; maps; fliers and so on. This can be kept as a master by the lead organiser.

Using a line management or team structure when planning an event is efficient for schools and their partners. This ensures that alternate staff can take over day-to-day planning and management should the need arise. Always use generic email addresses which can, if necessary, be accessed by each authorised member of the line or managing team: for example **hestem@yorkhighschool.com**.

8. The School Plan

'The School Plan' is an important planning tool. It can have a number of names but essentially it is a one-two or three-five year strategic planning document normally in the form of a costed development plan.

Whilst there is no statutory requirement to have strong links with local universities, this is a universal aim of schools, and so a carefully thought through strategy will improve communication within the school and enhance chances of success. Enthusiastic and committed individuals will make the logistics work and they will drive the development of quality experiences and refine and adapt when necessary.

Top Tips

Top Tips 1: To begin

- Develop the vision first: Consider cost and practical reality later
- Unaffordable ideas or scaling can be deferred and may be achieved over time
- Centre the School Calendar on STEM Interventions
- Invest some time early in the venture to develop strong relationships
- Make senior contact with the school if possible
- Meet the Head Teacher if possible
- Identify at least one individual who is totally committed to the liaison work
- Identify the best STEM role models and invite them to participate
- Be aware of possible gender bias in design, participants etc.
- Plan years rather than months ahead, if at all possible
- Repeat activities at similar times each year
- The start of the year is too late for planning – consider 3-5 year plans
- Direct targeting is most effective but utilise head teacher networks

- Ensure the different types of schools are considered
- Develop on-line booking tools in schools and universities at **www.easybook.me.uk**

Top Tips 2: Build up to activity

- Prepare high quality communications for all including the media
- Clarify the commitment and responsibilities of all involved including obligations, individuals and costs
- Ensure early on that the individual participants will actually attend on agreed dates. Agree payments whatever the outcomes
- Where supply chains are involved ensure their stock levels and delivery guarantees
- Prepare agreements in writing using memoranda or contracts for larger work
- Commission high quality photography and video
- Deal with parental permission for use of photographic content at the outset

Top Tips 3: Post-Event and the Future

- Publish results of the work widely
- Reward as many participants as possible through recognition in publications, prizes and repeat activity.
- Consider developing the safe use of proprietary web-sites like Flickr, Facebook and Twitter
- Systematically take new ideas into the classroom to be 'road-tested' with school-aged children.

Conclusions

The legacy of this initiative to schools and colleges and its impact is very wide and very positive. The numbers known to have been involved is one indicator and there are encouraging qualitative indicators too.

Numerous examples of both university and school based work have been included in this report. One or two university staff travelling to a school to present or spend the day assisting with an activity is, of course, very efficient and cost effective for the school, especially if the visit is externally funded. Transport costs are low and there are minimal health and safety considerations. On the contrary, of course, university staff spend time travelling and are thus away from other duties for an extended period. The presence of a member of university staff in a school adds value and the first hand insight into a specialist STEM field or career pathway is invaluable; however, the vital ingredient of university, ethos, cannot be transported. The alternative, pupils attending the university itself, means that they gain knowledge but also visit or revisit the university buildings, see older students learning, spend time in a lecture hall or university laboratory and enjoy some social interaction while travelling and during the event. It is difficult to argue, therefore, that university staff going to schools is better than the pupils attending the university.

A relatively small investment in an outreach activity has led to some really creative interventions for school age and other people. The initial concepts from the work of the four pilot projects were taken to various schools and universities to be enjoyed by thousands of people. Through pub style quizzes, holiday homework, making ice-cream and racing cars pupils have learned about STEM in an exciting way and they have been naturally exposed to higher education along the way. Survey evidence provided by the individual projects suggests that they are more likely, as a result, to want to study STEM post-16 and to aspire to university in the future. The nature of the engagements with harder to reach pupils means that the additional goal of attracting first generation university attendees has also been addressed.

Pooling expertise in designing and implementing activities is bound to be more efficient as we only have to invent something that works well once. Exactly whom will co-ordinate this is open to question but regional networks do exist: there are the Professional Bodies, the National STEM Centre, STEMNET and private companies. Once co-ordinated, the future of successful school and university work probably rests with the establishment of strategic partnerships at the highest possible level and on a regional basis.

The school landscape is increasingly complex and there are ever-sharper targets for school leaders to meet, although there is no direct target for university involvement. However, by overcoming the school-limiting factors for engagement with universities relationships can flourish. Involving third parties or employers maybe another opportunity. Timing is crucial. School calendars and timetables need to be examined in the planning stages. Longer term planning will be hard to achieve, but this could have the greatest impact of all on the future positioning of higher education STEM interventions. Good outreach doesn't have to be expensive. The key to success is in design. Momentum is good and should not be lost.

Les Jones

Chief Executive of Solutions 4 Schools and The Engineering Company (Europe)

The National HE STEM Programme

The National Higher Education Science, Technology, Engineering and Mathematics (HE STEM) Programme was a three-year initiative funded by the Higher Education Funding Councils for England and Wales through an activity grant to the University of Birmingham in August 2009. The Programme co-ordinated its activities through six geographical regions represented by the Universities of Bath, Birmingham, Bradford Manchester Metropolitan, Southampton and Swansea, and by working in collaboration with four Professional Body Partners: The Institute of Mathematics and its Applications, The Institute of Physics, The Royal Academy of Engineering, and the Royal Society of Chemistry.

Working across the higher education sector in England and Wales, with a particular focus upon the disciplines of Chemistry, Engineering, Mathematics and Physics, the Programme supported higher education institutions in encouraging the exploration of new approaches to recruiting students and delivering programmes of study. It enabled the transfer of best practice across the higher education STEM sector, facilitated its wider adoption, and encouraged innovation. Through collaboration and shared working, the Programme focused upon sustainable activities to achieve longer-term impact within the higher education sector.

About the Editors

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Les Jones is Chief Executive of Solutions 4 Schools and The Engineering Company (Europe) both of which support STEM education. He pioneered and was founding head teacher of two specialist schools of Engineering. His teaching covered eight secondary schools in the state and independent sectors when he chaired the National Engineering Head Teachers' Steering Group and his secondary head teachers' association. He has overseen the design, creation and building of three new schools including the Building Schools for the Future Wave 1 exemplar scheme. For the Royal Academy of Engineering he has convened and chaired several influential educational groups working on vocational qualifications and devising and writing the new principles for design and technology in response to the Government's review of the National Curriculum, as well as leading a programme of Higher Education support for the new University Technical Colleges. Much of his time is spent devising new STEM approaches in 14-19 education in the UK, Germany and Italy.

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