Variety in Chemistry Education 2013

and

Physics Higher Education Conference 2013

University of Liverpool

29-30 August 2013

This year's conference is generously supported by the Royal Society of Chemistry Tertiary Education Group and Education Division, the Institute of Physics and the Higher Education Academy.

Organising Committee

Ross Galloway
Tina Overton
David Sands
Natalie Rowley
Karen Moss
James Gaynor
Gita Sedghi

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University of Liverpool, 29-30 August 2013

Thursday 29th August

10.00 Arrival, registration, coffee

10.50-11.00 Welcome and introduction

11.00-11.55 *Location: CTL-Flex / Chair: Ross Galloway*
Keynote lecture: Thinking Physics
Peter Main, Institute of Physics

12.00-12.30 **Oral bites**
Discussion boards for supporting chemistry teaching
Michael Seery
iAnnotate
Simon Lancaster
Lies, damned lies and usage statistics
Charles Harrison
Authentic Assessment: An Information Retrieval Exercise for 1st Year Students
David McGarvey
Turn to your virtual neighbour: Peer instruction in an online setting
Judy Hardy and Ross Galloway
Undergraduate-led design of 'impactful' outreach
Paul Duckmanton

12.30-13.30 Lunch

13.30-15.30 **Choice of parallel workshops**

Location: Environmental lab
Chemical Concepts Inventory: Fast-Tracking Tools for Evaluating the Impact of Pedagogical Innovations
Simon J. Lancaster, David Read and Paul C. Taylor

Location: CTL-Flex
Teaching concepts through modelling: designing teaching and assessment activities
David Sands

Location: Brunner LT (Chemistry)
Hands-on programming with the Arduino: open-source hardware in an introductory programming laboratory
Paul Cruickshank

15.30-16.00 Tea/coffee

16.00-17.00 **Choice of parallel sessions of oral presentations**

Location: Brunner LT (Chemistry) / Chair: David Sands
Focus on physics
A more detailed diagnosis: Applying item response theory and item response curves to the Force Concept Inventory
Judy Hardy, Ross Galloway, Evguenia Usoskina and Eloise Kohler
Interesting Lessons from a Lecture-less Course
James Collett
Collaborative initiatives between university Physics and Education departments: the mutual benefits and possibilities
Judith Hillier
Curriculum for Excellence – what's it all about?
Judith H Steven-Setchell

Location: Gossage LT (Chemistry) / Chair: Natalie Rowley
Focus on chemistry
First year chemistry students' expectations of their chemistry degree course in a changing fee regime
Jacquie Robson and Paul Low
Letters from America
Simon J. Lancaster and Simon Rees
Interactive quantum mechanics simulations for chemistry students
Antje Kohnle and Georg Hähner
The development of student self-study activities to enhance student understanding of the language of chemistry
Simon Rees

Location: CTL-Flex / Chair: Dave McGarvey
Focus on understanding learning
Peerwise: Threshold concepts vs revision – results and motivation
Gita Sedghi and James Gaynor
A discussion of the reason for, and types of threshold concepts in the physical sciences
Vijay Tymms
Solving ill-structured problems: Differences between undergraduate chemists and physicists
Christopher Randles, Marsali Wallace, Tina Overton and Ross Galloway
Scaffolding for Cognitive Overload using Pre-lecture E-resources (SCOPE) for First Year Chemistry Undergraduates
Claire Mc Donnell

17.30 RSC TEG AGM for members of TEG
Location: CTL-Flex

19.30 Wine reception
Location: Vine Court accommodation

20.00 Dinner
Location: Vine Court accommodation

Friday 30th August

9.00-9.55 *Location: CTL-Flex / Chair: Karen Moss*
Keynote lecture: Why the Variety?
Michael Seery, DIT

10.00-12.30 **Choice of parallel workshops**

Location: CTL-Flex
New Quantum Curriculum Project
Derek Raine and Antje Kohnle

Location: Environmental lab
When is a Problem not a Problem? Analysing the Victorian Pharmacy
Jane Essex and Katherine Haxton
(Note: Restricted numbers – see sign up sheet).

Location: Brunner LT (Chemistry)
Leadership and Management for Scientists and Engineers
Mike Cole

10.45-11.15 Tea/coffee

12.30-13.30 Lunch

13.30-14.30 **Choice of parallel oral presentations**

Location: CTL-FLex / Chair: Bruce Sinclair
Focus on physics
Inverting the laboratory: Experimental research at home
Helen Vaughan and Sergey Burdin
Quantum Fears: Are students afraid of time-dependence?
Niels Walet
And Now for Something Completely Different
Morag Casey
Students as co-creators: the development of student learning networks in PeerWise
Alison Kay and Judy Hardy

Location: Gossage LT (Chemistry) / Chair: James Gaynor
Focus on chemistry
Total Recall: Adventures with Synoptic Activities
Kyle W. Galloway
Chemistry: Making a Difference
Christopher Pask, Samantha Pugh and Patrick McGowan
Science Communication for the 21st Century
Dylan Williams
Assessing Practical Skills of Undergraduates: A First Year Practical Exam
Laura Hancock

Location: Brunner LT (Chemistry) / Chair: Claire McDonnell

Focus on assessment

Students' use of resources and implications for open-book exams
Ross Galloway and Marsali Wallace
Objective Structured Chemistry Examinations (SChemEs): Developing Methods of Assessment
Suzanne Fergus and Stewart Kirton
The 'Apprentice' approach to group work assessment
Elizabeth Page
Student based assessment for Instant Feedback
Andrew McKinley and Laura Patel

14.30-15.00 *Location: CTL-Flex / Chair: Gita Sedghi*

Oral bites

Scared to ditch the cookbook? Just do it slowly
James Gaynor
Overcoming misconceptions: testing the conceptual understanding of mechanics with mature learners
Sam Nolan
Do Chemists Have Chemophobia?
Katherine Haxton
Science Summer Internships Support Scheme (SSISS)
Samantha Pugh
Recession proof outreach
Kristy Turner
New *New Directions* Journal
Derek Raine

15.00-15.15 **Closing discussion**

15.15 Coffee/tea, depart

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Keynote lectures

1. Thinking Physics
   Professor Peter Main, Institute of Physics

2. Why the Variety?
   Dr Michael Seery, Dublin Institute of Technology

1. **Thinking Physics**

Professor Peter Main
Director of Education & Science at the Institute of Physics
Peter.Main@iop.org

Physics is a mature subject at all levels of education and, in recent years, there has been a marked resurgence in its popularity. But, beyond the ever popular manifestations of the subject in its most esoteric areas, such as cosmology, most people, even physicists themselves, struggle to define what physics is. What it most certainly is not defined by is content and yet almost the whole educational system takes that as the starting point, by producing a list of the topics to be studied, whether via A-level specs or the core of physics in the degree accreditation process. In this talk I will take a different view of what physics is, more as a way of thinking, and comment on how our current educational approaches, including assessment, match that approach. I will also look at the inputs and outputs of physics degrees. In the former case, I will comment on how physics might attract a more diverse body of students and, in the latter, whether we are delivering graduates with the skills we think they have. Finally, I will raise the question of whether there is even a need for separate physics education in an increasingly interdisciplinary world.

2. Why the Variety?

Dr Michael Seery
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There are a variety of attractive innovative teaching methods that are available to the science education practitioner. The question arises: which, if any, to choose? Why should we deviate from a traditional lecture format? In this presentation, I wish to highlight some alternatives to the lecture format that are based on cognitive load theory. These include pre-lecture activities, worked examples, and "flipping" lectures.

Pre-lecture activities[1] were introduced to a first year chemistry group after it was found that students who had no school chemistry were underperforming relative to those who had.[2] These activities were used to introduce terminology and the main topics of each lecture. After implementation, the difference in student performance was not dependent on whether they had completed chemistry at school.[3]

Worked examples have a strong literature basis[4] but appear to be relatively under-used (or at least under-reported). I plan to highlight a few instances of where I have used them in a Maths for Chemistry module[5] and a thermodynamics module with a view to advocating their use among practitioners.

The concept of flipped lectures is gathering momentum,[6] although there is little literature on the concept. Following on from work on pre-lecture activities and worked examples, I ran a pilot study this year in a thermodynamics module. Some general findings are highlighted regarding structuring the activities, usage, and problems that arose. Plans for a more formal evaluation will be shared with a view to discussing how best to consider evaluating teaching innovations as we experiment with a variety of teaching methods in our classrooms.

1. Michael Seery, *Jump-starting lectures*, **Education in Chemistry**, 2012, 49(5), 22-25.

2. M. K. Seery, *The Role of Prior Knowledge in Undergraduate Performance in Chemistry – A Correlation-Prediction Study*, **Chemistry Education Research and Practice**, 2009, 10. 227 – 232.

3. M. K. Seery and R. Donnelly, *The implementation of pre-lecture resources to reduce in-class cognitive load: A case study for higher education chemistry*, **British Journal of Educational Technology**, 2012, **43(4)**, 2012 667 – 677.

4. K.J. Crippen and D.W. Brooks, *Applying cognitive theory to chemistry instruction: the case for worked examples*, **Chemistry Education Research and Practice**, 2009, **10**, 35 – 4.

5. Maths for Chemistry resources: www.mathsforchemistry.info (2013)

6. C. H. Arnaud, *Flipping Chemistry Classrooms*, **Chemical and Engineering News**, 2013, **91(12)**, 41-43; H. R. Sadaghiani, *Controlled study on the effectiveness of multimedia learning modules for teaching mechanics*, **Phys. Rev. ST Physics Ed. Research,** 2012**, 8**, 010103.

Oral presentations

1. A more detailed diagnosis: Applying item response theory and item response curves to the Force Concept Inventory
   Judy Hardy, Ross Galloway, Evguenia Usoskina and Eloise Kohler, University of Edinburgh

2. Interesting Lessons from a Lecture-less Course
   James Collett, University of Hertfordshire

3. Collaborative initiatives between university Physics and Education departments: the mutual benefits and possibilities
   Judith Hillier, Oxford University

4. Curriculum for Excellence – what's it all about?
   Judith H Steven-Setchell, UWS

5. First year chemistry students' expectations of their chemistry degree course in a changing fee regime
   Jacquie Robson and Paul Low, Durham University

6. Letters from America
   Simon J. Lancaster and Simon Rees, University of East Anglia and Durham University

7. Interactive quantum mechanics simulations for chemistry students
   Antje Kohnle and Georg Hähner, University of St Andrews

8. The development of student self-study activities to enhance student understanding of the language of chemistry
   Simon Rees, Durham University

9. Peerwise: Threshold concepts vs revision – results and motivation
   Gita Sedghi and James Gaynor, University of Liverpool

10. A discussion of the reason for, and types of threshold concepts in the physical sciences
    Vijay Tymms, Imperial College London

11. Solving ill-structured problems: Differences between undergraduate chemists and physicists
    Christopher Randles, Marsali Wallace, Tina Overton and Ross Galloway, University of Hull and University of Edinburgh

12. Scaffolding for Cognitive Overload using Pre-lecture E-resources (SCOPE) for First Year Chemistry Undergraduates
    Claire Mc Donnell, Dublin Institute of Technology

13. Inverting the laboratory: Experimental research at home
    Helen Vaughan and Sergey Burdin, University of Liverpool

14. Quantum Fears: Are students afraid of time-dependence?
Niels Walet, University of Manchester

15. And Now for Something Completely Different
Morag Casey, University of Glasgow

16. Students as co-creators: the development of student learning networks in PeerWise
Alison Kay and Judy Hardy, University of Edinburgh

17. Total Recall: Adventures with Synoptic Activities
Kyle W. Galloway, University of Nottingham

18. Chemistry: Making a Difference
Christopher Pask, Samantha Pugh and Patrick McGowan, University of Leeds

19. Science Communication for the 21st Century
Dylan Williams, University of Leicester

20. Assessing Practical Skills of Undergraduates: A First Year Practical Exam
Laura Hancock, University of Keele

21. Students' use of resources and implications for open-book exams
Ross Galloway and Marsali Wallace, University of Edinburgh

22. Objective Structured Chemistry Examinations (SChemEs): Developing Methods of Assessment
Suzanne Fergus and Stewart Kirton, University of Hertfordshire

23. The 'Apprentice' approach to group work assessment
Elizabeth Page, University of Reading

24. Student based assessment for Instant Feedback
Andrew McKinley and Laura Patel, Imperial College

1. A more detailed diagnosis: Applying item response theory and item response curves to the Force Concept Inventory

Judy Hardy, Ross Galloway, Evguenia Usoskina and Eloise Kohler
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Diagnostic tests are widely used in science education research; in particular, they have been instrumental in the development of evidence-based instructional strategies. One of the best-known examples in physics is the Force Concept Inventory (FCI), a multiple-choice diagnostic test designed to assess students' conceptual understanding of Newtonian mechanics (Hestenes, Wells, & Swackhamer, 1992). It has recently been estimated that the FCI has been taken by many hundreds of thousands of students worldwide (Lasry, Rosenfield, Dedic, Dahan, & Reshef, 2011).

Item response theory (IRT) can be used to model the characteristics of individual items in a multiple-choice test such as the FCI, including the difficulty, discrimination and probability of guessing correctly (Wang & Bao, 2010). This approach can result in deep insights into students' performance, however a large number of responses (typically ~1,000) are needed in order to obtain a good fit. A simpler approach uses item response curves (IRC) to represent responses to test items graphically (Morris et al., 2012). This facilitates visual comparison between test items but does not provide quantitative measures.

IRT and IRC have been applied to FCI responses from students taking an introductory physics course at the University of Edinburgh between 2008 and 2012. In this presentation we will describe the two approaches, outline the pros and cons of each, and discuss the insights they can provide into student understanding and common misconceptions.

Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher*, *30*(3), 141–158. doi:10.1119/1.2343497

Lasry, N., Rosenfield, S., Dedic, H., Dahan, A., & Reshef, O. (2011). The puzzling reliability of the Force Concept Inventory. *American Journal of Physics*, *79*(9), 909. doi:10.1119/1.3602073

Morris, G. a., Harshman, N., Branum-Martin, L., Mazur, E., Mzoughi, T., & Baker, S. D. (2012). An item response curves analysis of the Force Concept Inventory. *American Journal of Physics*, *80*(9), 825. doi:10.1119/1.4731618

Wang, J., & Bao, L. (2010). Analyzing force concept inventory with item response theory. *American Journal of Physics*, *78*(10), 1064. doi:10.1119/1.3443565

2. **Interesting Lessons from a Lecture-less Course**

James Collett
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I will describe some interesting observations made from a course, 'Space Dynamics', which I have been running for the last seven years with a mixed cohort of physicists, engineers and mathematicians. The course has no formal teaching: instead, the students work at their own pace in a computer lab through a set of numerical challenges. Structuring the course becomes critical and I will describe how exercises are sequenced, and give the students the opportunity to invent their own methods of attack as the level of difficulty increases. The level and type of support the students require in the lab changes during the progress of the module. I have noticed some interesting trends in their response to this form of teaching. Most unusually, they import skills and knowledge acquired in other courses and tackle quite complex systems (e.g. the Euler equations) without the difficulty I would anticipate in a formal taught class. The core of this presentation will be a set of examples illustrating both the opportunities and challenges of this type of course, to help others who wish to attempt something similar. As part of the assessment, the students use the skills they have learnt to design and plan entrepreneurial space missions. They attend a pitching workshop run by the University's enterprise team and have a session with an industry expert to discuss their plan before final presentation. The student feedback on the course is almost uniformly positive and the self-pacing structure of the course has allowed some students who have struggled in other modules to shine here. The students also end up with an impressive portfolio of work to discuss with future employers.

3. **Collaborative initiatives between university Physics and Education departments: the mutual benefits and possibilities**

Judith Hillier
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Many universities have cross-departmental links between the sciences and Education: these can be seen as beneficial for outreach and the widening access agenda. However, recent research, currently accepted for publication in the Canadian Journal of Science, Mathematics and Technology Education, shows that these links are also crucial for teacher recruitment and retention. Physicists from seven pre-service teacher training cohorts from three English universities were invited to answer an online survey with follow-up telephone interviews exploring their decisions to become teachers and the factors influencing their retention in the profession. Key to becoming teachers were pivotal experiences revealing teaching as a career they could enjoy. Analysis also showed a frequent lack of support and feelings of isolation for beginning physics teachers in schools. Given the chronic, international shortage of science and mathematics teachers, particularly in chemistry and physics, this is a matter of concern to both secondary and tertiary education sectors, as the quality of education of current and future generations is at stake. However, our research suggests that university science departments also have a role to play in the recruitment and retention of science teachers. Collaborative initiatives between university Physics and Education departments can provide undergraduates with the experiences needed to reveal teaching as a career they could enjoy successfully. Partnerships between university Physics and Education departments and local schools can also be valuable sources of continuing professional development for physics teachers and non-specialist teachers of physics. These are some examples of mutually beneficial collaborations between university departments: more must already exist and many others are possible, with the ViCE/PHEC 2013 conference being an ideal opportunity for explorative discussions.

4. Curriculum for Excellence – what's it all about?

Judith H Steven-Setchell
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Scotland's Curriculum for Excellence is now in place. The first of the new national exams will take place in 2014. What will this mean for our future intake of Scottish students? Will we need to change what we do? The HEA and Education Scotland have funded work seeking to develop knowledge and awareness of the potential impact of the new curriculum in a number of disciplines in HE. I was tasked with the physics and maths subject areas, and will report on the findings of this work. Work is also on going at UWS into the chemistry subject area, and I also hope to present a flavour of that work, carried out by my colleague Dr Ruth Durant.

5. First year chemistry students' expectations of their chemistry degree course in a changing fee regime

Jacquie Robson and Paul Low
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The UK Higher Education sector is facing a number of significant changes over the coming years arising from dramatic changes in the structure of undergraduate fees and funding of undergraduate places, changes to rules governing the number of high achieving students that can be recruited outside of quota, and the national economic landscape that may influence student attitudes to their choice of degree, and the consequence of these factors on student motivation and expectations of the teaching, learning and assessment of their degree work.

In response to the potential for the changes to the landscape in which the UK HE sector is operating, a survey of the 2011/12 first year class at Durham University taking the core unit Chemistry 1A was undertaken, followed a year later by the 2012/13 class. These surveys set out to explore both the factors that influence the student's decision to study Chemistry at Durham, and the expectations of the contemporary student of HE teaching methods and provisions for learning support in light of the various well publicised factors indicated above. This presentation will report summary of this research.

6. Letters from America

Simon J. Lancaster [1] and Simon Rees [2]
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[2] The Foundation Centre, Pelaw House, Leazes Lane, Durham City, DH1 1TA simon.rees@durham.ac.uk

We are the fortunate recipients of 2013 RSC Activating Pedagogical Research travel bursaries to attend the Gordon Research Conference on Chemistry Education Research and Practice. We will each provide our take home impression of the conference and how it reflects the state of the art of pedagogical research in the US.

7. Interactive quantum mechanics simulations for chemistry students

Antje Kohnle and Georg Hähner
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ak81@st-andrews.ac.uk

Since 2009, we have been developing and evaluating interactive simulations for the learning and teaching of quantum mechanics concepts at university level. The QuVis simulations build on education research and our lecturing experience, and aim to specifically target student misconceptions and areas of difficulty in quantum mechanics.

Thanks to HEA Teaching Development funding, we have been able to extend the resource to be useful to chemistry students studying introductory quantum mechanics by modifying existing simulations, developing new simulations and developing accompanying problems sets suitable for chemistry students. Simulations and instructor resources (problem sets with full solutions) are freely available at www.st-andrews.ac.uk/~qmanim/chemistry. Topics of the simulations link to Atkins' Physical Chemistry, with most simulations developed so far focussing on basic quantum theory. Each simulation includes a main controls view and a step-by-step exploration view with texts and animated highlighting, making the simulations self-contained instructional resources. Problem sets aim to help students make links between different representations, compare and contrast situations and promote guided exploration while still providing sufficient scaffolding for students to progress from simpler to more complex situations.

We have trialled one of the simulations as a homework assignment and used them in lectures in a St Andrews introductory physical chemistry module. Analysis of homework responses was used to optimize the simulation and problem set, and general aspects found were included in all simulations and problems wherever applicable. We collected survey responses from students on this module on their use of and attitude towards the simulations and suggestions for improvement. We also incorporated aspects of interface design into all simulations that were found in individual student observation sessions with physics students interacting with similar simulations. This presentation will give an overview of the resources developed so far for chemistry students and instructors and discuss future plans.

8. The development of student self-study activities to enhance student understanding of the language of chemistry

Simon Rees
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Chemistry is a subject rich with a specialist vocabulary that a student must grasp if they are to be successful. This is a challenge for home and international students. This presentation will describe the development of a suite of self-study activities that embed the use a substantial database of student writings in chemistry (the Foundation Corpus – FOCUS) to enhance student understanding of the language of chemistry and improve their academic writing skills.

A range of software tools (e.g. Wimbacreate, Camtasia) have been utilised to create a diverse and media rich experience for the students that is engaging and addresses significant areas of concern through the application of corpus linguistics. The activities include "how to improve your lab reports" and "the meaning of affixes in science". The impact of these strategies on a diverse student cohort consisting of home and international students was explored using a pre and post course scientific language assessment and evaluative questionnaires.

9. Peerwise: Threshold concepts vs revision – results and motivation

Gita Sedghi and James Gaynor
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In the Department of Chemistry at the University of Liverpool we have implemented Peerwise in two different ways and have looked at two different aspects of the system:

1) Threshold concepts vs Revision: Peerwise was implemented as a way of embedding core concepts during our "Chemical Engineering for Chemists" module and also used as a revision tool for year 2 spectroscopy. For the threshold concepts there was an inbuilt control, with a question in the exam related directly to the concepts covered in the Peerwise task, and then questions in the exam with no link to the Peerwise task. Four comparisons were made: authoring/answering vs concepts covered/concepts not covered; findings show a good correlation between authoring questions and the appropriate questions in the exam but less correlation of the other three comparisons.

2) Motivational factors: During the two modules above, we looked at student perceptions of the system, in particular the motivational factors behind their engagement with it. A student survey was completed in both courses (over 50% return rate) with an interesting mix of results. Perhaps unsurprisingly, the rewards on offer were popular, which goes strongly against the ethos of most motivational theories for creating a learning environment that promotes intrinsically motivated students. However, there are other benefits, and it appears as though the method of implementing Peerwise strongly influences students' perceptions of the system.

10. A discussion of the reason for, and types of threshold concepts in the physical sciences

Vijay Tymms
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When studying physical sciences students frequently encounter conceptual frameworks that are difficult to understand and take time to master but once conquered allow the learner a more enlightened and deeper understanding of the world. All disciplines have these so-called threshold concepts that appear at all levels of education; two examples that are encountered at undergraduate level in physics are an appreciation of quantum mechanical behaviour of bound electrons and practical circuit assembly in electronics.

Careful classification of the different types of threshold concept can help with our understanding of why students find them difficult and an appreciation of the idea of loss aversion can go some way to understanding why some students never fully master some concepts despite ample time and support being available during their degree.

Regarding classification, Krathwohl et al's revised taxonomy of learning, used alongside other similar schemes, which essentially divide knowledge into four types – factual, procedural, conceptual and metacognitive - can be helpful in understanding the obstacles students face. Using the two examples, practical electronics can be viewed as a factual and procedural threshold and quantum understanding as a conceptual and metacognitive threshold. Developing an appreciation of these differences should be able to enhance our understanding of how students learn and thereby assist our teaching.

Regarding loss aversion, studies (by Daniel Kahneman for example) show people tend to fight harder to avoid loss than acquire gains. This goes some way to explaining why some students struggle to make headway with thresholds concepts: to being to understand one must deliberately lose a level of understanding, pass through a phase of intense confusion to then finally gain a greater understanding. It is this reluctance to let go of cherished beliefs that often holds students back. Being aware of this we can also fortify our course planning and delivery.

11. Solving ill-structured problems: Differences between undergraduate chemists and physicists

Christopher Randles [1], Marsali Wallace [2], Tina Overton [1] and Ross Galloway [2]
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Ill-structured problems have missing information, require estimations, and the process of getting to the solution is as important as the answer itself. These types of problems are similar to those that students will face after University, though they often find solving ill-structured problems difficult.

This study examines the differences between undergraduate physics and chemistry students when solving the same ill-structured problems. The aim was to understand how students from different disciplinary backgrounds approached, solved and evaluated their answers when solving ill-structured problems.

This talk presents a case study of physicists and chemists, from the University of Edinburgh and the University of Hull respectively. Students spoke aloud whilst solving three ill-structured problems. Their pen strokes and audio were recorded in synchronisation using a Livescribe smartpen.

This talk will present the results of this cross-disciplinary study and whether any major differences or similarities between the chemistry and physics students were found. It is hoped that this talk will also encourage listeners to think about the use of ill-structured problems and how they can apply to both physics and chemistry education.

12. Scaffolding for Cognitive Overload using Pre-lecture E-resources (SCOPE) for First Year Chemistry Undergraduates

Claire Mc Donnell
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The aims of this project were; (i) to develop online pre-lecture resources in organic chemistry for first year chemistry undergraduates to complement those prepared in 2010-11 in inorganic and physical chemistry by a colleague, Dr Michael Seery, (ii) to evaluate the effect of implementing these resources by analysing quantitative data (test and exam results) and qualitative data (pre- and post-implementation surveys and focus group interviews). Ten pre-lecture activities on organic chemistry were prepared and were used with 87 students in semester 2 of the 2011-12 academic year and with 102 students in 2012-13.

The E-resources were designed to;

- reduce cognitive load by introducing some new terms and concepts before the lecture
- incorporate worked examples to scaffold students' learning
- provide short online test questions with immediate feedback so that students could identify areas of difficulty.

The anticipated benefit was that that the gap in performance often observed in first year between learners who have and have not studied chemistry at second level would disappear or be reduced. Analysis of mid-semester test and examination results for the two cohorts (2011-12 and 2012-13) showed that, among groups who had similar performance levels at secondary school, the gap between those who had and had not previously studied chemistry either decreased or was not statistically significant. The surveys and focus groups undertaken revealed that learners felt more confident in the lecture and that they could focus more when they had completed a pre-lecture activity.

13. Inverting the laboratory: Experimental research at home

Helen Vaughan and Sergey Burdin
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Pre-laboratory activities and virtual experiments are allowing students to study some practical skills at a distance and at their convenience. The Central Teaching Laboratory at The University of Liverpool has gone one step further by providing each year 2 physics student with a new electronics system, a National Instruments MyDaq, and access to £10 of components. The intention was for students to use it to work on an open ended, 12-week team project in their own time. In line with the New Physics curriculum, the project aims to develops student's independent learning and problem solving skills in preparation for final year individual projects.

In addition to creating 14 electronic devices (including a linear accelerator), the projects have introduced our students to research and collaborative learning. Our very small pilot study showed that stronger students used it to better prepare for their lab session. We hope to share our experiences in inverting the lab for experimental projects and what we intend to do next.

14. Quantum Fears: Are students afraid of time-dependence?

Niels Walet
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(work with J. R. Chapman and S. O. Hunt)
It has been noted from anecdotal evidence that in quantum mechanics exams students typically avoid questions involving time-dependence. A diagnostic questionnaire has been created and administered to students starting a third year quantum mechanics course to investigate their level of understanding of quantum mechanics. It looks to identify student misconceptions and the threshold concepts that might prevent competence, especially in dealing with time-dependent problems. The questionnaire consist of two parts, a self-evaluation section followed by a conceptual survey. Analysis of the results of this questionnaire indeed reveals areas of weakness in student understanding of time-dependence and other fundamental quantum mechanical concepts. We discuss the revision of the questionnaire after the analysis with the aim of improving the determination of student difficulties as well as the reliability of the questionnaire itself.

15. And Now for Something Completely Different

Morag Casey
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What if you could design your degree programme from the ground up? What would you teach and how would teach it? What would you need? What if you couldn't get access to all the resources you wanted? In which areas would you be prepared to compromise? What if you wanted to do this not in the UK but in Sub-Saharan Africa?

In 2009, a partnership agreement was signed between the Universities of Glasgow, UK, and Dodoma, Tanzania. Founded in 2007, the University of Dodoma is an ambitious young institution and the agreement was intended as a capacity-building exercise, utilising Glasgow's internationalisation strategy and long-standing commitment to philanthropic activity.

In 2011, we started to investigate the structure of the University of Dodoma Physics degree programme. Nearly all the things we take for granted in the UK were in short supply: textbooks, lab equipment, buildings. However, it transpired that we also faced a lot of common problems: a lack of sufficient staff and money, non-attending students, red-tape. So we set about overhauling the Dodoma physics degree curricula as well as stocking the libraries and teaching laboratories with second-hand donations from Glasgow.

Two years down the line, the University of Dodoma has a functioning physics degree programme with the first graduates expected soon. As a cultural and academic exchange, individual staff members from the University of Glasgow have benefitted immensely. But with staff time in short supply and a squeeze on local teaching and learning activities, donations of textbooks and teaching laboratory equipment continue to be one of the more straightforward means of collaboration. In the future, we aim to attract Tanzanian PhD students to Glasgow to with a view to fostering scientific research collaborations between our two institutions, further building capacity in both countries.

16. Students as co-creators: the development of student learning networks in PeerWise

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Connections between students using PeerWise were explored using the tools of social network analysis (SNA), motivated in part by Brewe's use of SNA to investigate face-to-face learning communities (Brewe, Kramer, & Sawtelle, 2012). Preliminary results show that a relatively dense and equitable network was formed among the cohort. It might be hypothesised that this provides greater opportunities for the transfer of social capital, opening up the possibility of an extended network of peer support providing opportunities for students to deepen their own understanding and evaluative skills.

Brewe, E., Kramer, L., & Sawtelle, V. (2012). Investigating student communities with network analysis of interactions in a physics learning center. *Physical Review Special Topics - Physics Education Research*, *8*(1), 010101. doi:10.1103/PhysRevSTPER.8.010101

17. **Total Recall: Adventures with Synoptic Activities**

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A potential side effect of modular structures in degree programmes is a tendency for students to compartmentalise knowledge into chunks based on summative assessment windows. Problems with the retention of knowledge between years can lead to reduced student performance and lack of confidence at the start of academic year. Students are also concerned by year-long modules and the highly weighted end-of-year final exams. To address these issues we have introduced a variety of new synoptic tasks. These activities will be discussed, including recent developments in the use of the online PeerWise system.

18. **Chemistry: Making a Difference**

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Chemistry: Making a Difference, a joint project between the Universities of Leeds, Hull and Warwick, is an undergraduate module in Chemistry due for launch in 2013 which aims to introduce to students the idea of how Chemistry can be used to make a difference, either socially or environmentally, and to build commercial awareness skills, which tend to be underdeveloped in Chemistry graduates.

Students, working in groups, will be asked to develop their own ideas of Chemistry making a difference, prepare a business plan around this idea and be ready to present this plan to an "investment panel" at the end of the module.

Interactive workshops will be used to introduce the tools the students will need in order to complete their business plan, with the added benefit of building their team working, communication, presentation and information retrieval skills, as well as increasing their commercial awareness, all vital skills when embarking on their future careers.

Student participation during the module preparation is important, and we will be using focus groups to determine levels of background knowledge so that the module and relevant materials can be pitched at an appropriate level, along with a trial run of the module with groups of students prior to launch, in order to ensure it will give the best possible experience to future students taking the module.

19. Science Communication for the 21st Century

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In many cases, core science communication skills are taught in broadly the same ways by a number of different departments. This talk will present a project which will develop, implement and evaluate an innovative online-led interdisciplinary science communication course which integrates aspects of good practice from existing courses, minimising the contact time requirements of individual departments to teach many of these core skills (thus removing the duplication of teaching between departments). The course will focus on the development of core communication and digital literacy skills as well as specific applications that are of use to all science graduates (e.g. writing journal articles, oral communication of science, peer-reviewing work, proof reading reports and work-related applications of social media).

The new course will integrate online supports such as video clips and quizzes as well as a series of new learning activities. Students will remotely collaborate on a series of contextualised case studies using a group wiki. The online component of the module will be supported by a small number of contact sessions which can be used for group problem solving or oral presentation sessions. The developed course and the component resources will be made freely available to the HE community along with a comprehensive tutor guide. The course will be designed in a way which will allow it to be easily integrated into existing programmes of study.

This talk will present the preliminary findings of the project and will discuss the work that will be carried out in the next phase.

20. Assessing Practical Skills of Undergraduates: A First Year Practical Exam

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The QAA chemistry benchmark statement states a key aim of a chemistry bachelor's degree is '*to develop in students a range of practical skills so that they can understand the risks and work safely in a laboratory*'. Laboratory teaching provides the opportunity for students to obtain practical and analytical skills training, which may compliment the theory learnt in lectures and problem classes,[1] and assists in preparing students for what follows their undergraduate degree, in terms of both subject-specific and more generic skills.

In a modular system we have found that first year undergraduates struggle to retain the necessary practical chemistry skills between modules leading to students demonstrating inadequate practical skills in the second year of their degree and ultimately when undertaking their final year project. In addition it may be argued that students have no incentive to ensure that they are competent in these important techniques when practical skills are rarely explicitly assessed.

To this end, we have developed a module specifically designed to develop practical chemistry skills which are assessed via a two hour practical exam.[2] In this exam students are required to complete five stations where they may be assessed on their ability to perform any technique included in the practical module. This presentation will discuss the development and implementation of this practical exam and some initial evaluation of the impact of the exam on the practical skills of first year undergraduates.

1. Hofstein, A. and Lunetta, V. N. (2004). *The laboratory in science education: foundations for the 21st century*, Sci. Educ. 88, 28-54.

2. Neeland, E. G. (2002). *A one-hour practical lab exam for organic chemistry*, J. Chem. Educ. 84, 1473-1455.

21. Students' use of resources and implications for open-book exams

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Open book exams remain a rare breed in the STEM disciplines, despite affording a more authentic form of practice than that of the more widespread closed book exam. (After all, if you were trying to solve a problem would you purposefully close yourself off from books, the internet, or any other source of information? It's just not how we behave.) Open book exams necessarily move the emphasis away from factual recall and regurgitation of standard results, and towards applications and genuine problem solving. One common claim about open book exams is: surely everyone will pass if they can just look up the answers? From a controlled experimental setting, we find that even open access to the entire internet does not allow students to successfully answer genuine problems if they do not have the necessary subject competence. Successful students must have a sophisticated, well-organised network of knowledge and related techniques, and need to be able to identify problem strategies to succeed. If they don't know what they're doing, they don't know what to look up, and can't solve the problem. We find that even with open book exams there is no substitute for proper learning, in the true sense of the word.

22. Objective Structured Chemistry Examinations (SChemEs): Developing Methods of Assessment

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The increase in tuition fees and renewed pressure on universities to provide courses which provide extensive training in both subject-specific and generic skills is a factor which impacts on curriculum and assessment design. For graduates of Chemistry this includes embedding the generic, practical and laboratory-based skills associated with industrial research as an integral part of their training. In this presentation we introduce SChemEs (Structured Chemistry Examinations), a novel method of authentic assessment which focuses on developing and rewarding competency in the laboratory.

The discrepancy between competency and academic achievement is well-documented, particularly in clinical disciplines such as medicine, nursing and pharmacy. The reason for such a discrepancy is succinctly summarised in Miller's Pyramid of Competence[1] (Figure 1) which shows four interconnected levels. In terms of graduate scientific laboratory skills, these are predominantly exhibited at the lower levels ("Knows" and "Knows How") but lacking at the "Shows How" and "Does" levels.

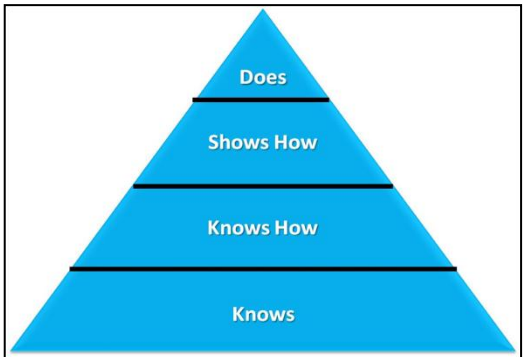

Figure 1: An adaptation of Miller's Pyramid of Competence

Clinical disciplines assess and develop competencies in addition to knowledge using Objective Structured Clinical Examinations (OSCEs). Each station details a different scenario designed to test a range of clinical competencies which take between five and fifteen minutes to complete.

This research outlines the methodological development of SChemEs, which was inspired by the Objective Structured Clinical Examinations (OSCEs) used in clinical programmes. This approach enables a broad and versatile range of skills to be assessed together thus developing a multi-skill set competency range. A large number of students can be assessed in a relatively short time and there is an opportunity to provide timely feedback on the OSCE performance.
An overview of how a SChemEs assessment runs will be provided and initial evaluations will be included from a pilot study with Year 1 students in both a Pharmacy and Bioscience degree programmes.

[1] Miller, G.E. The assessment of clinical skills /competence/performance . *Acad. Med* 1990;65: S63-67

23. The 'Apprentice' approach to group work assessment

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As part of a curriculum design programme to introduce key transferable skills throughout our undergraduate chemistry course we have integrated an enquiry-based learning exercise with career development activities. The new module is built around a tried and tested problem based learning exercise rooted in industrial chemistry. Students work in 'management' teams where they adopt specific professional roles. In these roles they undertake responsibility for some aspect of the company. Initially students investigate the chemistry, economic, environmental and social factors behind the industrial processes involved. They then produce a pitch for the future of the company and their jobs at the existing UK production site. The pitch is delivered in the form of a video which is assessed and the successful teams compete in an 'Apprentice' style board room play-off.

The presentation will give evidence to show that assessment of group work using video production is an effective way of promoting the development of a range of transferable skills. By integrating the group work with a chemical problem, and requiring students to consider the different roles which constitute an effective management team, students develop an appreciation for project management and delivery. The exercise is also used to provide practice in writing cv's and covering letters in preparation for applications for industrial placements.

24. Student based assessment for Instant Feedback

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We have implemented both self and peer assessment mechanisms for UG practical work in the synthetic chemistry laboratory, enabling students to better able to reflect on their performance. This allows students to design routes for improvement without reliance on laboratory demonstrators, while developing key graduate skills of giving and receiving criticism.

In our second year laboratory students are given a mark scheme and invited to assess their products according to the provided criteria; they are then afforded the opportunity to discuss this with a marker whereupon their sample purity is assessed directly.

This progresses to the third year laboratory where in small groups with a facilitator, the students develop, apply and revise a mark scheme, assessing and critiquing their samples as well as those of their colleagues.

This approach has been popular with students, GTAs and staff, and has resulted in greatly improved student satisfaction within our lab course.

Oral bites

1. Discussion boards for supporting chemistry teaching
Michael Seery, Dublin Institute of Technology

2. iAnnotate
Simon Lancaster, University of East Anglia

3. Lies, damned lies and usage statistics
Charles Harrison, University of Southampton

4. Authentic Assessment: An Information Retrieval Exercise for 1st Year Students
David McGarvey, Keele University

5. Turn to your virtual neighbour: Peer instruction in an online setting
Judy Hardy and Ross Galloway, University of Edinburgh

6. Undergraduate-led design of 'impactful' outreach
Paul Duckmanton, University of Southampton

7. Scared to ditch the cookbook? Just do it slowly
James Gaynor, University of Liverpool

8. Overcoming misconceptions: testing the conceptual understanding of mechanics with mature learners
Sam Nolan, Durham University

9. Do Chemists Have Chemophobia?
Katherine Haxton, Keele University

10. Science Summer Internships Support Scheme (SSISS)
Samantha Pugh, University of Leeds

11. Recession proof outreach
Kristy Turner, University of Manchester

12. New *New* Directions Journal
Derek Raine, University of Leicester

1. **Discussion boards for supporting chemistry teaching**

Dr Michael Seery
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This is an oral bite providing an overview of my experiences and literature tips for maintaining a healthy and active discussion board to support a module or particular topic. The presentation will cover: (1) Why use discussion boards? (2) Encouraging students to use discussion boards and (3) some effective moderation tips.

2. **iAnnotate**

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Just occasionally an application introduces the ideal set of functionality to facilitate a step-change in way we perform a routine task. Many apps allow you to annotate digital documents by typing or handwriting. Do you want to automate stamps to indicate common errors? Would you like to provide audio comments pinned to specific points in a PDF document? iAnnotate is the killer application that justifies academics owning an iPad!

3. **Lies, damned lies and usage statistics**

Charles Harrison
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Huge amounts of data are produced from the tracking of every online movement generating millions for companies such as Google and Amazon. At a more attainable level many software packages offer to track user interactions with online resources. Using these statistics is however a minefield for the non-specialist.

In this oral byte I will discuss the various types of statistics which can be outputted and their uses with a particular focus on those useful for furthering education research. The examples presented were obtained from a blackboard course with extensive video resources.

A short podcast on the subject is available here:
http://youtu.be/yHxCzjiYBoU
A summary of literature found whilst researching the subject can be found here:
http://www.edshare.soton.ac.uk/11135/
The software used to sort the data can be found for free here: http://www.edshare.soton.ac.uk/11134/

4. Authentic Assessment: An Information Retrieval Exercise for 1st Year Students

David McGarvey
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Information literacy is a key graduate attribute [1] that encapsulates the ability to locate, evaluate and synthesise information, ideas and data. The development of students' information literacy is embedded in the teaching and learning (including assessment) activities at every level within the Keele Chemistry Curriculum and includes accessing, retrieving and using information from research papers, public and commercial sources, textbooks and major databases. Experienced chemists in academia and industry routinely access the Sigma-Aldrich online catalogue [2] for a variety of purposes and apply their skills and experience to exploit its advanced search features. In view of the wide-ranging utility and relevance of this resource to practising chemists, I developed an assessed information retrieval exercise for 1st year chemistry students based on the advanced search features of the Sigma-Aldrich online catalogue, with the aim that students would learn how to use these features in the process of completing the assessment and also that they would have acquired new knowledge and skills of use to them not only in their studies but potentially in their future careers. The assessment is personalised in that each student is allocated a different molecule to research. The tasks to be completed include use of the structure search facility, finding the CAS number and IUPAC name, product details (cost, purity etc.), physical properties, health and safety information and research into applications. The activity is highly flexible, adaptable and transferable and the highly positive student feedback to be presented testifies to its personalised nature, authenticity and the acquisition of new skills.

[1] http://www.keele.ac.uk/distinctive/keelegraduateattributes/ (June 2013)
[2] http://www.sigmaaldrich.com/catalog/AdvancedSearchPage.do (June 2013)

5. Turn to your virtual neighbour: Peer instruction in an online setting

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The well-known Peer Instruction method developed by Eric Mazur (1996) aims to improve students' understanding by actively involving students during lectures using conceptual questions. Peer instruction is used most commonly in large undergraduate lectures, where there would otherwise be few opportunities for active engagement. Using this approach, students are asked to formulate an answer to a multiple-choice question on a particular topic or concept. Students then 'turn to their neighbour' and discuss their responses in small groups before finally re-voting individually on the same question.

We recently used Peer Instruction in a short online lecture series aimed at teaching physics concepts to a general audience. In this oral bite we will describe how we implemented Peer Instruction in a synchronous online setting and will discuss the pros and cons of this approach.

Mazur, E. (1996). *Peer Instruction: A User's Manual* (1st ed., p. 253). Prentice Hall Series in Educational Innovation.

6. **Undergraduate-led design of 'impactful' outreach**

Paul Duckmanton
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Undergraduate students have long been involved in the delivery of university outreach activities, acting as ambassadors for subjects. Activity design however is most often led by staff, and many activities are common between a number of universities. This short presentation will discuss the value of involving undergraduate students in the design of outreach activities to highlight institutional research, and the possibilities of incorporating ways to evaluate impact into the event.

7. **Scared to ditch the cookbook? Just do it slowly**

James Gaynor
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Whilst there is plenty of evidence to suggest more enquiry based methods is hugely beneficial to student development, knowing when best to implement these techniques can depend on the scenario. This is certainly the case in the laboratory and successfully changing a well-established, but traditionally run, lab module that already has its own place within a wider programme framework can be challenging.

In this bite, I will briefly present a "Questions to Consider" approach that I introduced as a way of getting students to think more deeply about what they are doing in the laboratory whilst being able to maintain a more traditional approach. I'll introduce the approach and show some very basic evaluation results from student feedback.

8. **Overcoming misconceptions: testing the conceptual understanding of mechanics with mature learners**

Sam Nolan
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As Higher Education changes, emphasis is brought to the important areas of widening participation and increasing social mobility. As discussed in the recent Milburn Report, Foundation Centres are an excellent mechanism to allow mature learners entry to Higher Education.

Examining how we support mature learners back into education and help them make often difficult paradigm shifts in their understanding of the world is therefore critically importance. This oral bite introduces work done at Durham University's Foundation Centre looking at the conceptual understanding of the often tricky subject of mechanics amongst adult learners.

This work makes the distinction that conceptual understanding of physics is distinct from mathematical ability. Using the Force Concept Inventory (FCI) - a diagnostic test of conceptual mechanics understanding, which has been used as a corner stone of changes in the American Education system, we will briefly present the results of a preliminary FCI study with mature students and compare their measured gain in understanding with published results. Our results are illuminating and show that the gain in conceptual understanding amongst the mature students studied exceeds the gain shown in published work with traditional students, thus highlighting the important role life experience and motivation play in student success

9. Do Chemists Have Chemophobia?

Katherine Haxton
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As a society, we are bombarded with the message chemicals = bad, organic/chemical free = good. The forces of marketing lead the general public, including chemists, down a route where chemicals are perceived as artificial, potentially toxic and something to be avoided, usually at some expense. There are many initiatives designed to surmount this public relations issue, focussing on the good that chemistry does in the world, and why we get 'better living through chemistry'.

My research question is whether undergraduate chemistry students are just as susceptible to these messages, and how these messages colour their perception of laboratory safety and chemistry in general. There seems to be a disconnection between how students act in the laboratory and what may seem to be common beliefs about the dangers of chemicals. As part of a wider project on laboratory safety, I am developing an attitude questionnaire to gauge the perception of chemicals and related issues amongst chemistry students. In this oral byte, I will explain what the goals of the project are, and introduce the questionnaire. I would welcome volunteers from the audience willing to deploy the electronic questionnaire to undergraduate students, both incoming first years and later years.

10. Science Summer Internships Support Scheme (SSISS)

Samantha Pugh
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The Faculties of Mathematics and Physical Sciences and, Biological Sciences at the University of Leeds are planning to develop and pilot a science-wide support programme for students who wish to spend their summer on an industrial placement. The programme would not be credit bearing but would be a value-added activity to support students who wish to enhance their future employment prospects through a summer internship. There is a lot of sense in bringing together the science subjects for such a scheme, since there are many overlaps with respect to graduate destinations.

There are numerous benefits to setting up the SSISS:

1. More students would be encouraged to undertake a summer placement;
2. More students than those who eventually find a placement will benefit from involvement in the process.

3. Structured support would be available to students to help them to find summer internships and compete in the application process;
4. Students will be supported to plan for and reflect upon their internship, so that they make the most of the opportunity and can better articulate what they have achieved to prospective employers;
5. The Schools (and Institution) would have detailed information on how many students applied for placements, how many were successful and who the placement providers are;
6. Schools will be able to track the impact of undertaking a placement on the employability of their students (currently only possible for those taking a year in industry);
7. The Schools will be able to gather information on the suitability and quality of placement providers, and
8. The model could be rolled out to other schools/faculties/institutions once the SSISS is established.

11. Recession proof outreach

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Outreach that is low cost, high impact and ticks off many boxes in the school action plan sounds too good to be true…. A small scale outreach pilot project in the School of Chemistry at the University of Manchester puts academics back into the classroom to teach lessons from the A-level syllabus. Working alongside an experienced A-level teacher to plan and deliver the lesson, academics gain insight into the day to day teaching and learning diet of 6th formers and improve their understanding of the issues surrounding transition to undergraduate study.

12. New *New* Directions Journal

Derek Raine
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New Directions was previously the journal of the Physical Sciences Subject Centre. It has been re-launched an HEA on-line journal. This short talk will highlight some of the changes to the journal.

Workshops

1. Chemical Concepts Inventory: Fast-Tracking Tools for Evaluating the Impact of Pedagogical Innovations
   Simon J. Lancaster, David Read and Paul C. Taylor, University of East Anglia, University of Southampton and University of Warwick

2. Teaching concepts through modelling: designing teaching and assessment activities
   David Sands, University of Hull

3. Hands-on programming with the Arduino: open-source hardware in an introductory programming laboratory
   Paul Cruickshank, University of St Andrews

4. New Quantum Curriculum Project
   Derek Raine and Antje Kohnle, University of Leicester and University of St Andrews

5. When is a Problem not a Problem? Analysing the Victorian Pharmacy
   Jane Essex and Katherine Haxton, Keele University

6. Leadership and Management for Scientists and Engineers
   Mike Cole, Manchester Metropolitan University

1. **Chemical Concepts Inventory: Fast-Tracking Tools for Evaluating the Impact of Pedagogical Innovations**
Simon J. Lancaster [1], David Read [2] and Paul C. Taylor [3]
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[3] The Reinvention Centre, Chemistry Department, University of Warwick, Coventry, CV4 7AL
P.C.Taylor@warwick.ac.uk

Regular participants in ViCE events will know that there is no shortage of well-intentioned and highly inventive experimental teaching taking place in Chemistry Higher Education. One of the challenges exponents face when trying to convince colleagues, less receptive than fellow attendees, to follow-suit is the call to present evidence of efficacy. The combination of the ViCE and PHEC conferences and the STEMPedR initiative have illustrated that Physics is somewhat more advanced in the application of instruments such as the 'Force Concepts Inventory'.

The workshop will introduce and provide hands-on experience of the Mulford and Robinson "Chemical Concepts Inventory" (CCI). To facilitate uptake, the inventory has been prepared in a number of digital formats and these can already be downloaded at www.chemistryvignettes.net. We believe this inventory is an interesting benchmark for new undergraduates; it addresses concepts that we would like to take for granted in undergraduates and do not teach explicitly on the degree programme. However, preliminary results suggest that nothing should be assumed. We have found comparison of test results at the beginning and end of the academic year intriguing.

The workshop has two objectives. By presenting the CCI at ViCE we wish to prepare and execute a common strategy for synchronized deployment of this instrument at as many chemistry HE departments as possible. The ambition would clearly be to publish these collaborative results. We also wish to explore the potential for building a community to develop new instruments tuned to the requirements of assessing our pedagogical innovations.

2. **Teaching concepts through modelling: designing teaching and assessment activities**
David Sands
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It's well known that students need to be intellectually active in order to learn meaningfully and develop a conceptual understanding. The approach at Hull has been to adopt modelling as a method of instruction and assessment within the first year. Introduced initially into the mechanics course two years ago, modelling will be extended this year to electrostatics and adopted more generally as a consistent approach to solving problems throughout the first year in an attempt to promote a deeper level of learning.

Modelling instruction is based on the ACME protocol developed by the author under the National HE STEM programme. Standing for, "**A**ssess the problem, **C**onstruct the **M**odel, and **E**valuate the solution", ACME is based on the use of multiple representations, such as graphs, diagrams, equations, and verbal descriptions.

It is essential, therefore, that as part of the modelling instruction students are shown how the use of representations is itself a vital aspect of thinking about a problem. In modelling a problem they are expected to use whatever representations are appropriate rather than attempt to find the "correct" solution. There are two reasons for this: first, focusing on a particular solution makes the modelling itself algorithmic, whereas in reality the model should reflect the individual's thinking about the problem. Therefore, there is no incorrect solution, simply an incomplete use of the available representations. Secondly, if students understand the concepts, correct reasoning about the problem should follow. Conceptual understanding is indicated by consistency among the representations making up the model.

The protocol was designed primarily to assess the use of representations, both formatively and summatively, but necessarily it also provides the basis of modelling activities within a lecture setting. This workshop will demonstrate how the protocol is used in practice, using typical problems from mechanics, electrostatics as well as chemical equilibrium.

3. Hands-on programming with the Arduino: open-source hardware in an introductory programming laboratory

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The Arduino (www.arduino.cc) is a low-cost open-source microcontroller platform and programming environment Primarily employed by hobbyists, it can also be used in awide range of teaching environments. The platform features analogue and digital inputs and digital outputs and may be easily interfaced with sensors and peripherals such as accelerometers, LEDs, actuators, etc. Programs are written using a subset of C/C++ and platform-specific functions make it simple to address the inputs and outputs. Once a program is compiled and uploaded to the platform, it runs independently of the host computer.

The ease with which the Arduino can interface with and control external peripherals allows for a more interactive approach to teaching fundamental programming concepts than that afforded by traditional "command-line" based activities. We have developed and trialled an introductory programming lab (total length of 7.5 hours) for Scottish 2nd year physics students, most of whom had little or no previous programming experience. Evaluation capturing various aspects of the student experience found the lab to enhance student motivation and interest and the exercise met our objectives of introducing students to fundamental programming concepts such as loops and decision making.

In this workshop, participants will be given an overview of the Arduino platform and its capabilities and limitations and will have the opportunity to experiment with the platform and the programming environment with a number of sensors and peripherals. Participants will have the opportunity to work though some exercises taken from our laboratory course and we will present evidence for student engagement and learning using the Arduino. The necessary hardware will be provided but participants will be required to bring their own laptops. Software will be available to install at the beginning of the workshop, but participants may wish to install this prior to attendance. (Windows, Mac OS X, and Linux, see www.arduino.cc).

Advanced installation: Participants intending to attend the Arduino workshop should obtain the Arduino development environment (version 1.0.5), which is free and open-source, in advance from http://arduino.cc/en/Main/Software which offers the software for download, as well as installation instructions for MacOSX, Widows and Linux. Once you have installed the software, participants should run it to ensure that they have an appropriate version of Java installed, which can be downloaded from Oracle if necessary. (Windows and MacOSX will ask you if you want to do this and deal with it themselves. If you are installing Java from Windows, be aware that by default it will try to install a browser toolbar, an option you may wish to decline.) Windows users will need to install a driver during the workshop itself once the hardware is connected.The software will also be available on USB stick for any participant that is not able to obtain it in advance.

4. New Quantum Curriculum Project

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The Institute of Physics New Quantum Curriculum (quantumphysics.iop.org) consists of freely available online texts and interactive simulations with accompanying activities for an introductory course in quantum mechanics starting from two-level systems. This approach immediately immerses students in inherently quantum mechanical aspects by focusing on experiments that have no classical explanation. It allows from the start a discussion of interpretative aspects of quantum mechanics and quantum information theory.

The IOP website provides a range of support materials which can be used in a variety of ways from supplements to existing courses to a complete programme. The core text is presented as around 100 articles co-authored by leading experts that can be selected from to provide a range of approaches. Many of the articles include interactive simulations with accompanying activities and problem sets that can be explored by students to enhance their understanding. The linear algebra needed for this approach is part of the resource. Solutions to activities are available to instructors.

In this workshop, participants will be given an overview of the new curriculum and have the opportunity to trial some of the materials. We will describe methods used to optimize the simulations and activities in terms of clarity, ease-of-use, promoting exploration, sense-making and linking of multiple representations. We will give exemplars of use, and evidence for student engagement and learning using these new materials. The workshop will explore the ways in which lecturers and students can use the materials in their courses.

5. When is a Problem not a Problem? Analysing the Victorian Pharmacy

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Since 2011 we have been involved with local museums who are interested in the contents of their Victorian Pharmacy exhibits. The motivation for this analysis comes from concerns about the health and safety issues surrounding upkeep of such exhibits, and from an educational point of view in identifying the components of proprietary mixtures such as 'Mr Doo's Mixture'. Each jar represents a unique chemical puzzle, where the name on the label kickstarts a process of literature research, wet chemical testing and modern spectroscopic analysis. Where possible, participants in workshops are encouraged to use analysis techniques contemporary to the pharmacy, resorting to infrared and NMR spectroscopy, and chromatography and mass spectrometry as a last resort.
In this workshop, we will introduce participants to the challenge of identifying unknown compounds and mixtures use in the Victorian Pharmacy in a complex, real-life analysis session. We will present a strong rationale for the value of such authentic scenarios, and the benefits of involving school children in such an exercise, as well as a way of incorporating this exercise into first year undergraduate chemistry laboratories to develop team working, higher order thinking and dealing with ill defined outcomes.

Reference: Essex, J. Education in Chemistry, May 2013, pg 26-29

6. Leadership and Management for Scientists and Engineers

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With graduate employability skills being a key performance indicator that HEIs have to now explicitly address, there is a heavy emphasis (wherever possible) to accentuate these throughout a course of study. The roles of Leadership and Management are key elements in graduate-level jobs, and employers are keen to see evidence at interview of the awareness of such issues and the characteristics associated with these important roles.

This workshop (for ViCE) will showcase how a specific workshop session (used with a wide audience of full-time undergraduates) was developed by adapting course materials (taken from a bespoke FdSc Chemical Science course for part-time students who are all employed within the Chemical Industry sector). The context of this developed Leadership and Management workshop is centred around Safety (in the workplace), where a number of case studies (including laboratory explosions and averting disasters) are presented – which is obviously a vital area for the entire Process Manufacturing sector (which more often than not involves both Chemistry and Engineering disciplines).

The workshop will involve a number of self-evaluation exercises, i.e. audience participation, in determining the leadership and/or management qualities demonstrated by an individual. This L&M workshop caters primarily for an audience with a Scientific/Engineering background, but it can easily be modified to be applicable to other commercial sectors.