Variety in Chemistry Education
Physics Higher Education
Conference 2015

20-21 August 2015

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University of Nottingham, Jubilee Campus

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Thursday 20th August

10.00	Arrival, registration, coffee
10.50-11.00	Welcome and introduction
11.00-11.55 Lecture theatre	**Keynote Plenary** Is "interactive" teaching sufficient to promote conceptual development in physics? *Professor Paula Heron, University of Washington*
12.00-12.30 Lecture theatre	**Oral bytes** Chemistry and Physics: ScoopIt and Share *Simon Lancaster* The IPython Notebook as a pedagogic tool for physics *Louise Dash* Connecting it all together- The TECHEMOL project *Tejas Joshi* Royal Society of Chemistry: online resources for higher education *Rachel Purser-Lowman* Report on the European Chemistry Thematic Network *Karen Moss* The Physics Teaching Fellows Forum *Derek Raine*
12.30-13.30	Lunch
13.30-15.00	**Choice of parallel workshops**
Workshop A Lecture theatre	**'Flipping' Pedagogy 101- Learning Theories for the Flipped Classroom** *Anna Wood*
Workshop B Meeting room 5	**New RSC Context/Problem Based Learning Resources for Chemistry** *Nimesh Mistry, Samantha Pugh*
15.00-15.30	Coffee (incorporating Physics TF Forum discussion)

15.30-17.00 **Choice of parallel sessions**

Parallel 1
Lecture theatre

Focus on supporting learning and achievement

The BME attainment gap in Chemical Sciences - Does the use of assessment criteria contribute to the gap?
Neil Williams

Why do women do less well on some of our physics modules?
Sally Jordan, Pam Budd, Niusa Marigheto, Victoria Pearson, Richard Jordan, Jimena Gorfinkiel

Effects of Workshop Group Gender Balance on Student Exam Performance
Ross K Galloway, Ross W Hunter

Are individual learning styles relevant to teaching in Higher Education?
Gan Shermer, Gareth Price

The Impact of Provision of Lecture Recordings on Student Experience and Academic Performance
David McGarvey

(Byte) Investigating the impact of gender and socioeconomic status on attitudes towards science in school students of age 12 and 13, and science and engineering undergraduates
Joanna Furtado

(Byte) "It's personal…": Supporting learning through effective pastoral care
Andrew McKinley

Parallel 2
Meeting room 5

Focus on diagnostics and assessment

Bridging the Chemistry knowledge gaps with Year 1 students
Suzanne Fergus, Stewart Kirton

Peer assessment using adaptive comparative judgement
Judy Hardy

Do Chemists have Chemophobia? - Update
Katherine J. Haxton

The use of online, formative assessment for contextualising key physicochemical concepts for pharmacy students
J.J. Keating, Eileen M. O'Leary, Timothy P. O'Sullivan

(Byte) Peer Assessment as a tool for Engaging Students with Learning Outcomes & Assessment Criteria
Anna Bertram

(Byte) Peer-to-peer review & feedback encourages self-critiquing and reflection
James Gaynor

(Byte) Electronic Marking in Chemistry UG courses
Rossana Wright

17.15 RSC ETG AGM for members of ETG

17.30 RSC TEG AGM for members of TEG

19.30 Wine reception

20.00 Dinner

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Friday 21st August

9.00-9.55 Lecture theatre	**Keynote Plenary** Ecopedagogy: Teaching Sustainability Topics in the Physical Science Curriculum *Professor Paul C Taylor, University of Leeds*
10.00-12.00	**Choice of parallel workshops**
Workshop C Meeting room 5	**IPython notebooks for data analysis and visualization** *João Pedro Malhado, Clyde Fare, Andrew McKinley, Michael Bearpark*
Workshop D Lecture theatre	**Publishing on innovation and education research in chemistry and physics for a range of audiences** *Claire McDonnell, Michael Seery, Derek Raine*
Workshop E Meeting room 1	**Successful and Sustainable STEM Clubs** *Janet Smith-Harrison, Nazira Karodia, James Machell*
10.30-11.00	Coffee break during workshop session
12.00-13.00	Lunch
13.00-14.30	**Choice of parallel sessions**
Parallel 3 Meeting room 5	**Focus on models of learning** Learn it off or make it up? Situating our educational innovations in a theoretical framework *Michael Seery* (Flipped) Is a conceptual understanding of Mathematics vital for Chemistry? *Michael Grove, Samantha Pugh* Tackling challenges of maths through entry requirement, teaching delivery and assessment methods *Gita Sedghi* Flipping unpopular courses *Charles Harrison* Back to de Broglie: aiding students' conceptual understanding of quantum theory *Chris Dewdney* (Byte) Developing Screen Experiments to Support 3rd Level Quantum Optics *Sam Nolan* (Byte) Defining expertise in order to inform the design of learning experiences in experimental chemistry *Kerry J. Knox, Lynda Dunlop*

Parallel 4
Lecture theatre

Focus on laboratories

Augmented laboratories: Near-peer constructed technology enhanced labs.
Barry Ryan

(Flipped) Lab skills portfolios
David Read, Charles Harrison

Teaching Practical Physics in Africa: problems expected and unexpected
Babalola Femi Emmanuel

(Flipped) How can I measure the success of my lab teaching?
Jenny Burnham

(Byte) Developing a Laboratory Skills Matrix
Kyle W. Galloway

(Byte) The importance of practical work in school science
Matthew Gundry

(Byte) Second year physics labs: taking data is the easy part
David Westwood

Parallel 5
Meeting room 1

Focus on transition, interdisciplinarity, internationalisation

Supporting Transitions into the Physical Sciences
Sam Nolan

iTube, YouTube, WeTube – Engaging Undergraduate Chemistry Students in Collaborative Global Education
David K. Smith

Can University Chemistry Teaching be Informed by Practice in the Arts, Humanities and Social Sciences?
Matthew Almond

'Opening up' the teaching-learning scenario in India! An overview of open-educational resources (OERs) in India, and inspiration from the UK
Tejas Joshi, Simon Lancaster

Do Practical Skills Portfolio and quiz based Wordsearches help in the understanding and comprehension of practical chemistry for Chinese students?
Julie Hyde

(Byte) Authentic assessment at your fingertips: Developing a cross-disciplinary template for implementation
Vanessa Murphy, James Fox, Sinéad Freeman, Nicola Hughes

(Byte) Exploring technology enhanced instruction and assessment in the advanced physics laboratory
Aaron Mac Raighne, Elizabeth Gregan, Aidan D. Meade, Izabela Naydenova, Fran Pedreschi

(Byte) Student & Staff Perceptions of Transferable & Workplace Skills Development in Chemistry Degree Programmes
Dylan P. Williams, Sandeep Handa

14.40-15.00 Lecture theatre	**Oral bytes** Design your own purification: a guided-inquiry experiment for the first year chemistry laboratory *Nimesh Mistry* A Careers Fair with a Difference *Alison Voice* Embedding Enterprise in the Physics Curriculum *Samantha Pugh* Assessing the practicalities and benefits of using immersive Virtual Reality technology to explain complex chemical concepts *Janet Smith-Harrison, Nazira Karodia, James Machell*	
15.00-15.15 Lecture theatre	**Closing discussion**	
15.15	Coffee, depart	

Durations:	Keynotes	55 mins
	Workshops	90 mins
	Oral presentations	15 mins
	Flipped presentations	15 mins
	Oral bytes	5 mins

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Prof Simon Lancaster, University of East Anglia

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Book of Abstracts

(in order of conference programme and in the session groupings)

Thursday 20th August

Keynote Plenary

Is "interactive" teaching sufficient to promote conceptual development in physics?

Professor Paula Heron
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Over the past few decades, systematic research has shown that many physics students express essentially the same (incorrect) ideas both before and after instruction. It is frequently assumed that these ideas can be identified by research and then addressed through "interactive" teaching approaches such as hands-on activities and small-group collaborative work. In many classrooms, incorrect ideas are elicited, their inadequacy is exposed, and students are guided in reconciling their prior knowledge with the formal concepts of the discipline. Variations of this strategy have proven fruitful in science instruction at all levels from elementary through graduate school. However, this summary greatly over-simplifies the use of students' ideas as the basis for effective instructional strategies. Examining what students have actually learned after using research-based curriculum is essential for improving the curriculum and validating its effectiveness. I will illustrate the process with examples from introductory physics.

Oral bytes

Chemistry and Physics: ScoopIt and Share

Simon Lancaster
University of East Anglia
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www.scoop.it is an easy to use web aggregation tool that allows content from across the internet to be elegantly presented, commented upon and widely shared. A number of examples exist that will be of great interest to the ViCEPHEC community, not least http://www.scoop.it/t/chemed. However, the focus of this byte will be the suggestion that the community might wish to come together to encourage student curation of ScoopIt pages.

The IPython Notebook as a pedagogic tool for physics

Louise Dash
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louise.dash@ucl.ac.uk

The IPython Notebook (part of Project Jupyter, jupyter.org) is an interactive environment which combines computation, text, mathematics and other media in a single document. This enables students to analyse and present data in a convenient electronic format, and also enhance their understanding of physics by creating and manipulating their own computational models. Moreover, the notebook format naturally encourages students not only to program effectively but also to consider the underlying physics more deeply than is possible in traditional stand-alone code. This opens up areas of computational physics that were previously inaccessible to undergraduates, and expands the pool of possible problems that they can explore.

In this talk I will present examples that we have used in our second year undergraduate practical physics module, and demonstrate the effectiveness of the IPython Notebook in expanding and underpinning students' understanding of physics.

Connecting it all together- The TECHEMOL project

Tejas Joshi
Homi Bhabha Centre for Science Education, TIFR, India
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The TECHEMOL project launched in May 2015 is conceptualized to be a confluence of art, science, education and communication- made possible in an open-access format for students and teachers. With interdisciplinary approaches to learning and teaching gradually assuming centre-stage, the idea of this project is to make available, visual resources that can be used by teachers and students in their own setup- be it the quintessential periodic table with information in multiple combinations, or printable posters that highlight the principles of Green Chemistry.

Often, students and teachers from less privileged institutions are not able to access or afford simple materials they need, and thus the impetus here is to organize knowledge in easily useable formats. The online portal has five sections at launch- Collection, Inspiration, Showcase, The Proud Bookworm and Bulletin.

The collection will be expanded by contributions from science practitioners across disciplines and expertise to share their knowledge, and in a free, visual and portable format. In addition to compiling the large pool of existing resources across themes, the website will also showcase experiences from science illustrators, communicators, educators and artists in the time to come.
(www.techemol.org, www.facebook.com/techemol)

Royal Society of Chemistry: online resources for higher education

Rachel Purser-Lowman
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At the Royal Society of Chemistry we want to improve the support we offer higher education audiences. Increasing the amount of information, teaching materials and learning resources available online will be a key part of this.

Through our online resource platform, Learn Chemistry for higher education, we want to engage with, and provide support to, those learning, teaching and working in chemical sciences higher education. Our aim is to help ensure that those learning have access to a high quality chemistry education that gives them the knowledge and skills required to pursue successful careers in science. It will also ensure that those teaching and working have the resources and tools they need to be impactful and efficient educators, and the support and skills they need to develop professionally and gain recognition within their institutions, and from the community as a whole.

This talk will briefly summarise some of the resources we currently have available on the site for students and educators, and outline our development plans for the future. In terms of these future plans there will be an emphasis on community involvement and how best we can meet your needs.

Report on the European Chemistry Thematic Network

Karen Moss
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The Physics Teaching Fellows Forum

Derek Raine
University of Leicester
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Choice of parallel workshops (A, B):

Workshop A:
'Flipping' Pedagogy 101- Learning Theories for the Flipped Classroom

Anna Wood
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Numerous studies have shown that students learn more and have better conceptual understanding when involved in learning that is active rather than passive. The most common way to do this is through a pedagogy such as peer-instruction (PI) in combination with 'flipping' the classroom. However, research shows that there is a wide degree of variation in how these pedagogies are used in practice. In order to get the most out them for a given context and pedagogical aim, instructors have a variety of decisions to make: what type of clicker question to ask; whether to get students to think/vote individually before discussing with each other; what to do during the peer-discussion section and at which point to show the result of the vote. Although there are many resources available which explain *how* to flip a lecture, or *how* to introduce PI into a lecture we also know that when teachers simply follow a recipe without fully understanding *why* they are doing things, the chances of success are greatly reduced.

This workshop is therefore NOT a 'how to' session, but rather a 'why to' session! We will introduce some of the key ideas and theories in science education (such as constructivism, conceptual change theory, and social theories of learning), discuss their application to the flipped classroom and to peer-instruction and then apply them to some of the decisions that instructors need to take, so that they can make flipping/peer-instruction work for them. Planned activities will last approximately 60min, leaving plenty of time for more informal discussions.

No experience necessary, this workshop is for both experienced 'flippers' and those tempted to have a go in the future.

Flipped pre-session activity:
If you are planning to come to this workshop please do the 3 short pre-workshop activities, which should take no longer than 10-15 minutes and then complete the short quiz. This will help me to plan the workshop and give you an authentic flipped learning experience.

The pre-workshop activities can be found here:
http://bit.ly/1IZ3YAm
Please do this by noon on Wednesday 19th August at the latest.

Additionally, we will be using a web-based voting system in the workshop. To get the most out of this, please remember to bring along any web-enabled device you have, e.g. smartphone, tablet, laptop, Kindle Fire, etc. Anything that can connect to the web will be fine. You don't need to set up anything in advance for this, just bring your device along to the workshop.

Workshop B:

New RSC Context/Problem Based Learning Resources for Chemistry

Nimesh Mistry and Samantha Pugh
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In 2014, the RSC commissioned the University of Leeds to create three context/problem based learning resources for the Learn Chemistry repository. The resources were on the themes of turning waste into wealth, working with SMEs and recycling Naproxen waste products.

All three resources focus on skills development within the context of learning Chemistry, and a team project approach was taken in all cases. This project was unique in that we worked in partnership with undergraduate and postgraduate students in the creation of the resources, with the students taking a substantial authorship role.

The laboratory based project, entitled Recycling the Undesired Enantiomer of Naproxen is a team based project that begins with a series of lectures and workshops to introduce the concepts relating to the project, followed by a laboratory investigation.

In this workshop, we will discuss the development of the resources that we produced, which include lectures, workshops, experimental procedures, and videos from industry experts and placement students. We will provide delegates with the opportunity to participate in some of the activities that we designed.
The first part of the workshop will include activities to develop students' collaboration skills and understanding of process chemistry which the students will then have to apply in the laboratory component of the project.
The second part of the workshop will involve delegates taking part in an activity from the "Careers in Chemistry SMEs" which are designed to provide students with an insight into the opportunities and challenges that working with an SME might entail.

Choice of parallel sessions (1, 2):

Parallel 1: Focus on supporting learning and achievement

The BME attainment gap in Chemical Sciences - Does the use of assessment criteria contribute to the gap?

Neil Williams
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The BME attainment gap (the difference between the percentage of white students and BME students achieving a 1st or 2.1 degree) is a concern throughout the UK HE sector. The gap is 17.6% nationally and at Kingston University it is 29.4%. The gaps has been attributed to range of factors, fair assessment and clear assessment criteria have been identified by the NUS as a key concern for many BME students.

Details of the attainment gap in Chemical Sciences at Kingston and the use of Value Added Scores to monitor differences between white and BME students will be briefly introduced. This prompted research into student opinion of the use of assessment criteria in modules on chemistry, pharmaceutical science and pharmacy degrees at Kingston. Questionnaires containing Likert Scale questions on the use of assessment criteria for each of a student's four modules were completed by students (n>210) giving n >570 module responses from BME students and n>270 from white students. The responses to these questions will be reported and discussed. Statistical analysis of the Likert Scale responses using Mann Whitney tests showed some statistically significant differences between the responses of BME students and white students. For example, it was indicated that BME students (Mdn =3) were less in agreement with the statement "It was clear how marks were awarded for assignments" than white students (Mdn =4), z=-2.807, p = 0.005 two tailed. A similar difference was seen for the statement "The assignment criteria made it clear what was required". This suggests that assessment /marking criteria were less clear to BME students. This research suggests that methods for making assessment criteria more transparent to students may well help reduce the BME attainment gap in the chemical sciences.

Why do women do less well on some of our physics modules?

Sally Jordan, Pam Budd, Niusa Marigheto, Victoria Pearson, Richard Jordan, Jimena Gorfinkiel
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Examination of historic data since 2009 for a Level 2 (FHEQ Level 5) physics module at the UK Open University has identified that barriers to success may exist for women compared to men; there are significant statistical differences between men and women for both completion and credit. For the total student cohort of women registered over 5 years (n=946), the completion and pass rates are both 10 percentage points less than the corresponding figures for men (n=2415). Similar trends were seen on a level 2 astronomy module, but not on

equivalent modules in other science disciplines or at level 1. At level 3, women perform slightly better than men.

Gender differences in attitude to assessed tasks have been reported by others (e.g. Gipps & Murphy, 1994) whilst Bates et al. (2013) report on a gender difference in outcomes on the Force Concept Inventory (Hestenes et al, 1992), whose reliance on multiple-choice questions has been questioned (Rebello & Zollman, 2004).

We will present the results of data analysis which has sought to investigate whether the observed effect at the Open University can be explained by the assessment strategy or by other factors (e.g. online forum activity, gender of tutor). For the level 2 physics module, none of these factors appear to explain the difference in performance, though for the level 2 astronomy module there is some evidence that women are performing relatively less well on multiple-choice examination questions.

For the level 2 physics module, there is some evidence that women do less well on parts of the module with which Newtonian mechanics and develop problem solving and abstract reasoning. Future work will investigate whether this is linked to women being less likely to have A levels in mathematics and physics or to our increasing number of younger students of non-UK background.

Effects of Workshop Group Gender Balance on Student Exam Performance

Ross K Galloway, Ross W Hunter
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A number of studies have reported on the influence of gender balance in group-based teaching environments on student assessment performance. We have conducted an experimental intervention in our introductory physics class at the University of Edinburgh. This is a calculus-based course and is taught in a 'flipped classroom' format. The class consists of around 280 students, around a quarter of whom are female, and is taught in four workshop sections. Within the workshops, the students are seated in groups of five or six. We manipulated the seating arrangements (without highlighting our intentions to the students) such that in two of the sections, groups containing female students were either gender-balanced or contained more females than males ('balanced groups'). In the remaining two sections, groups were allocated randomly, such that there were typically only one or two female students per group ('random groups'). We investigated student performance in these grouping types, and found that female students in balanced groups outperform female students in random groups by nearly 10 percentage points in the final exam, a highly statistically significant result. Male students in the balanced groups also outperformed their randomized equivalents, but not to a statistically significant extent. Causation is difficult to unambiguously determine, but it appears that prior ability in physics, major/non-major status and country of origin of the students are insufficient to explain the observed differences in performance.

Are individual learning styles relevant to teaching in Higher Education?

Gan Shermer, Gareth Price
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Learning styles such as, Visual, Auditory and Kinaesthetic are terms with which we are all familiar. Although not often discussed in Higher Education it is a topic which is still highlighted and commonly used in some schools. Several studies have shown that there is very little evidence for the existence of defined learning styles,[1] so it is therefore interesting that many of our students believe they possess a particular learning style, an idea perhaps picked up from the classroom. Teachers are often asked to design learning environments which cater to all learning styles however at University many of us rely on traditional lectures and practicals which may favour particular learning styles.

Over the last few years we have asked first year students to answer a short questionnaire which is purported to identify their learning style based on the VARK system and to capture the sorts of methods that they used to study at school. We have tracked some of these students over the course of their degree to see if their learning styles and study practices changed as they adapted to University, and whether any students who associate with particular learning styles seem to be more or less successful on our courses. This presentation discusses the findings from this study and possible implications for teaching and learning chemistry and the transition to higher education.

[1] H Pashler, M McDaniel, D Rohrer, Psychological Science in the Public Interest 2008, 9(3) 105-119 doi: 10.1111/j.1539-6053.2009.01038.x

The Impact of Provision of Lecture Recordings on Student Experience and Academic Performance

David McGarvey
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The provision of lecture recordings is growing in UK Higher Education [1] and numerous institutions have committed substantial investment to this technology. In recent years I have used screencast technology to provide stand-alone learning resources for students, to provide feedback and to support a flipped classroom through the use of pre-lecture screencasts [2, 3], but it is only recently that I have trialled the provision of lecture recordings. During the Spring Semester of 2014-15 I provided lecture recordings for two separate series of lectures (1st year Chemical Kinetics and 2nd year Chemical Applications of Group Theory).

This intervention has been evaluated via an online (Google form) survey exploring (i) the extent of student use of the recordings and how they are used, (ii) what students liked about the recordings and what could be improved, (iii) student perceptions of whether the recordings benefited them, and if so, how?, (iv) the value of recordings as substitutes for attending the live lecture, (v) the value, if any, of attending the live lecture. In addition, the academic performance of students in examinations has been analysed using comparisons

between and within cohorts. The results of the online survey suggest provision of these lecture recordings is extremely popular with students and that students believe the recordings have benefited their learning. However, preliminary analysis of exam performance data suggests no significant impact from the provision of lecture recordings. The results of the online survey, my own experiences and a critical discussion of the analysis of academic performance will be presented.

Investigating the impact of gender and socioeconomic status on attitudes towards science in school students of age 12 and 13, and science and engineering undergraduates

Joanna Furtado
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This project has focused on investigating the attitudes that young people have towards science, with a particular focus on gender and SES, in two age groups- school children of ages 12 and 13, and STEM undergraduates. Data was collected using a standardised attitude instrument, longer answer questions and focus groups. From this data, it was found that students are indeed more negative about science than other subjects, with girls in particular holding more negative views. School students tended to link their subject preferences in with a job they perceived to be of value to society, and hence this might highlight a disconnection between students' perception of the importance of science in society and what a scientist does. As highlighted in previous research, students tended to conform to conventional gender roles within their subject preferences and the way in which they relate to science. Undergraduate data revealed insight into how students negotiate a science identity with a desirable identity, and some the tensions that might arise as a result of this tension, something which has not be researched within the UK. The way in which these students perceive a science career was also investigated, with an aim to understanding why some do not go on to work within a STEM career. The change in attitudes that undergraduates have towards their STEM subject across the course of their degree was also explored. Comparisons between the two age groups showed how many stereotypes and prevalent beliefs about a STEM career and those who work within STEM remain similar.

"It's personal…": Supporting learning through effective pastoral care

Andrew McKinley
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Pastoral support is a matter affecting every educator, with many university academics undertaking the role of 'personal tutor' to undergraduate students. This complex role places an unusual set of demands on the academic in supporting students' learning. The realities of 21st century higher education places students under ever more pressure to succeed, and to be seen succeeding. With improving knowledge of the importance of mental health, more students than ever are disclosing their needs; consequently it is imperative we develop our pastoral care provision to better accommodate these. We present here a "Circle of Care" model for preserving student confidentiality while ensuring continuity of support to students and staff alike.

Parallel 2: Focus on diagnostics and assessment

Bridging the Chemistry knowledge gaps with Year 1 students

Suzanne Fergus, Stewart Kirton
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Year 1 students in Pharmacy and Bioscience study chemistry as a fundamental topic underpinning their degree programmes. A significant number of students struggle with the transition into HE and the previous strategies adopted at A-level (or equivalent) to learn chemistry are not satisfactory in Year 1 of university. This has implications not only on module performance but also for their self-esteem and further success on the programme.

A chemistry diagnostic test using Microsoft-PowerPoint© with 20 individually timed questions is presented post induction week to Year 1 Pharmacy students (n=120). The questions range from basic chemical nomenclature to more complex areas such as stereochemistry. The diagnostic test highlights problem areas with fundamental chemistry concepts that students find difficult to either grasp or solve.

As we cannot directly observe what a student is thinking during the diagnostic test, a think-aloud protocol was used (with 4 students) to verbalise specific areas they found difficult and the reasons for this. Analysis of both the diagnostic test and the student interviews will be discussed and presented.

Peer assessment using adaptive comparative judgement

Judy Hardy
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Reviewing the work of their peers can help students enhance their own learning. It can also help them develop metacognitive skills such as the ability to appreciate what constitutes high quality work and to critically evaluate their own work; skills which are crucial if they are to improve.

Adaptive comparative judgement (ACJ) is a process in which multiple pairwise comparisons are used to rank assessment items. We used ACJ as part of an in-course assessment in an early-years physics course. Students were presented with pairs of solutions authored by their peers and asked to make a comparative judgment as to which of each pair was the better, based on the dimension of quality 'which piece of work most clearly and effectively satisfies the task set out in the question?'. Student ranking using ACJ was compared to standard marking by staff and TAs. In this presentation we will discuss the rationale for using ACJ together with the intended and actual educational benefits.

Do Chemists have Chemophobia? - Update

Katherine J. Haxton
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The impact on chemistry education on attitudes to chemistry, particularly an irrational fear of chemicals embodied in the term 'chemophobia', has important implications for teaching chemistry in HE, particularly in laboratory classes. Does greater knowledge about chemicals offer a false sense of security in the laboratory? Do the words we use to describe chemicals and processes alter our students' attitudes? Does general knowledge, obtained in the home or through the media change our students' ability to evaluate risks?

Two preliminary studies investigating the impact of education and chemistry education on attitudes towards chemicals and related concepts, and the impact of jargon on attitudes have been conducted in 2014/15 by two final year project students. In this presentation I will provide an update on the 'Do Chemists have Chemophobia?' project first presented at ViCEPHEC in 2013, show some of the data obtained in the preliminary studies and outline the next steps. I will also describe the challenges I've experienced of getting chemistry students to investigate this type of research question.

The use of online, formative assessment for contextualising key physicochemical concepts for pharmacy students

J.J. Keating, Eileen M. O'Leary, Timothy P. O'Sullivan
University College Cork
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Pharmacy students entering the final stages of their degree often display an inability to apply fundamental scientific concepts to clinical scenarios. Important physicochemical principles such as lipophilicity (LogP) and acidity/basicity (pKa) are often poorly understood despite repeated exposure to these topics in early years.[1] An appreciation of the link between drug structure and both LogP and pKa is critical to the understanding of drug action in vivo.[2] We have developed an online, formative assessment model to improve students' application of these concepts.

Our model is composed of three parts. Firstly, a set of short videos provides a summary of basic concepts such as LogP, pKa and drug metabolism. The second intervention comprises a series of online exercises focussed on the physicochemical properties of drugs and their impact on clinical application. These exercises are divided on the basis of system, disease and drug class. Incorporated into these electronic exercises is the ability to draw and manipulate drug structures using a combination of the MarvinSketch molecular editor and SMILES (Simplified Molecular Input Line Entry System) to communicate with the VLE.[3] The final part of the model takes the form of automatic, standardised feedback supplemented with detailed solutions following a weekly deadline. Students are exposed to the same fundamental concepts in different scenarios, with the combination of exercises and feedback forming the basis of the formative assessment.

The impact of our intervention was assessed using both survey feedback and pre- and post-assignment quizzes. Survey feedback was positive across the range of questions posed. Equally, student's displayed an improved performance in the post-assignment quizzes, further highlighting the positive impact of this approach. Both surveys and quizzes demonstrate that this intervention had a positive impact on student performance. Finally, we outline the benefits of our approach as well as remaining challenges.

[1] V. F. Roche, Improving Pharmacy Students' Understanding and Long-term Retention of Acid-Base Chemistry. *Am. J. Pharm. Ed.* **2007**, *71*, 122-1.

[2] N. Z. Alsharif, C. J. Destache and V. F. Roche, Teaching Medicinal Chemistry to meet outcome objectives for pharmacy education. *Am. J. Pharm. Ed.* **1999**, *63*, 34.

[3] G. C. Hargaden and T. P. O'Sullivan, Using Structure-Based Organic Chemistry Online Tutorials with Automated Correction for Student Practice and Review. *J. Chem. Ed.* **2014**, 93, 1851.

Peer Assessment as a tool for Engaging Students with Learning Outcomes & Assessment Criteria

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Encouraging students to engage with learning outcomes and assessment criteria early in the assessment cycle continues to be a challenge particularly in laboratory modules. Feedback from student focus groups highlights a lack of understanding of the assessment requirements prior to the submission of work; this is despite students being aware that the information is provided. Attempts have been made each year to increase the prominence and signposting of the information but engaging the students early with the requirements continues to be a challenge.

We anticipated by engaging students in a peer assessment exercise that this would force students to engage with learning outcomes and assessment criteria earlier.

Students were asked to opt into a pilot in organic chemistry 1st & 2nd year labs; engagement was very good with just under 50% of the class volunteering. The pilot required students to submit their first organic report for peer marking; reports were submitted through Turnitin using a tool called PeerMark. Feedback on the pilot was gathered via focus groups and questionnaires.

This presentation will outline how the pilot was carried out, including setting up and delivering the PeerMark exercise through Turnitin. It will also summarise the feedback from the students and discuss plans for future implementation.

Peer-to-peer review & feedback encourages self-critiquing and reflection

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During VICEPHEC 2014, I presented a byte outlining my plans for the re-design of a final year employability module looking at the introduction of peer-to-peer feedback as a tool for encouraging self-critique, self-assessment and reflection. Here I plan to discuss the results and evaluation of this project, with a consideration of how to move forward.

PeerMark in Turnitin was used to facilitate the peer-to-peer feedback process. On four occasions, students submitted their work which then underwent peer review, with students getting the opportunity to leave feedback for their peers, as well as receive individual feedback. At this stage, and where necessary, students could make changes to their work and resubmit. Academic assessment was of either the final resubmission or the quality of peer feedback.

Key to the process was a requirement for students to directly judge the work they were reviewing, not in terms of the level of work (ie, a 1st, 2.1, etc), but by indicating whether their own submission was the same quality as the work they were reviewing, or whether one of them was better than the other (both the reviewer and author could see the response – this was a formative process). It was clear that the process of giving feedback was more important than simply reviewing work or receiving peer feedback, and the element of self-assessment was valued by students.

Electronic Marking in Chemistry UG courses

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The presentation will outline the development and implementation of electronic marking in some of our undergraduate modules. A great motivation for the use of electronic submission of coursework and subsequent electronic marking is obviously the reduction on environmental impact, by the elimination of printing and storing of paper coursework. In our case an additional incentive for moving to electronic form was to deliver feedback to the students in a timely fashion: students can now access the annotated feedback as soon as the coursework is marked. Additionally, students are now able to access the feedback as and when required.

The amount of work submitted in our courses, particularly in laboratory modules, is rather large, with the corresponding difficulties of not only marking it, but also *managing* the submitted work: logging of submission dates and times, storing and retrieving individual work as required. Using electronic submission of coursework tackles these issues in a more efficient way. Therefore the use of online resources is advantageous, not only for students, but also for staff: both academics and support staff. The tools used to support the submission and marking of electronic coursework will be discussed, as well as the challenges encountered along the way.

Friday 21st August

Keynote Plenary

Ecopedagogy: Teaching Sustainability Topics in the Physical Science Curriculum

Professor Paul C Taylor
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Ecopedagogy invites us to teach about the world in a way that neither assumes that the interests of humans are privileged over other species, nor accepts that a particular group of humans has a privileged view on what should be taught. Ecopedagogy therefore is an interesting framework in which to teach sustainability topics. There is an increasing demand from students, employers and other stakeholders for topics on economic, social and environmental sustainability to be more prominent in HE curricula. In this session, we will discuss what this might mean for the Physical Sciences and, with an Ecopedagogy framework in mind, explore how participants' own geographical roots and the environment in which they learn can inform their understanding. The session will make use of the indoors and outdoors environments of the "eco" Jubilee Campus and will be accessible to all.

Choice of parallel workshops (C, D, E):

Workshop C:
IPython notebooks for data analysis and visualization

João Pedro Malhado, Clyde Fare, Andrew McKinley, Michael Bearpark
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This workshop is based on a course on data analysis and visualization taught at the Chemistry Department of Imperial College London as part of the first year undergraduate curriculum. The purpose of the course is to introduce the basic data analysis techniques required to interpret experimental (or otherwise) data collected in the laboratory, along with introducing the IPython notebook as an electronic, multi-media, interactive computing notebook that students are encouraged to use throughout their degree.

Whilst the focus of the course is not computer programming, it could serve as a pre-introduction to the subject. It introduces variables, data structures in the form of arrays, functions, and more generally a computing platform.

The course was designed as a series of self-learning interactive exercises using IPython notebooks. The first three notebooks introduce concepts interactively while the two exercise notebooks develop problem solving based on these concepts. The course material can be found at:
https://github.com/imperialchem/python-data-viz-intro

The conference workshop will be a session encompassing an adumbrated version of the key parts of this student class. This will be a hands-on session for participants to explore the possibilities of this new notebook technology and how to use it in a teaching environment.

(Participants should bring or have access to a computer with the Scientific Python installed – installations instructions will be circulated prior to the conference.)

Workshop D:

Publishing on innovation and education research in chemistry and physics for a range of audiences

Claire McDonnell, Michael Seery, Derek Raine
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This workshop will incorporate guidance and hands-on activities on publishing pedagogical research (e.g. New Directions and Chemistry Education Research and Practice) as well as publishing for a more general audience (e.g. Education in Chemistry, The Mole).

We are all aware of the misconceptions, negative perceptions and lack of understanding of chemistry and physics that the public can have. To ensure a sustainable future, there are many issues (energy, environment, food and nutrition, health, etc.) that society needs to resolve. Publishing is an effective and high impact way of promoting science positively to non-specialists.

It is also important to ensure that investigations undertaken in physics and chemistry to explore effective ways of supporting and enhancing learning are published and thus that teaching is evidence–informed. Writing up science education research for publication has some similarities to writing up science research in that articles should provide an argument for new knowledge supported by careful analysis of evidence. However, there are some important differences (e.g. selection of an appropriate theoretical framework and methodology and consideration of ethical issues when working with human subjects).

In this workshop, we will consider how to engage a range of audiences, from those interested in educational research to non-specialists and the general public. We will ask you to consider the impact of different article types, language and medium. Participants will discuss ideas for different article types and how to scope these out. You will also develop tools to write a pitch for an article of your choice for publication and consider the structure so that a clear message is conveyed. We will touch on aspects to include in your writing which can help ensure that speculative articles are attractive to a commissioning editor and that science education research articles are of the quality to make a positive impact on reviewers.

Workshop E:

Successful and Sustainable STEM Clubs

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STEM (science, technology, engineering and maths) clubs create an excellent opportunity to engage young people with scientific enquiry outside of the classroom in an environment not restricted by curriculum. They can be cross-curricular, single subject, linked to external challenges and competitions or focused on pupil interest. There is no one formula for a successful STEM club, but enthusiasm and fun are vital ingredients.

STEM at Bradford have engaged with a wide range of schools to explore the best methods and activities to engage Key Stage 3 pupils and teachers in schools and undergraduate and postgraduate student STEM Ambassadors in an innovative programme of STEM clubs. The aim of the clubs has been to enhance pupil learning and skills, encourage take up of STEM GCSE's and A Levels and promote STEM based HE courses and careers. From September 2014 six STEM clubs were run on a weekly basis, with the initial aim of entering the First Lego League Regional Final in December 2014 and continuing into 2015 with a programme of Formulation Science clubs. Current activity will complete in July 2015.

This workshop will explore the ingredients which contribute to running successful STEM clubs and the framework needed to support continuation and sustainability. It will also explore the undergraduate and postgraduate student value of leading STEM clubs and describe the benefits to HE institutions in terms of student engagement, success and satisfaction. Participants will be offered the opportunity to take part in two activities (one chemistry and one physics) and to then share thoughts on the application of the activities to their own student recruitment, retention and success.

Choice of parallel sessions (3, 4, 5):

Parallel 3: Focus on models of learning

Learn it off or make it up? Situating our educational innovations in a theoretical framework

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As science educators and educational researchers, we are comfortable with educational innovations that appear to subscribe to the principles of constructivism (e.g. problem-based learning, inquiry-based learning, etc). However, as advocates, many of us find it difficult to convince and persuade colleagues that such approaches have value, given both their differences from "the norm" and given that there is a substantial literature favouring direct instruction.

In this presentation, I aim to discuss with the audience both sides of this debate. In doing so, two educational approaches that are currently popular will be used. The first, inquiry-based learning, has a significant literature arguing both for and against this approach, with a long and ongoing discussion on its merits and role in education. The second, flipped teaching, currently has little literature grounding it in a theoretical framework, with current literature promoting it as an approach based on individual classroom case-studies, typically using student feedback as an argument for implementation.

The presentation will use these two approaches to prompt thoughts on how we can place our educational innovations within a theoretical framework in order to move towards their consolidation in the science curriculum.

Is a conceptual understanding of Mathematics vital for Chemistry?

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In summer 2014, the Universities of Birmingham and Leeds embarked upon a programme of research, led by student interns, to update the data collected in the 2008 review of UK chemistry, undertaken by the Physical Sciences Subject Centre, and most significantly to better define the exact nature and extent of the mathematics problem within chemistry in UK higher education.

Flipped pre-session activity:
This flipped session will be based upon pre-reading of the published article "Is conceptual understanding of Maths vital for Chemistry?"
www.rsc.org/eic/2014/12/mathematics-problem-chemistry-university

We will review the findings of this initial scoping study and together, the session will seek to establish what the sector sees as the priority for future plans for

establishing a longer-term programme of action research to better support the learning of mathematics within a chemistry context; it will also highlight some of the resources that were developed over last summer as a starting point for supporting chemistry learners.

The session will then focus on discussions of where efforts should be directed in supporting Mathematics in Chemistry. Questions for discussion will include:
1. What are the current resources, and how much are they used?
2. What is the role of Maths Support Centres in helping Chemists?
3. What is the nature of the problem with Mathematics? Knowledge, understanding or confidence?
4. What can the Chemistry Education community do to address the issues?

If you plan to attend this session, it would be very helpful to find out in advance how Maths is taught in Chemistry within your own department, and to have answers to the questions stated above.

The findings from the session will feed into the Steering Group that the Royal Society of Chemistry has recently established to address the issue.

Tackling challenges of maths through entry requirement, teaching delivery and assessment methods

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Our project to create online multiple choice maths questions with increasing complexity, quality formative feedback and grading to enhance student learning in maths in a chemistry context was funded by Sigma Mathematics. The rational for this project was to enhance students' knowledge and skills in maths and to provide them various resources to practise this subject. The evaluation performed on chemistry students' performance in maths, various learning styles and A level maths requirements showed that our undergraduate chemistry programmes could benefit from a combination of assessment techniques in maths module to ensure validity, reliability and efficiency of the assessment system. Embedding maths online assessments with increasing complexity onto the Year 1 maths course was followed with some changes to the delivery of the teaching material and the assessment system. The outcome of the evaluation of the new system will be presented and also students' performance in maths and its relation with the A level entry requirements will be discussed.

The experience of engaging undergraduate students to develop new teaching and learning activities in the Department of Chemistry has shown the importance of students' involvement to enhancing teaching and learning activities. The new online assessments were created by Year 2 and 3 undergraduate students and the levels of the tests were evaluated by Year 1 students before embedding onto the course. Chemistry undergraduate students working on this project gained great confidence and experience of working

independently and successfully on an educational project. The online assessments could be easily saved in formats compatible with all virtual learning environments and shared with other institutions.

Flipping unpopular courses

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Service courses can be unpopular with students and tutors alike. Whilst 'remedial' chemistry for biologists or maths for chemists are essential for some students, they may be treated with lower priority than core courses. This can have further impacts which are detrimental to the student experience as well as staff engagement. This presentation focusses on the 'Introduction to Chemistry' module, which is taken by biology students without A-level chemistry. This was redeveloped in 2014, with online lectures complemented by weekly workshops.

This oral presentation will outline the approach taken, which represents a model for flipping such courses which enhances the student experience whilst making efficient use of academic input. The approach involved sequences of short video lectures recorded using the university's Panopto system, which were further enhanced by the addition of interactivity (e.g. multiple choice questions) using the online platform Zaption. The presentation will outline the findings of research conducted during the course which provides insight into how students use online material as well as their perceptions of the novel course structure. Suggestions for changes that will be made in the coming academic year will be discussed, along with plans to adapt the model to fit other courses.

Back to de Broglie: aiding students' conceptual understanding of quantum theory

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Quantum theory is notoriously difficult for students to grasp conceptually. The mathematical formulation itself is precise and well defined, and the experimentally predictions are verified to high orders of accuracy but there is an unsettling air of mystery surrounding the meaning of the theory. The absence of a clear and intuitive conceptual understanding of the theory may well impede student's progress in the subject and certainly drives them towards a positivist philosophical position. The latter position is in strong contrast to the "natural attitude", a straightforward realist position that is implicit in their understanding of every other aspect of physics. This conflicted position is common amongst physicists who in this regard "think like Einstein but talk like Bohr".

Approaching a century after its genesis there is still no agreement concerning matters of interpretation. Although the impact of this on the experimental and theoretical progress of quantum theory is minimal, beginning students often feel "suspended in the language" of the formalism without knowing which way is up.

I consider three approaches to the interpretation of quantum theory and discuss their relation to student's conceptual development in quantum theory. The approaches considered are: the so-called Copenhagen Interpretation, the Many Worlds Interpretation and the de Broglie Pilot Wave Theory. I argue that, whereas the first two approaches listed only add to confusion, the last provides a well-defined and intuitive understanding of apparently "paradoxical" quantum mechanical behaviour that is more in line with students' expectations of physical theory. Consequently introducing de Broglie's original (1927), and later Bohm's (1952), approach to quantum theory may actually aid conceptual understanding. I show how the pilot wave approach can be integrated in a beginning quantum theory course in a relatively straightforward manner without impacting significantly on the content of the standard first quantum theory course.

Developing Screen Experiments to Support 3rd Level Quantum Optics

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Quantum optics allows students direct access to experiments that can fundamentally shift their understanding of how the Universe operates at the atomic level. However access to quantum optics labs is often costly, and many physics students progress through their entire degree learning quantum mechanics as a purely theoretical subject, without the ability to test their understanding experimentally.

As Beck[1] and others have pointed out allowing students to repeat the famous experiments of quantum optics, helps solidify their understanding of this conceptually challenging area of modern physics.

In this short oral bite, we'll discuss a new quantum optics interactive screen experiment developed at Durham University in collaboration with partners at the University of St Andrews, which creates a photograph based virtualisation of a 3rd year laboratory experiment to calculate Bell's Inequalities.

We'll discuss some qualitative feedback from students and discuss how this experiment (freely available as an OER) can be embedded into your courses to aid in supporting students to actively engage with quantum mechanics.

Quantum Mechanics: Theory and Experiment, Beck M., 2012, OUP USA, ISBN-10: 0199798125

Defining expertise in order to inform the design of learning experiences in experimental chemistry

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Expertise in experimental chemistry relies on a deep knowledge base and mastery of a wide range of skills. It also demands the effective execution of complex cognitive tasks, for example defining a research question, designing an

experiment, and evaluating the results. A programme of ongoing work will be outlined which aims to: (i) better understand and more precisely define expertise in experimental chemistry; (ii) investigate how such expertise is currently developed by learners on both sides of the secondary-tertiary educational transition; and (iii) apply the findings to design effective investigative learning experiences in chemistry in both secondary and tertiary educational settings. It is hoped that this presentation will provide the opportunity to establish links with parties interested in collaborating on the work.

Parallel 4: Focus on laboratories

Augmented laboratories: Near-peer constructed technology enhanced labs.

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Can an augmented reality smartphone based application assist students in developing scientific laboratory skills and enhance their conceptual understanding in a problem based learning environment?

Adaption and adoption of alternative pedagogies, such as problem based learning, and integration of technology-enhanced learning, such as augmented reality, can offer a more student-centred, research-orientated approach to laboratory teaching. In this intrinsic case study, a final year undergraduate student, acting as a near-peer change agent, designed a single problem based laboratory session for first year students. Technology was integrated to enhance the learning experience whilst simultaneously developing independent, 'just-in-time' laboratory technique learning. To enhance student independence and preparation, *Aurasma* was integrated as the key enabling technology. This technology permits simple augmented reality development, which aligned to the laboratory technique developed in this case study.

In order to address the research question, a pre-intervention survey was designed, piloted and conducted by the undergraduate learner-researcher in order to determine the level of preparation typically carried out by the first year students (n=18) in this case study. Survey results were analysed by quantitative and qualitative methods and used to design and develop the most appropriate augmented reality resources to support the first year students as part of a problem-based, scenario-contextualised, laboratory. This offered a relevant testing ground for augmented reality enhanced pedagogy.
After completing the augmented reality enhanced laboratory; participants were re-surveyed to gauge their perceived enhanced understanding and skill development. A discussion forum provided rich data that was analysed and thematically coded using the Braun and Clarke's (2006) six-step approach. Iterative coding and analysis were carried out until data saturation was achieved. A discussion of the findings from this intrinsic case study will be offered and underpinned by contemporary literature. Finally, conclusions will be drawn and recommendations for practice locally and more widely will be suggested.

Lab skills portfolios

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Practical skills are notoriously difficult to assess effectively, while the retention of lab skills in fast paced undergraduate courses can also be challenging for students who are encountering a bombardment of new ideas, techniques and concepts. In this flipped presentation we will discuss the development of a

practical skills portfolio for a foundation year chemistry course. The skills portfolio provides a framework for students to collate photographic evidence of their progress in developing a range of practical skills, while also requiring them to reflect on techniques and what makes them difficult. Another feature of the skills portfolio is that students are periodically asked to write a section of a lab report e.g. a method, on which they receive detailed feedback to support them in advance of writing a full report. Portfolios are submitted electronically via Turnitin, facilitating rapid marking and feedback.

We will present data obtained showing the benefits to both students and course tutors. As part of the flipped package, we will include example portfolios which can be easily adapted to suit other courses (note that the approach has been already adopted by a colleague at the University of Sheffield and a number of schoolteachers), and we believe that this is a highly transferable model. In the discussion session we will be happy to debate the relative merits of this system with relation to existing and other innovative practices.

Flipped pre-session activity:
http://www.edshare.soton.ac.uk/14653/

Teaching Practical Physics in Africa: problems expected and unexpected
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In countries with a long tradition of laboratory based teaching, practical work is seen by many teachers as essential aspect of their practice. It is widely accepted that practical work not only enables skills acquisition but also leads to greater conceptual understanding. However, whilst there has been much research into the teaching and learning of practical science across the economically developed countries, there has been little research into the teaching and learning of practical physics in Africa. This study examines the major challenges to the teaching and learning of practical physics in African secondary schools. The issues are relevant to all educational sectors.

Qualitative and quantitative data were collected from four countries in Africa. Surveys were carried out with ~400 final year secondary students and ~30 secondary physics teachers. Qualitative data were gathered from focus group discussion with the students and semi-structured interviews with; physics teachers, heads of science department, school principals and ministry officials. Other key stakeholders including physics curriculum planners and voluntary IoP coordinators were also interviewed. The numerical data were coded to produce descriptive statistics while qualitative data were transcribed and categorised into emerging themes.

The initial findings from the study reveal that there is a wide gap between practice in developed countries and the countries studied. This gap is attributable to many factors, some of which are predictable, e.g. various resource constraints. Other factors include ambivalent or negative teacher and pupil attitudes with prioritisation of 'theory' and a limited interest in or awareness of the importance of inquiry. These factors underlie the lack of

practical physics assessment in some countries in Africa which is a further disincentive to practical physics engagement.

The data from the study is informing a system-led analysis of practical physics teaching which, it is hoped, will guide future interventions and initiatives.

How can I measure the success of my lab teaching?

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I am using the flipped session format to seek help and opinions on how I can evaluate the effectiveness of my teaching laboratory instruction style. I have amended traditional expository exercises to resemble a guided inquiry style of learning with the intention of reducing the cookery and increasing the chemistry being done by students in my teaching lab. I have some ideas on how I can evaluate the success of this intervention and I am hoping that, through discussion, these will be critiqued and other methods suggested. The pre-session work will involve reading about the changes I have made, and in the session I will facilitate discussion on how one can evaluate the impact of these changes.

Flipped pre-session activity:
Read the discussion document found as an appendix at the end of this abstract book, which was also circulated via email.

Developing a Laboratory Skills Matrix

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Our level 1 inorganic teaching laboratory programme was redeveloped to streamline teaching and improve the student experience. Experiments were evaluated and selected on the basis of skills development to ensure good coverage of practical techniques and provide a solid foundation for experiments in later years. The utility of a Laboratory Skills Matrix will be discussed, both as a tool for practical curriculum construction, and as a means to highlight skills development to students. The matrix allows students to see the skills employed in the formative, summative and synoptic parts of the laboratory programme, while also providing a basis for a reflective skills checklist after completion of the rotation.

It is possible to increase the efficiency of teaching by identifying the key skills required by the students and then focusing resources to provide the required experience. The revised first year inorganic teaching laboratory emphasises skills development, yet requires less documentation, less equipment, fewer chemicals and produces less waste, all of which reduces costs.

The importance of practical work in school science

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After looking into the reforms, it is clear the government are putting less weighting on the importance of practical work in school science. But does this correlate with the views of school pupils, teachers and members of higher education? This project was carried out over 7 months across two semesters. In the first semester, an online survey for the first year chemistry undergraduate cohort at the University of Nottingham was created and released, to find out what students' expectations of university practicals were, and to find out what their A-level practical experience was like. Following that, late in the first semester, and early in the second semester, a survey was created and released to school pupils, and teachers, in both Key Stage 4 (KS4, age 14-16) and Key Stage 5 (KS5, age 16-18) to find out whether pupils enjoy science, what importance they place on the usefulness of practicals in aiding learning, and whether they actually enjoy practicals, see them as an alternative learning method or something else entirely. No general conclusions could be made from the data collected, with only broad conclusions made about the schools and university responses, but an outline for further research has been laid out.

Second year physics labs: taking data is the easy part

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A goal in the practical training of physics undergraduates is for them to emerge as independent researchers, an important characteristic of which is the skill or ability to extract meaning and understanding from open ended research projects whose outcomes by definition are uncertain. For a wide variety of reasons this skill difficult to train for. The aim here was to aid year two students in this, primarily by introducing a global "requirement" to perform an advanced data analysis technique: non-linear curve fitting. The hope was that the structure this provided would ultimately encourage a deeper consideration of data. Engagement was mainly evidenced through students' formal written reports (submitted at the end of each semester). It was found that the approach did prompt a much deeper consideration of data by a significant fraction of students. Based on a study of ~100 reports per year over three years it was found that the percentage of students who did not engage at all was relatively low and consistently decreased from ~25% to < 10% between first and second semester. In addition the maximum recorded percentage who engaged at or above a, subjectively defined, "reasonable level" was always greater than ~40% and could be encouraged up to a maximum of ~80%.

Parallel 5: Focus on transition, interdisciplinarity, internationalisation

Supporting Transitions into the Physical Sciences

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A recent report from the HEA[1] detailed the importance of belonging to a community for student retention and success. Student belonging is achieved through:

- Supportive peer relations
- Meaningful interaction between staff and students
- Developing knowledge, confidence and identity as successful HE learners
- An HE experience relevant to students' interests and future goals

The collegiate system and academic departments at Durham University have a proven track record in supporting students when they start their degree study, however, pre-arrival support is a key area that can be overlooked.

In this presentation we will discuss two projects that support students in making the transition into higher education. The first project developed a new student generated pre-arrival web-based support system for STEM students from the Foundation Centre at Durham University. This site prepares both local mature students and international students for studies at Durham and engenders a sense of community in a virtual landscape. This portal has had a high take up with students, and we will present both qualitative and quantitative evidence to show how it has impacted the student experience.

After the success of this project, we'll conclude by looking at its successor "Transitions into HE". This project is developing an innovative e-learning course to support all incoming first years before they start at Durham University. The course is designed to help students develop study skills and to successfully make the transition into higher education. The presentation will focus on the web-based resources being developed for Chemistry and Physics students and detail how these resources were developed through working with students as partners in the process and will focus on the rationale and the solutions being created.

[1] Sanders, John, and Louise Higham. "The role of higher education students in widening access, retention and success." (2012), Higher Education Academy

iTube, YouTube, WeTube – Engaging Undergraduate Chemistry Students in Collaborative Global Education

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This presentation will outline the development and implementation of an educational strategy based on YouTube to engage students within my own institution, as well as a broader, highly diverse global community of interested potential non-traditional learners.

This started as a personal instructor-led project (iTube) to present highly contextualised chemistry, engage people's interest with the science, and explain the relevance of it to their everyday lives. The local and global impacts of this approach will be presented based on student surveys and international YouTube engagement statistics.

In the second phase, students were enabled to evolve from simply being passive consumers of video content to having the opportunity to actively make their own (YouTube). Year 1 chemistry students are given the option to do this as part of a module on polymer science, and well over 100 York undergraduates have made videos that are personal, informative, creative and entertaining. We will reflect on the educational impact of this approach in comparison to writing more traditional 'magazine-style' articles on similar topics. Using YouTube engagement statistics we will also demonstrate that the students become global educators in their own right.
Finally, we will reflect on how YouTube empowers its audience with a voice, allowing them to enter into a dialogue with video-makers and with each other. This enables the development of a spontaneous online community (WeTube).

D. K. Smith, *J. Chem. Educ.* 2014, **91**, 1594-1599.

Can University Chemistry Teaching be Informed by Practice in the Arts, Humanities and Social Sciences?

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I have an unusual position at University of Reading in being both a Professor of Chemistry and Dean of the Faculty of Arts, Humanities and Social Sciences. This has given me an opportunity to study critically the practice in teaching across my faculty and to compare this with the ways in which we teach physical science. It has also made me think about the question: as university science teachers can we learn from the practice in other parts of the university? In this short talk I shall explore four areas where, perhaps it could be argued we lag behind in science teaching. These are:

1. "Reading" for a Degree; how to access and use background information
2. Use of primary sources to inform academic discussion
3. Seminar-based teaching
4. Student independence and student-led curriculum.

I shall give some examples of these and discuss how they may perhaps be included into university science curricula.

'Opening up' the teaching-learning scenario in India! An overview of open-educational resources (OERs) in India, and inspiration from the UK

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With a gradual but significant cognizance to the open-education approach and its possible implications for the teaching learning process, a range of initiatives have been undertaken in India in the past decades. Interestingly, these efforts span a range of government supported national projects to individual locally serving projects, many across disciplines and age groups. Apart from primarily serving higher education content, some of these projects also aim at popularizing Science.

That said, there is a lot that needs looking into- that will help OERs percolate further across the country, in particular how to enable teachers to execute their ideas into deliverables.

This talk discusses these initiatives in India, with an emphasis on Chemistry oriented efforts, seeking inspiration from OER initiatives from developed countries like the UK where the OER movement is strong. The origin of these projects, their present status and aspects to be considered in the Indian context with reflections from projects in the UK will be discussed.

Do Practical Skills Portfolio and quiz based Wordsearches help in the understanding and comprehension of practical chemistry for Chinese students?

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After delivering three years of the practical programme for students on our joint degree programme delivered in China and evaluating the progression. I started to really appreciate many of the problems the Chinese students faced in the understanding of their practical chemistry whilst carrying out their experiments in China. The students need to gain the required practical skills to enter our final year BSc course at Level 3 for their 4th year of study, how can the learning process be helped?

One problem is that many of the Chinese students joined the degree programme with limited or no practical skills. They were also developing their language skills whilst studying for their degree. Now I have delivered the whole programme in China it has led me to reflect on the gaps and developments needed to enhance their learning. At the RSC University Teachers Conference in Liverpool September 2014, I heard Dr David Read speak about the practical portfolio he used with his foundation students. His comments inspired my thinking could I adapt the practical skills portfolio for the Chinese students? I was also concerned about the comprehension of the students so I had an idea about using wordsearches to help understand more complex words that will be found in the practical method scripts. My talk will focus on the use and adaption

of the skills portfolio, the wordsearches that were developed and used, the problems, the updates and the benefits of this trial. Have these ideas been a success? Come along to this talk to find out about my progression with this project to date.

Authentic assessment at your fingertips: Developing a cross-disciplinary template for implementation

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While assessment is an integral part of the educational process, traditional assessment methods may not always provide students with the desire to move beyond strategic learning. The use of more authentic assessment types can play an important role by giving students more real-world experiences and helping to integrate graduate attributes into the curriculum. In addition to this, authentic assessment methods can provide students with greater opportunities for collaboration with their peers and interaction with the wider community.

This presentation will give an overview of the creation of a cross-disciplinary template to assist lecturers in the development and implementation of authentic assessments in their own modules. Some examples of authentic assessment in DIT will also be discussed.

Exploring technology enhanced instruction and assessment in the advanced physics laboratory

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This project remodelled senior physics laboratories to adapt to changing skillsets required in the workplace and to instil the graduate attributes necessary for flexible employment in physics and related disciplines. The project aimed to foster an enquiry-based model to help engage the students with their subject and to foster expertise in their subject area. This was achieved by the rewriting of lab descriptors to remove much of the 'step-by-step' experimental instruction and replacing in with theory or references to further theory. Students where encouraged to read the theory and write a pre-lab statement of intent, which was to contain a skeleton proposal for the experimental procedure and an estimation of uncertainties. This pre-lab work was loaded to the student's Wiki site which also acted to replace the student hand written log book. Furthermore an informal reflective paragraph was requested on the wiki after the completion of the experiment. In order to improve student's understanding of the lab reports evaluation criteria, students were asked to peer review a lab report and their mark was discussed and compared to the one given by the tutor.

It was envisaged that the development strategic, thoughtful and reflective approach to the undertaking of experimental work would be key to the development of physicists in the senior laboratory.
Staff and student feedback will be presented on this first year of implementation.

Student & Staff Perceptions of Transferable & Workplace Skills Development in Chemistry Degree Programmes

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In 2010 a Higher Education Academy study showed that a significant proportion of chemistry graduates believed chemistry degree courses should provide more opportunities to develop transferable skills, especially oral presentation skills.[1] This talk will introduce a new project which aims to measure the attitudes of chemistry students (both undergraduate and postgraduate) and teaching staff towards transferable and workplace skills development throughout the degree programmes they are involved in. The project aims to measure the student attitudes towards transferable skills development at entry to the degree and to determine whether there is a change in the perceived importance of these skills as students progress through the degree. It is also hoped the project will reveal whether there is a connection between the teaching methods employed in a course and the perceived benefit to transferable skills development. It is hoped the findings of this project will provide additional insight to chemistry programmes reviewing the way they provide transferable skills training. Preliminary findings from the pilot phase of this project will be presented.

[1] Hanson, S. and Overton, T., Skills Required by New Chemistry Graduates and their development in degree programmes, The Higher Education Academy, UK Physical Sciences Centre, Hull, UK, 2010.

Oral bytes

Design your own purification: a guided-inquiry experiment for the first year chemistry laboratory

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In this oral byte, I will discuss the development of a guided-inquiry practical that was introduced to a first year laboratory course for Chemistry and Natural Science students.

This activity was themed around purification where students had to design and implement their own purification procedures rather than follow a recipe. Students had two tasks to complete: to isolate compounds from a mixture using a liquid-liquid extraction process, and to purify a compound by recrystallisation.

I will discuss how we designed the practical so that student could develop their problem-solving skills and experience of experimental design. An evaluation after the practical was performed by the first cohort of students will reveal if these learning gains were achieved.

A Careers Fair with a Difference

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Why do so few students bother to attend traditional careers fairs? And why do so many students put off thinking about their career until after they graduate? This presentation reports on our inaugural 'Opportunities Day' – a day of talks and activities integrating both academic and career development. The presenters were employers, alumni, academic staff and current students, and all sessions were focussed on opportunities within and beyond a physics degree. The day catered for everyone whatever their stage of career planning and thus attracted students from 1st year to final year. This is now established as an annual event and should help our students to decide on, prepare for and hence be competitive in achieving a graduate job or further study by the time they graduate.

Embedding Enterprise in the Physics Curriculum

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The School of Physics and Astronomy engaged with industry on a new module that consisted of a series of 'live' projects, working with groups of Year 3 students. The development is based upon a model initially established at Durham University, to create a "Group Industrial Project" module (the Leeds development was undertaken with support from Durham). The School worked with a number of companies to develop realistic and feasible project briefs that students undertook as a project for the whole of the academic year. There was

an excellent level of dialogue between the students and the company in each case, including site visits and presenting the work to company representatives (often at a senior level). This module gave students ownership of a project; the opportunity to become the experts over the course of the year, and work in a pseudo-business environment. They gained an appreciation of the commercial pressures that companies face, and how this must be considered alongside the scientific research.

The module introduces students to enterprise and business skills in a wholly authentic way that contains the discipline at the heart of any activities so that student develop both disciplinary awareness and enterprise skills; such an approach has been critical to achieving the engagement we have from both students and academic members of staff. Significantly, the development of these interventions has not been undertaken by staff alone; a key feature in their development has been the role of Industrial Advisory Board, which was established in parallel. The Industrial Advisory Boards consist of representatives from business and industry, with strong links to the University, who can advise upon and contribute to curriculum developments and enhancements (http://journals.heacademy.ac.uk/doi/abs/10.11120/ndir.2014.00026).

Assessing the practicalities and benefits of using immersive Virtual Reality technology to explain complex chemical concepts

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The STEM at Bradford team is currently developing materials and programs using the Oculus Rift immersive technology headset to test its application in explaining chemical concepts. The stimulating and immersive materials developed through the project are aimed at bringing difficult concepts to life, making studying chemistry an exciting option for pupils when considering their A Level choices. Promoting the study of chemistry at A Level and beyond is a key aspect of the project and the materials developed will be designed to increase knowledge and confidence in the study of chemistry. Teaching, learning and explaining complex or abstract chemical concepts without misconception can prove difficult and a potential barrier to successful study. This project aims to tackle these barriers and support student engagement and success.

This oral byte will give a snapshot of the results of this development, provide a stimulating talking point and offer an opportunity for collaboration for any colleagues interested in testing the materials developed.

Appendix
Flipped pre-session activity:

How can I measure the success of my lab teaching?

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Abstract:
I am using the flipped session format to seek help and opinions on how I can evaluate the effectiveness of my teaching laboratory instruction style. I have amended traditional verification, expository exercises to resemble a guided inquiry style of learning with the intention of reducing the cookery and increasing the chemistry being done by students in my teaching lab. I have some ideas on how I can evaluate the success of this intervention and I am hoping that, through discussion, these will be critiqued and other methods suggested. The pre-session work will involve reading about the changes I have made, and in the session I will facilitate discussion on how one can evaluate the impact of these changes.

Your homework:
Your homework is to read the following and come prepared for a discussion on researching into teaching practice.

The setting:
The Level 2 inorganic laboratory course makes up one third of the Level 2 laboratory module. Groups of 50 students spend 5 weeks of 1 ½ days in one of the three teaching laboratories (inorganic, organic, physical) before moving on to one of the other labs making room for the next group. Because of this cyclical arrangement, my course needs to be suitable for a student fresh from Level 1 as well as one ready to move to Level 3.

The theory:
Domin (1999, 2007) convincingly criticised the verification, expository style when he said that most of the learning done by students occurs after the lab class has finished. Other criticisms are that the style of the experiment leads to robotic following of instructions rather than careful thought about the chemistry. The review written by Hofstein and Lunetta (2004) supported this saying that in laboratory classes, the student perceives their purpose to be following the instructions or getting the right answer and they frequently fail to link the manipulations they are doing to the experimental investigation they are performing.
The principles of cognitive load and working memory space championed by Johnstone (1991, 1997) and Reid (2008) suggest that the volume of information in a typical laboratory class is a direct cause of the robotic instructions-following. Johnstone and Reid advocated prelaboratory work to help with this but my experience of the prelaboratory exercises I inherited has been that students answered the set questions for 10 marks but were not prepared for the experiment, even when the task was to fill in the blank boxes in a procedural flow chart.

The changes:
The changes I have made have been instigated against a backdrop of increasing student numbers and decreasing teaching time and resource. My aim has been to increase the amount of Chemistry being done during the class and to decrease the amount of mindless instruction following.
I decided to keep the advantages of the verification, expository experiments which are that they are predictable hence easy to resource and easy to support and the reactions are reliably successful. I repackaged them by adding questions and structure to help the students prepare better, think about what they are doing, and cultivate an awareness of the purpose of their actions. I focussed on five aspects to do this: time; purpose; preparation; thought; and consistency of style.

People need time and space to think. In each experiment, I removed unnecessary repetition and extraneous (albeit interesting) information to ensure the students had enough time and space to focus on their work. My intention was to avoid situations where the students are reduced to rapidly following the instructions in order to complete the allotted tasks before the end of the laboratory session.

To facilitate a purposeful approach to experimentation, I branded each experiment with a research question or aim. Students are required to write this out as part of their prelab preparation and postlab writing up, and the write-ups address the question or aim through a structured set of questions in the order Results – Discussion – Conclusion.

Pogačnik and Cigić (2006) shifted the balance of work outside of the lab into prelaboratory preparation to increase student engagement with the laboratory activities. I also thought that students needed to be better prepared before they entered the lab and so I increased the amount of prelaboratory preparation required and compensated for this with a decrease in the postlab work required. The prelaboratory work in three parts, a theoretical look things up part, an experimental read through and prepare part, and a part for submission which draws on selected information in the first two parts. Prelabs are pass/fail.

To encourage the students to think more deeply about their actions, I added conceptual questions in the text along the lines of – "why are you adding acid at this point?" and "how can you be sure water is not detrimental to the reaction?" Cox and Junkin (2002) did a similar thing and reported benefits from it, although their intervention also included additional discussion of the concepts.

Luckett (2009) advocated a 'unifying dominant regulative discourse' to help students form the conceptual links needed to relate knowledge from different parts of a course. Where experiments have been devised by different staff members, style, activities and font will vary from week to week. In providing consistency of style, my intention has been that the message that experiments should have purpose will be reinforced, and that students will learn to think about what they are doing and to prepare well in advance of their work.

For discussion in the flipped session:
I have made all of these changes and I have put the onus on the students to engage with the style in order to reap the benefits of it. I anticipate that the benefits are that the students will know the aim of the experiment they are performing when they are in the lab, they will know what they are doing,

and they will know why they are doing it. Finally, I anticipate that the students will have fully understood the experiment by the time they have finished addressing the research question or aim in their write-up.

In the flipped session, I would like to explore ways I can measure the success of my changes. I will ask for audience participation in discussing how I can define 'success', the theoretical frameworks I can use to investigate it, and what sorts of data I can collect.

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