

# UNIVERSITY OF Southampton

25-26<sup>th</sup> August  
2016

## Variety in Chemistry Education Physics Higher Education Conference



### Thursday 25<sup>th</sup> August

10:00-10:50	Arrival, registration and coffee	
10:50-11:00	Welcome and introduction	
11:00-11:55	<b>Keynote Plenary - Chair: Paul Duckmanton (58/1067)</b> The ChemTube3D Story: The power of Open Educational Resources [p5] <i>Nick Greeves, University of Liverpool</i>	
12:00-13:00	<b>Oral Bytes - Chair: Paul Duckmanton (58/1067)</b> Postgraduate students as partners to facilitate effective undergraduate learning in chemistry [p25] <i>Glenn Hurst, Rob Smith</i>  Coming full circle: Chinese joint degree graduates as Laboratory Teaching Assistants on their former BSc degree programme [p25] <i>Julie Hyde</i>  A new school teacher fellow model [p26] <i>Kristy Turner</i>  Using online quizzes for low-stakes assessment motivates Biochemists to practice calculations [p26] <i>Hazel Corradi</i>  New Directions Update [p26] <i>Derek Raine</i>  YikYak: A social network too far? [p27] <i>Simon Lancaster</i>	
12:30-13:30	<b>LUNCH (Garden Court)</b>	
13:30-15:00	<b>Choice of parallel workshops</b>	
	Team Based Learning – take an academic, a class of students and scratch cards [p7] <i>Laura Hancock, Chloe Howe, Graeme Jones, Tess Phillips, Daniela Plana</i> <b>(58/1067)</b>	Overcoming a fear of words – collecting and analysing qualitative data [p7] <i>Rachel Koramoah</i>  <b>(58/1007)</b>
		New C/PBL Material – A Sticky Situation [p8] <i>Kevin Parker</i>  <b>(58/1009)</b>

15:00-15:30 Coffee

15:30-17:00 **Choice of parallel sessions**

<b>Focus on the student journey</b> <b>Chair: Andrew McKinley (58/1007)</b>	<b>Focus on interactive approaches</b> <b>Chair: Felix Janeway (58/1009)</b>
Teaching as a journey: Signposting tacit and explicit tertiary chemistry pedagogical content knowledge and practice [p11] <i>Gwen Lawrie</i>	How Interactive are Lectures? - A case study from a flipped introductory Physics class [p14] <i>Anna K Wood, Ross K Galloway, Robyn Donnelly, Judy Hardy</i>
Changing Places – a longitudinal study into the perceived differences between secondary and tertiary education of first year chemistry undergraduates [p10] <i>Elizabeth Page</i>	Students' appraisals of multi-cultural group activities [p14] <i>Gita Sedghi, Elisabeth Rushworth</i>
How does A-level maths affect first year student performance? [p10] <i>David Jewell, Fiona Dickinson</i>	Bringing the Research Group Ethos into Taught Master's Learning [p15] <i>Richard James Lewis</i>
Students' perceptions of the purpose of laboratory work for a Chemistry undergraduate course and scientific thinking approaches [p12] <i>Ruiqi Yu, Kon Hao Kwek, Kathleen M Quinlan, Fabrice Birembaut, Malcolm Stewart</i>	Bringing Research-led Teaching to a Wide Audience through Digital Learning Methods [p16] <i>Paul C Taylor</i>
Laboratories, projects and the development of scientific thinking [p12] <i>David Westwood</i>	NearPeer: Harnessing the power of the populous to enhance the learning environment [p17] <i>Barry Ryan</i>
Student engagement and the paradox of 'developing' employability in HE Physics [p13] <i>Sinead Marian D'Silva, Samantha Pugh, Jim Ryder</i>	Chemistry for the 21st. Century [p17] <i>Ketan Trivedi</i>

17:15 RSC ETG AGM for members of the ETG  
17:30 RSC TEG AGM for members of TEG

19:00 Wine reception  
19:30 Dinner

**Friday 26<sup>th</sup> August**

- 08:00-08:45 Breakfast
- 09:00-09:55 **Keynote plenary - Chair: Katherine Inskip (58/1067)**  
Opening the lab [p5]  
*Ian Bearden, Neils Bohr Institute*
- 10:00-10:55 **CERG lecture - Chair: Katherine Inskip (58/1067)**  
Progress through collaboration: Taking education research from HE into the classroom (and back again) [p6]  
*David Read, Stephen M. Barnes, University of Southampton*
- 11:00-13:30 **Poster session [Titles pp30-31] (Garden Court)**  
Coffee will be served 11:00-11:30  
Lunch will be served 12:30-13:30

**13:30-15:00 Choice of parallel sessions**

<b>Focus on labs and collaborative working Chair: Jenny Burnham (58/1007)</b>	<b>Focus on concepts and confidence Chair: Matthew Mears (58/1009)</b>
Enhancing the value of science education activities in primary schools through interdisciplinary and intercollege collaboration [p18] <i>Vanessa Murphy, Claire McDonnell</i>	How A-level students justify organic mechanisms [p22] <i>Robert Campbell</i>
The EPQ – A vehicle for school to university collaboration [p19] <i>John Carrol</i>	ChemInteractive: Design and Development of an Online Education Resource [p22] <i>Mike Casey</i>
Collaborative teaching for collaborative learning [p19] <i>Fiona Dickinson, Andrew McKinley</i>	What can free-text questions tell us about conceptual understanding in physics? [p23] <i>Sally Jordan, Ross K Galloway, David Sands, Christine Leach, Lorenzo Principe</i>
The prevalence of pre- and post-laboratory scaffolding activities in HE STEM courses [p20] <i>Karen Moss, Jennifer Evans, Sarah Rayment</i>	Is there a correlation between correctness and confidence in conceptual questions? [p23] <i>Simon Lancaster, Dennis Cook</i>
Trialling the use of Tablet PCs in Undergraduate Physical Science Laboratories [p20] <i>Cate Cropper (in collaboration with Helen Vaughan, Ross Clements and Manesh Mistry)</i>	An educated guess: score prediction for tailored student support [p24] <i>Felix Janeway</i>
A Dynamic Laboratory Manual – Construction, Consolidation & Consequences Eleven Years On [p21] <i>Jenny Slaughter, Dudley Shallcross</i>	Effects of Workshop Group Gender Balance on Student Exam Performance: update on replication study [p24] <i>Ross K Galloway, James Salmon, Ross W Hunter</i>

- 15:10-15:40      **Oral Bytes - Chair: Fiona Dickinson (58/1067)**  
R-D-L Me This [p27]  
*Matthew Mears*
- Visualizing Russell-Saunders terms: an activity with quantum numbers [p27]  
*Paolo Coppo*
- New C/PBL Material – The Analytical Chemistry of Platinum Recycling [p28]  
*Kevin Parker*
- GRASping opportunities for our students [p28]  
*Glenn Hurst, Avtar Matharu*
- The use of coversheets to promote dialogue in feedback assessment [p29]  
*Alice Collier*
- Synthesis 'by proxy' – a reasonable adjustment? [p29]  
*Laura Patel*
- 15:40-16:00      **Closing discussion (58/1067)**
- 16:00              Coffee (to take away) and depart

## Abstracts

### Invited Lectures

#### **The ChemTube3D Story: the power of Open Educational Resources**

*Nick Greeves, University of Liverpool, Thu, 11:00-11:55, 58/1067*

ChemTube3D <http://www.ChemTube3D.com> is a unique collection of over 1200 web-pages containing interactive 3D molecular animations for use in lectures and private study. This talk will focus on the development of the resource, principally by undergraduate students, supporting such a project financially, the use of Google Analytics to drive development, and a novel approach to linking traditional textbooks to online resources.

Nick Greeves is a Cambridge graduate, obtaining his PhD there in 1986 for work on the stereoselective Horner-Wittig reaction with Stuart Warren. He then held a Harkness Fellowship at the University of Wisconsin-Madison and at Stanford University, California, with Barry Trost and a Research Fellowship at Cambridge University before joining Liverpool in 1989 where he was promoted to Professor in 2015. He was selected for a HEA National Teaching Fellowship in 2009 and SFHEA in 2014. Nick is married with two children and lives in Formby. His interests include Macs, music (iPhone), photography (iPhone), and social media. He is saving up for the next version of Apple Watch.

#### **Opening the Lab**

*Ian Bearden, Niels Bohr Institute, Copenhagen, Fri, 09:00-09:55, 58/1067*

Introductory labs are often "closed" assignments leaving no room for students to do any actual science. Such labs lead to poor habits of mind. Not only do they lead many students to believe that the role of experiment is to confirm already known theory, they also make them think that the quality of an experiment is solely determined by how close the results are to tabulated quantities. I will argue that many of our "traditional" introductory labs can be transformed from closed, "cook book" experiments, to open experiments that can show students more accurately how science is actually done. Such an approach invites students to be much more active in choosing how to perform experiments and teaches them that the measure of quality of an experimental result is not how close one comes to previous results, it is rather the uncertainty on the result. Evaluation, both short term (course) and long term (year-to-year), of the results of courses using this approach will be discussed.

Ian received his Bachelor of Arts in Physics from Hendrix College in Conway, AR in 1987. His PhD research in gamma-ray spectroscopy was performed at Argonne National Lab and he received a PhD from Purdue University in 1993. Since then, he has been at the Niels Bohr Institute where he became "lektor" in 2003. Ian's research is in Ultrarelativistic Heavy Ion Physics; he is a member of the ALICE collaboration at the LHC. He was head of studies at NBI from 2008-2012 and is presently Professor with special responsibilities for the development of teaching and curricula. Ian is also

a member of the EPS Physics Education Division board, the IUPAP International Physics Education Committee, and Vice-chair of the Danish Physical Society. His teaching is primarily focused on laboratory exercises for first year physics students and pre- and in-service upper secondary physics teachers.

**CERG Lecture – Progress through collaboration: Taking education research from HE into the classroom (and back again)**

*David read and Stephen M. Barnes, University of Southampton*

*Fri, 10:00-10:55, 58/1067*

This presentation will outline work we have been doing to engage teachers in research projects that have been developed in Chemistry at the University of Southampton. We have drawn on the findings of education research to develop and evaluate our own teaching innovations, and we have now developed what is essentially small-scale 'action research' into something with a much broader impact. Our preliminary work investigations indicated that many teachers wanted to get more involved with education research, but there were numerous barriers that prevented them from doing so. To overcome these barriers, we have built on our strong links with schools and colleges across the region and are currently working with a number of teachers on a range of projects, including one which involves students self-assessing their own work to boost mechanistic organic chemistry skills. Over the course of 2014/15 and 2015/16, over 1500 sixth form students have engaged with our resources, providing a large body of data in the form of feedback and responses to evaluative questions. This has allowed us to probe students' perceptions of mechanistic organic chemistry and how they should best approach problem solving in this area, and the project has provided the opportunity to examine the relationship between students' confidence in their answers and their actual performance.

This project was implemented by a BSc project student in 14/15, who then went onto develop the work further in 15/16 as part of an MPhil project, facilitating interactions with teachers and providing the capacity to fully analyse the data collected. Such activity generates a symbiotic feedback loop where our interactions with teachers help them to improve their understanding and practice as well as our own in an on-going iterative process.

*References*

Page, E. M., Rowley, N. M. and Read, D., *New Dir. Teach. Phys. Sci.*, 7, 2011, 69.

Brown, R. C., Hinks, J. D. and Read, D., *New Dir. Teach. Phys. Sci.*, 8, 2012, 33.

Read, D., *Educ. Chem.*, 52 (6), 2015, 30.

Read, D., *PESTLHE*, 11, 2016, 6.

## Workshops

### **Team Based Learning – take an academic, a class of students and scratch cards!**

***Laura Hancock, Chloe Howe, Graeme Jones, Tess Phillips, Daniela Plana***

*Thu, 13:30-15:00, 58/1067*

This workshop provides a hands-on introduction to Team Based Learning (TBL), described by Sweet as ‘A special form of collaborative learning using a specific sequence of individual work, group work and immediate feedback to create a motivational framework in which students increasingly hold each other accountable for coming to class prepared and contributing to discussion.’ [<http://www.teambasedlearning.org>]

The best way to understand how TBL works is to experience it yourself so we will give you the opportunity to participate in a TBL workshop on NMR spectroscopy of organic molecules (FHEQ level 5). First we will introduce you to the structure of a TBL session and then we will divide you into teams based on ability – you will need to rank yourself on a 1-5 scale, novice to expert (all ability levels welcome).

TBL sessions begin with answering a multiple choice questions individually before solving the same problems with your team and receiving immediate feedback on your answers using scratch cards. Finally we will have you debating in your teams an application activity which will then be reported simultaneously and discussed as a whole class.

We will end with a discussion of the pros and cons we have encountered using TBL at Keele and at NXU Nanjing China, both in a full sense, replacing both lectures and problem classes (FHEQ 4 - Organic mechanisms) and in our version of "TBL Lite" to provide a framework for full cohort problem classes (FHEQ 3 - General and Organic Chemistry and FHEQ 5 Spectroscopy)."

TBL is an interesting teaching tool which may help develop the questioning and reasoning minds that we all strive for in our students and encourage them to become active learners who support each other. The physical sciences have been late to the TBL party – it’s time to knock back a glass and get down on the dancefloor.

### **Overcoming a fear of words – collecting and analysing qualitative data**

***Rachel Koramoah***

*Thu, 13:30-15:00, 58/1007*

As aspiring educational researchers emerging from scientific disciplines, we are often more comfortable with quantitative data than qualitative. Additionally, ‘science’ colleagues are usually more convinced by the numbers than the words. However, the combined benefits of qualitative and quantitative data have been recognized by many researchers as a method of enhancing the both the quality of data and depth of research produced (Johnson and Onwuegbuzie 2004).

In this participatory workshop, we will discuss what qualitative data can add to your research, and showcase one common method of data collection – the focus group - with hints and tips for running these yourself in as hassle free a way as possible. However, the work does not stop once the data has been collected. Coding is a term often used when dealing with qualitative data, but for many newcomers it can seem

mystical and daunting. Effective coding skills are essential for any research attempting to incorporate qualitative data into their research, and have been described as the key to generating high quality qualitative data (Saldaña 2012). This workshop will provide an introduction to coding, and give you an opportunity to practice and fine-tune your coding skills using live-generated data.

Qualitative information can provide a unique and detailed insight into a particular field by recording attitudes, behaviours and feelings, and can also be used to strengthen and explain the findings of quantitative data. The process does not need to be as time-consuming as interview recording and transcription suggests, and is a powerful combination of research tools that can, and should, be employed to enhance the quality of research produced.

*Johnson, R. B. and A. J. Onwuegbuzie (2004). "Mixed Methods Research: A Research Paradigm Whose Time Has Come." Educational Researcher 33(7): 14-26.*

*Saldaña, J. (2012). The coding manual for qualitative researchers, Sage.*

### **New C/PBL Material – A Sticky Situation**

**Kevin Parker**

*Thu, 13:30-15:00, 58/1009*

KKI Associates has developed this new 5-10 credit C/PBL resource, aided by Dr Dylan Williams of the University of Leicester, for the RSC.

**Scenario:** An Australian billionaire, who owns various oil exploration and products companies, has also developed a new ski resort. After the launch press conference his exotic sports car breaks down in front of the worlds press. The engine of the vehicle has been completely seized as the oil has gelatinised. The billionaire sues Northland Petroleum (NP) who formulated the oil used in his car, and threatens to sever all his important commercial links with NP. The Chairman of NP asks his head of technology to set up a task force to quickly investigate and respond. Student teams, typically of 4-6 people, are that task force...

The scenario turns on steps taken in Australia to reduce the slumping of Viscosity Index Improver (VII) polymer in storage at lubricants manufacturing facilities. One obvious solution is to introduce more crystallisation into the polymer. However, this can either make the VII very difficult to blend, and/or cause gel formation in the engine. Essentially, the oil can become more soluble in the polymer than the polymer is in the oil(!).

The module contains a variety of resources varying from formal Worksheets around the background of lubricants technology, to an e-mail correspondence trail, a lawyers' letter, a magazine article about the billionaire and his car, and a mysterious hand-written note with some scribbled web addresses. Team members will be required to investigate the issues contained in their Worksheets, and then to share crucial information in facilitated workshops.

Teams have a choice of spectroscopic techniques at their disposal and realistic simulated nmr, ir and calorimetry data. Can they solve the mystery of the 'Sticky Situation'...?



## Oral Presentations (15 minutes)

*Focus on the student journey, Thu, 15:30-17:00, 58/1007*

### **How does A-level maths affect first year student performance?**

*David Jewell, Fiona Dickinson*

Whether or not to require an 'A'-level in maths is a frequent discussion amongst chemistry academics, however it has not been clear whether students without 'A'-level maths are at a disadvantage, relative to those who have studied maths to this level.

Through the use of summative university assessments across both mathematical and non-mathematical based material and correlation in pre-university qualifications we found that an 'A'-level in maths, even at A or A\*, was not a significant predictor of success in Year 1.

As with many institutions where 'A'-level maths is not a requirement for entry, an in-house course teaching the fundamentals of maths for chemistry is delivered in the first semester of Year 1. Engagement with this unit and the problem based mathematical material delivered shows a moderate correlation ( $r_s = 0.560$ ) to success for students with 'A'-levels at B or higher, and a strong positive correlation ( $r_s = 0.793$ ) for students with GCSE as the highest level maths qualification. Students with a B or lower at GCSE have been shown to struggle, with a significant proportion repeating the year.

As a result of this work we assert the discussion regarding 'pre-U' qualifications should be focused on the students' attainment at GCSE maths, where numeracy is combined with problem solving, a paradigm more reflective of study in the physical sciences.

### **Changing Places – a longitudinal study into the perceived differences between secondary and tertiary education of first year chemistry undergraduates**

*Elizabeth Page*

A common observation of academic staff in higher education institutions is that students are not prepared adequately for university level study and have difficulty adjusting to the demands of tertiary education. At the same time UCAS personal statements portray applicants who are multi-talented with a wide range of skills gained from school and college and externally as well as exciting and worthwhile hobbies and part time work opportunities. From an academic perspective the Extended Project was designed to prepare students for the type of independent open-ended study required at university and the new A level specifications aim to test application rather than regurgitation of knowledge. How is it then that many of our first year undergraduates still struggle to manage their workloads and adapt to independent study?

In this talk the results of a longitudinal survey into the perceived differences between study techniques in secondary and tertiary institutions are described. Students were asked to compare different study techniques and roughly quantify how frequently they used them before and after starting university. They also evaluated how approaches to teaching changed as they began their degree courses and were asked to summarise their individual perceptions of the differences between studying at school or college and university. Amongst other findings this study shows that we expect students to demonstrate far higher levels of self-motivation, organisation and time management but simultaneously provide them with less guidance with which to succeed. Some initial results from a first year module to help students develop independent learning skills are reported.

### **Teaching as a journey: Signposting tacit and explicit tertiary chemistry pedagogical content knowledge and practice**

***Gwen Lawrie***

Tertiary chemistry pedagogical content knowledge (PCK) is a growing area of interest in educational research leading to a need to establish robust frameworks that evidence teaching practices. A consensus model for secondary teacher professional knowledge and skill, integrating PCK, was recently published as an outcome from a summit of world leaders in this field (Gess-Newsome, 2015). This model highlights the different facets of PCK and teachers' professional practice enabling exploration of evidence of effective teaching. In the current study, elements of tertiary chemistry PCK that may be transferable (explicit) as well as elements that can only be acquired through personal experience gained in teaching (tacit) have been explored. Multiple aspects of tertiary PCK and effective practices have been captured, collated and distilled into an online teaching resource of seven steps to assist both early career and experienced tertiary chemistry academics to transform their teaching.

Data was collected through voluntary participation of Australian tertiary chemistry academics in conference workshops and through focussed interviews of ten teaching academics, recognised as excellent teachers by their own institutions. Analysis of this qualitative data revealed several elements of tertiary PCK and significant project findings emerged from the shared stories of the individual participants. Common experiences and strategies, combined with the latest literature in effective tertiary teaching, led to the development of a set of generalizable steps as a journey towards good practice.

*Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK Summit. In P. Friedrichsen, & J. Loughran (Eds.), Re-examining Pedagogical Content Knowledge in Science Education (pp. 28-42). New York, NY: Routledge.*

## **Students' perceptions of the purpose of laboratory work for a Chemistry undergraduate course and scientific thinking approaches**

***Ruiqi Yu, Kon Hao Kwek, Kathleen M Quinlan, Fabrice Birembaut, Malcolm Stewart***

There have been many arguments put forward for the value of undergraduate chemistry laboratory courses. Yet, research suggests that lab courses often lead to little meaningful learning by chemistry students (Hart, 2000). This study argues that one of the causes of the problem is a limited understanding of the purpose of laboratory courses by students taught by a 'cookbook' approach, which is adopted by most universities.

We surveyed students from sixth form (n=59) to see if similar problems are evident before tertiary education. Chemists from first year to fourth year, PhD level and faculty (n=46, 63, 50, 41, 47 and 11 respectively) have also been surveyed to gain insight into students' views of the purposes of labs and their approaches to problem solving.

According to the literature (Handelsman *et al.*, 2007) and the responses of faculty and PhD chemists, we suggest that the main purpose of the teaching laboratory is to help students build up their scientific thinking skills. However, just 15% of undergraduate students agreed with this purpose. Instead, most students thought the most important purpose of labs is to consolidate taught knowledge.

This limited conception of the purpose of labs is associated with a fragmentary and unscientific approach to problem solving. More than 80% of the surveyed undergraduate chemists showed under-developed scientific thinking on the test embedded in the survey. Awareness that scientific thinking begins with identifying the question and is an iterative process did not dominate until doctoral study.

This study suggests laboratory courses need clearer purposes that are both stated explicitly and manifest in the design of labs, enabling students to gain experience in scientific thinking so that they grow in their problem solving abilities during their university degrees.

## **Laboratories, projects and the development of scientific thinking**

***David Westwood***

One goal in the training of physics undergraduates is to develop scientific thinking, i.e. characteristics such as critical mindedness, respect for evidence and objectivity. Therefore as educators we need to measure this behaviour. Viewing the process as a transition from "non-scientist" to "being a scientist", five stage-descriptors have been developed that reflect the struggles and successes that our students experience. In this (2015\_16) academic year survey >25 academic supervisors placed a total of ~130 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> year laboratory and project students on the resulting nine point scale (5 stages + 4 boundaries).

A broad brush analysis confirms that the transition from non-scientific to scientific behaviour takes place over an extended period. At the end of their second year most students are still at the early stages of transition – it is certainly not true that our students independently, validly and thoroughly extract scientific meaning at their first opportunity. At the end of year 3 and 4 the majority are in the middle and towards the end of the transition respectively. Only a minority of our first degree graduates can be labelled as scientists as we define it here.

In greater detail, viewing the variations in individual student performance as reflecting different responses to what is asked of them, their difficulties are more clearly revealed.

The importance of this work is in: providing a basis for a better understanding of student learning; informing our expectations of students; and in guiding (and perhaps evaluating) innovations aimed at improving scientific development on average and individually.

**Student engagement and the paradox of ‘developing’ employability in HE Physics**  
*Sinead Marian D’Silva, Samantha Pugh, Jim Ryder*

Concerns around the employability of graduates have often been vocalised in the media and in policy. Although at its advent it related to the entire working population, it has come to focus on graduates, embedding the agenda into the Higher Education landscape, generating a spectrum of responses to it. For my PhD research I attempt to understand how this fits in with Physics which is an ancient elite discipline. The employability agenda has received its fair share of criticism for promoting a certain type of student. Physics itself has diversity concerns that need to be addressed. The challenge at hand is to respond to the employability agenda within the context of a demand for widening participation, while simultaneously noting the graduate market has been making demands for “better” STEM graduates.

Through my presentation I will position my PhD research within the context of undergraduate physics students’ participation and engagement with the employability agenda. I argue that a better understanding of practice, motivation and ‘common sense’ will shed light on how we may address some problems directly and pave the way for a better understanding of others. Using a Sociological framework, I intend to unpick some of the concerns in Physics with a hope to understand these social phenomena and identify ways in which we can evaluate and improve the situation.

***Focus on interactive approaches, Thu, 15:30-17:00, 58/1009***

**How Interactive are Lectures? - A case study from a flipped introductory Physics class**

***Anna K Wood, Ross K Galloway, Robyn Donnelly, Judy Hardy***

Physics and chemistry lecturers are increasingly being encouraged to move from a purely didactic lecturing style to one which includes 'interactive engagement' activities in their lectures; and there is a great deal of evidence that this leads to better learning outcomes. However lecturing approaches tend to be described in binary terms as being either 'active' or 'passive', 'traditional' or 'reformed'. Very little is known about the detail of what takes place, or indeed how much interactivity is needed for it be classed as 'active' rather than 'passive'.

Here we describe a framework which is able to give a more nuanced description of activities in lectures, as experienced by the students. The Framework for Interactive Learning in Lectures (FILL) characterises student interactions (with the lecturer, with each other, and with the material). We applied the framework to two introductory physics courses (1A and 1B) at the University of Edinburgh, taught by the same lecturer, which both use a flipped approach together with Peer Instruction (PI).

Our analysis found that across the two courses 55% of the lectures were spent on non-interactive activities. The remainder was split between interactive (25%) (e.g. peer-discussion) and vicarious interactive (20%) activities (involving questions to and from the lecturer). As expected, the majority of both interactive and vicarious interactive activities took place during PI.

However, there were some significant differences between the two courses- notably in the way that interactive activities were used during non-PI sections of the lecture, as well as the overall time spent on lecturer-student interactions (28% for 1A and 12% for 1B).

Our results highlight the importance of considering both 'active' and 'passive' components of lectures as well as the role that contextual factors, such as course content and structure and student prior knowledge have in determining teaching strategies.

**Students' appraisals of multi-cultural group activities**

***Gita Sedghi, Elisabeth Rushworth***

Group working skills are essential attributes for graduates, and are highly valued by prospective employers of home and international students. Our project targeted modules from Chemistry, Electrical Engineering and Chemistry and aimed to examine the potential benefits for student integration in multi-cultural group work activities by measuring the students' appraisals of multi-cultural group activities compared with different aspects of group work in general.

The project targeted modules with different class sizes and proportions of home and international students. Modules were identified where multi-cultural group working could be implemented and the students asked to complete a questionnaire (SAGA instrument - contextualised) at the beginning and the end of the group work activity. The Contextualised SAGA questionnaire is a task-context sensitive instrument suitable for measuring changes in appraisals over the duration of a group assignment. At the next stage of the project, focus groups were organised to explore the results of questionnaires and also to generate new ideas.

Our study shows that students' attitudes towards multi-cultural group work were generally positive, although international students had a better perception of the benefits than home students. International students found the cognitive benefits of group work more favourable and home students have a better overall perception of the benefits of the emotional aspects of the group work, how they will manage the assignment, the development of interpersonal skills, and group assessment than international students. In general, the results imply that tutors should deliberately assign students to mixed groups to encourage integration, and that the academic tasks for the assignments should be developed sensitively to encourage engagement with both cohorts of students.

### **Bringing the Research Group Ethos into Taught Master's Learning**

*Richard James Lewis*

Within taught master's programmes which incorporate undergraduate modules as elective choices there is a risk that postgraduate students will struggle to forge their own unique cohort identity within the wider community. Due to finite teaching time and resources, there is a tension in designing dedicated core master's modules between (i.) the need to embed practical and research skills and (ii.) to foster engagement and support through partnership and a coherent master's community.

At Cardiff University, our MSc Physics and Astrophysics programmes incorporate dedicated teaching environment design and bespoke core modules which use aspects of research group organisation and operation to enhance the students' sense of community and enhance learning.

Our master's students have a dedicated MSc area which incorporates their meeting/study/seminar room, two teaching laboratories and the open-door policy office of the two MSc coordinators. In this space the 40 credits of core MSc modules are conducted across autumn and spring. Students take ownership of 10 week mini-projects which run in parallel to formal skills-based lectures, workshops and laboratory sessions. Students organise their engagement with these projects outside of formal contact hours. The entire cohort meets weekly for a research group style meeting containing action learning sets to enable students to support each other and to prioritise and set realistic goals for each week's activities.

Average scores in core modules are above the average of 65%. Student feedback this academic year has been overwhelmingly positive. Students cite the strong

community spirit, weekly meetings and dedicated space as the central positive experiences of their learning. Results and free text comments from the 2016 PTES survey (100% completion) show that these benefits have not been at the cost of perceived acquisition and improvement of general and transferable skills: the 2016 thematic area performance score for skills development was 98%.

### **Bringing Research-led Teaching to a Wide Audience through Digital Learning Methods**

*Paul C Taylor*

Research-led teaching is often presented as a core feature of the UK HE experience (Healey & Jenkins), although it can be unclear what research-led teaching is (Neary & Winn), or what its benefits are (Hattie & Marsh).

Through its “Final Year Project” commitment, the University of Leeds ensures all its students benefit from research-led teaching *in their major subject*, but it is challenging to bring research-led teaching to students in the early years of a Chemistry programme, or from other programmes.

The School of Chemistry at Leeds is addressing this through a Level 1 Discovery module ‘The Extraordinary Chemistry of Everyday Life’, available to any Leeds student with a Chemistry ‘A’ Level and covering seven contemporary topics, *e.g.* ‘Feeding a Growing Population’ and ‘Cancer Chemotherapy’. The material for each topic is presented by a researcher from Chemistry, with a case study from a researcher from the Medical School, Industry *etc.* Students receive instruction in science writing and are assessed through a written article and a YouTube-style video.

Connecting fourteen researchers with students from any programme in the University in a conventional classroom setting, given the typical constraints of diaries, timetabling and accommodation, is difficult. Hence, we worked with Leeds’ Digital Learning Team to develop a MOOC-like version of the module, strengthened by a weekly face-to-face seminar. This allowed us to capture our “experts” in video and web resources in digital format allowing students to access the materials at their convenience. The module will be re-used in future years with no further input from colleagues.

Our presentation reports staff and students experiences of the Discovery module and our plans to repurpose the digital objects created, *e.g.* through a short FutureLearn MOOC aimed at schools and entitled ‘Exploring Cancer Medicines through Science Writing’, whereby we take research-led teaching to an even wider audience.

*Hattie, John and Marsh, H W (1996) The relationship between research and teaching: a meta-analysis, Review of Educational Research, 66 (4), pp 507-42.*

*Healey, Mick & Jenkins, Alan (2009) ‘Developing undergraduate research and inquiry’. York: HE Academy.*

*Neary, Mike and Winn, Joss (2009) 'The student as producer: reinventing the student experience in higher education'. In: 'The future of higher education: policy, pedagogy and the student experience'. Continuum, London, pp. 192-210.*

### **NearPeer: Harnessing the power of the populous to enhance the learning environment**

***Barry Ryan***

*NearPod* is a multiplatform, blended e-learning tool that allows students to engage with each other and the lecturer in real time, independent of learning space size or type. In this project the use of *NearPod* was investigated in three different third level educational settings; a large foundation organic chemistry module, a medium size intermediate biochemistry module and a small maths for STEM programme.

The rationale for this project was two-fold; practical implementation of key trends in higher education and enhancing the student learning experience. Recent *NMC Horizon Reports* cite the higher education adoption of BYOD (Bring Your Own Device) and flipped classroom learning is imminent. One aim of this project was identify if *NearPod*, could address these two key trends in a simple, cost effective way. Secondly, the research sought to investigate if embedding engaging technology into the learning environment could enhance the student learning experience.

The use of *NearPod* as a constructivist learning tool was evaluated in terms of student interaction, engagement and participation through *NearPod* facilitated synchronous learning activities. Evaluative data was collected in several forms; anonymous questionnaires of all students that experienced a *NearPod* module, independent academic facilitated discussion fora with purposefully sampled students, staff reflective diaries and *NearPod* data analytics. Qualitative data analysis was carried out under Braun and Clarke's (2006) model and fed into a triangulated data set, ensuring only valid themes emerged. Overall, the students perceived use of the technology and the academics personal reflective writings during their use informed the success of the project. It was noted that the learning environment evolved towards a student-orientated, social constructivist space where the students took ownership for their participation in the learning activity. Students became responsible for constructing their learning 'product'; created by the students, for the students and, hence, their learning overall.

### **Chemistry for the 21St. Century**

***Ketan Trivedi***

The College Boards, has approved for the first time ever, an interactive software program for teaching college level , General Chemistry. Twenty one chapters of interactive tutorial instruction provides an engaging system , requiring student interaction. An audio/text, flash drive mounted system that students prefer over a textbook. Includes; printable notes, Glossary, Tables, Calculator and Periodic Table, and a searchable Index. No internet connection required and students can study at their own pace. Each chapter has multiple problem sets, using various pedagogies,



some with drop down solutions (audio/text), or some providing interactive solutions. Student interaction includes 'drop and drag' structures, student drawn graphs. Also included are hundreds of graphic representations and lecture/demo videos. Instant feedback to the student on thousands of embedded questions within the tutorials. No question encountered is left unanswered.

Much more engaging for the student, and certainly less expensive than the textbooks!

***Focus on labs and collaborative working, Fri, 13:30-15:00, 58/1007***

**Enhancing the value of science education activities in primary schools through interdisciplinary and intercollege collaboration**

***Vanessa Murphy, Claire McDonnell***

Since 2007, Community Based Learning (CBL) activities have been offered as part of a second year module in an undergraduate chemistry programme in Dublin Institute of Technology (DIT). CBL involves students undertaking a real world project within a community. They gain academic credit for the learning they derive and for reflecting on the experience.<sup>1</sup> The activity is planned and undertaken in partnership with the community concerned to meet a genuine need that they have. Participation in CBL activities has assisted in the development of DIT students' problem-solving, teamwork, organisation, digital literacy and communication skills.

The work presented will explore the outcomes of a project that developed and extended an existing CBL activity, through collaboration between DIT chemistry students and students in the Church of Ireland College of Education (CICE) teacher training college. The existing activity involved DIT chemistry students planning and implementing interactive hands-on sessions to support primary school children's learning on science topics selected by their teachers from their syllabus.<sup>2</sup> One of the main aims of this project was to facilitate collaboration between the chemistry students and primary school education students, allowing each to enhance their pedagogical and scientific knowledge through development of suitable demonstrations and activities for 9 to 12 year olds. The project is based on a similar one that had been run in the University of Hull by Prof Tina Overton.

Both pre- and post-surveys were employed with the DIT chemistry students and this allowed their perception of their professional skills development and attitude towards civic engagement in relation to this project to be probed. Surveys with the CICE students following completion of the project were used to gain their perspective on the effect of the project on their learning. These were complemented by an interview with their lecturer.

1. *Community Based Learning – An Introductory Guide For Higher Education Staff*, L. McIlrath & C. McDonnell; <http://www.campusengage.ie/userfiles/files/Community-Based%20Learning%20WEB.pdf>

2. 'Chemical Sciences in the Community', Students Learning with Communities, Dublin Institute of Technology poster; <https://www.dit.ie/media/ace/slwc/Claire%20McDonnell%20&%20V%20Murphy%20chemistry%20CBL%202015.pdf>

### **The EPQ – A vehicle for school to university collaboration**

***John Carroll***

The Extended Project Qualification (EPQ) is a Level Three qualification, currently offered to secondary schools in England and Wales. It is generally used as a stand-alone qualification alongside conventional curricula, and carries a UCAS tariff of 70 points. A key purpose of the EPQ is to engage and stimulate student interest in an area outside the confines of the existing specification, and to help support and develop independent learning skills and critical thinking. This talk will document the background, process and outcomes of a pilot study involving two A-level chemistry students working alongside their local university chemistry department. Opportunities for further work and evidence of how this qualification can be used to support Widening Participation (WP) in HE will also be presented.

### **Collaborative teaching for collaborative learning**

***Fiona Dickinson, Andrew McKinley***

In a collaborative effort across institutions, a course on optical spectroscopy was developed and delivered with a specific aim of improving students' skills in research analysis and in self authorship. Through delivering a discussion based course, centred around the learning partnerships model (Baxter Magolda, 2010), coupled with an authentic open note assessment, we delivered a valuable research focussed level 7 course.

The course was heavily discussion based, making extensive use of literature to enhance students' abilities in interpreting research data, followed with an open note assessment, a technique which has been presented previously at this meeting (R. Galloway, ViCE/PHEC 2013). For the examination students were given optical spectra to analyse using the concepts explored during the course, testing their analytical skills rather than simply their ability to remember course content.

This presented an innovative approach at both institutions, and has led to increased confidence among academic staff concerning the use of skills-based assessment, with an increase in the implementation of such assessment styles. Student satisfaction on the course was high, with particular praise on the authentic skills-based nature of the assessment, in which anecdotal student feedback at both institutions suggested that students were pleased to have been tested on their analytical skill, rather than their capacity to memorise content.

M. B. Baxter Magolda. A tandem journey through the labyrinth. *Journal of Learning Development in Higher Education*, Issue 2, 2010.

## **The prevalence of pre- and post-laboratory scaffolding activities in HE STEM courses**

***Karen Moss, Jennifer Evans, Sarah Rayment***

With the rise in the use of virtual learning environments and other technological developments, it is now possible to do a range of activities to provide pre- and post-laboratory scaffolding of learning and assessment, with students. Whilst anecdotal evidence of types of pre- and post-laboratory scaffolding is available, a recent systematic overview of sector-wide practices appears to be missing.

Research into the use of pre and post-laboratory scaffolding was undertaken by Reid and Carnduff in 2000<sup>1</sup>. However, their report focussed on the presence or absence of pre-laboratory work in a higher education setting, rather than the types of activities being used.

In light of this, it seemed timely to survey the range and types of activities currently being undertaken by students, before and after laboratory sessions, in a number of science subjects.

A survey tool was developed to assess the use of different activities, and methods, collecting data both within and across a range of Higher Education institutions across the UK and Ireland in STEM subjects, focusing mostly on Chemistry and Biosciences. Participants were asked to describe the activities students undertook within a module, to complement their laboratory sessions.

Preliminary findings show, as might be predicted, that the most common pre-lab activity is getting students to read the lab script; and for a post-lab is producing a lab report. However, these are not universal. In addition, we found that a wide range of activities are being used in pre-laboratory scaffolding, often with several activities being used within the same module. The range of activities used includes: watching a video, completing relevant calculations, taking an online quiz and completing a safety exercise.

Post-laboratory activities showed less variety, perhaps an interesting question is does this mean that opportunities to embed learning from labs are being missed?  
(294 words)

1. Carnduff, J., & Reid, N. (2003). *Enhancing undergraduate chemistry laboratories: pre-laboratory and post-laboratory exercises*. London: Royal Society of Chemistry.

## **Trailing the use of Tablet PCs in Undergraduate Physical Science Laboratories**

***Cate Cropper (in collaboration with Helen Vaughan, Ross Clements and Manesh Mistry)***

We have recently trialled the use of tablet PCs in the chemistry and physics labs in CTL. A range of tablets using various operating systems have been tested and their limitations documented. An evaluation of our finding is given and shows that

effective collaboration between chemistry and physics students has led to innovative use of tablet PCs for filming and recording observations and data; integration of software used on analytical equipment and for use as a lab book. We have explored various software for data capture and note taking in addition to the use of electronic COSHH systems and how tablet PCs could be used by demonstrators to assist in lab teaching. Our research shows methods of assessing pre-labs, key lab skills and reports can be enhanced by using tablet PCs. We have addressed many practical issues, such as contamination and mounting the screens to record experiments. We are currently working with developers to tailor software that is accessible for undergraduates in order to enhance their understanding of experiments and regard laboratories as enhancing their learning and exploring the science rather than following a recipe to get the right product.

### **A Dynamic Laboratory Manual – Construction, Consolidation & Consequences Eleven Years On**

*Jenny Slaughter, Dudley Shallcross*

Practical chemistry: what is it for? Laboratories are expensive, student fees and numbers increasing as is the demand for quality. Yet the majority of chemistry graduates leave university and never step foot in laboratories again. So we must provide worthwhile time in these spaces and give our students more than an impression of alchemy. Eleven years ago, this is what Bristol ChemLabS, set out to do. We will present the two key strategies to achieve this; the redesign of the laboratory course and the implementation of online support.

The impact of these strategies was measured by several methods. Evidence was gained from both staff and students through face-to-face meetings, questionnaires, students' marks and student numbers. All methods were utilised over a period of ten years. We will show that this evidence gives a clear picture of the practical skills of undergraduate chemists before, during and after the Bristol ChemLabS project (e.g. Shallcross et al., 2013a; Shallcross et al., 2013b).

Our analysis reveals more effective and efficient laboratory courses (Shallcross, Slaughter et al., 2015). Students arrive prepared, confident in their knowledge, able to start straight away and ask pertinent questions. Staff supervisors have greater confidence in the abilities of research undergraduates. This confidence is supported in a rise in final year project marks, despite greater class sizes.

Such success gives us confidence that it is the links between the practical and theory, not the order in which they are experienced, which is essential for learning. We propose that the focus on skills is key to the success of the project and outline the key aspects of design and implementation which other institutions might exploit to achieve successful, impactful laboratory teaching.

***Focus on concepts and confidence, Fri, 13:30-15:00, 58/1009*****How A-level students justify organic mechanisms*****Robert Campbell***

Model systems provide important tools for investigation of fundamental scientific principles. This project investigated students' conceptualization of mechanisms in organic chemistry by use of formal or informal model systems. The approach by year 13 students (n=6), to understanding of organic chemical reactions was investigated by response to examples tasks and semi-structured interview. Students were allocated example organic reactions, and asked to deduce organic mechanisms by which reactions occurred. As expected, students understanding of novel mechanisms was affected by their knowledge of similar mechanisms that they had studied in a different context. However, the study revealed disparities in the students' approach. Students could focus on individual steps of complex reactions but many had difficulties with a more holistic approach, whereby all steps were considered in logical sequence. Group discussions could raise misconceptions, for example concerning bond breaking or the sequence of events within a particular mechanistic pathway. This research defines issues relating to current teaching methodology and identifies opportunities for use of simplified sequential model systems, to aid learning of complex organic principles.

**ChemInteractive: Design and Development of an Online Education Resource*****Mike Casey***

This presentation will describe one approach to effective use of the power of technology for educational purposes. The design and preliminary evaluation of a 'semi-intelligent', adaptive, online tool will be presented. The evidence-based design principles that are key to this project, and are relevant to many other e-learning applications, will be discussed. ChemInteractive (<http://www.ucd.ie/chem/chemint/>) is a freely-accessible web-based application, designed to promote student learning through self-assessment. It is at a relatively early stage of development, but is a unique resource featuring (i) a platform-independent interface, (ii) a focus on key skills, including organic reaction mechanisms, (iii) a highly interactive environment in which users draw structures and mechanisms, and (iv) 'chemically intelligent' analysis of user responses so that helpful feedback can be provided. The current implementation will be described, and the major new features of the next version will be previewed. These include a complete redesign of the website, tracking of user skills, and adaptive selection of the problems presented to users. The modular architecture of the system will facilitate expansion, and plans for future development will be outlined. Anyone interested in the potential of this resource is invited to collaborate in its development.

### **What can free-text questions tell us about conceptual understanding in physics?**

*Sally Jordan, Ross K Galloway, David Sands, Christine Leach, Lorenzo Principe*

A concept inventory is, most commonly, a multiple choice questionnaire (MCQ), used to measure conceptual understanding. The Force Concept Inventory (FCI), developed by Hestenes et al (1992), has been used on millions of students around the world and its success has spawned numerous other concept inventories, in other topics in physics and in other disciplines including chemistry.

Whilst the FCI and other concept inventories have clearly led to improved knowledge of students' conceptual understanding in some areas, for some questions the commonly accepted interpretation of a student's choice of particular distractors has been called into question, and students have been observed to give answers which are not listed as distractors (Rebello & Zollman, 2004). Furthermore, the widely-observed gender difference in performance, particularly on some questions (Bates et al., 2013; Madsen et al., 2013) remains poorly understood.

Work is underway using the Moodle Pattern Match question type (Butcher & Jordan, 2010) to develop automatic answer matching for a free-text responses version of the FCI. Preliminary free-text versions of the MCQ questions have been tested on students at two universities and, in addition to providing responses for use in developing answer matching and giving confidence that automatic marking is likely to be sufficiently robust for over half of the questions, the student answers that have been collected are providing additional insight into misunderstandings. This oral presentation will concentrate on detailed findings from two or three questions, with discussion of the implications of these findings both in terms of conceptual understanding of Newtonian mechanics and, more generally, in considering the use of concept inventories for the future.

### **Is there a correlation between correctness and confidence in conceptual questions?**

*Simon Lancaster, Dennis Cook*

Peer instruction is most closely aligned with social constructivism. We pose conceptually challenging questions pitched in the 'Goldilocks zone' or 'sweet spot'. We then encourage students to talk to one another before polling again. The premise is that if the questions are too easy then everyone immediately knows the answer and there is no opportunity for learning. If the questions are too hard then nobody knows the answer and will not be able to propagate it amongst the class. The research question we have tried to address is "Is there a correlation between correctness and confidence in conceptual questions?". The answer to this question invites a raft of new ones such as whether peer instruction works best when students are confident.

The project has been conducted largely as a final year research project and has been a close collaboration between the presenter and his co-author. We began by inviting the student to review whether the questions being posed were genuinely conceptual and where necessary co-authoring alternatives.

We would like this project to serve as a preliminary investigation for a larger collaborative to investigate the research questions at a sample size that will yield compelling statistics in an environment free of the conflating impact of investigator bias.

Delegate engagement will be achieved through provision of an example question to illustrate the approach and careful attention to a time limit because we are keen to involve delegates in the development of the project and welcome their comments.

### **An educated guess: score prediction for tailored student support**

*Felix Janeway*

One of the aims of a science foundation year is to focus on developing an autonomous learner. A required skill is to reflect appropriately on both one's understanding and ability to answer the question fully. Gardner-Medwin's (2007) work on confidence-based marking required a student to state how confident they were with their answers as they submitted them during assessment, then rewarded students who were confident in their answers. This practice encourages the student to think carefully about their justifications and differentiates between the student guessing the correct answer and the student knowing the correct answer. This pilot study sought to build upon this practice on a programme scale to identify underlying relationships between confidence, reflection and attainment for science foundation year students. During this work, students were asked to predict their attainment on assessments during the course and comparisons were made between the achieved mark and predicted mark, with large disparities representing an over or under-confident learner and indicating a requirement for intervention. Over time, students seemed to become 'better' at predicting their score, leaving the question of what this means.

### **Effects of Workshop Group Gender Balance on Student Exam Performance: update on replication study**

*Ross K Galloway, James Salmon, Ross W Hunter*

At last year's ViCEPHEC we reported on an investigation conducted in the workshop element of an introductory physics course. We manipulated seating patterns so that in some workshops (the 'balanced' population), male and female student numbers in each group were equal, whereas in the 'control' workshops (the 'random' population) male and female students were randomly assigned, typically giving one or occasionally two female students per group of six. We found that female students in balanced groups scored statistically significantly higher marks in their final course exam than female students in random groups (and with no significant differences for male students). In the last academic year we attempted a replication study of this intervention, which we report here. We found that the results from the previous year were not repeated: there were no significantly different exam scores between

the populations for either male or female students. We shall discuss some possible influencing factors on this outcome, and the wider implications.



## **Oral Bytes (5 minutes), Thu, 12:00-13:00 & Fri, 15:10-15:40, 58/1067**

### **Postgraduate students as partners to facilitate effective undergraduate learning in chemistry**

*Glenn Hurst, Rob Smith*

The Department of Chemistry at the University of York provides bespoke internal training for postgraduate students who teach as part of our innovative Doctoral Training in Chemistry (iDTC) programme. As well as providing postgraduates with the necessary pedagogic knowledge to understand and cater for a diverse range of students with multiple learning styles, the course is specifically tailored to meet the demands of students studying chemistry and related subjects. As part of our customised training, postgraduates attend two workshops devoted to “Communication Skills” and “Assessment and Feedback”. A large emphasis is placed on actively training our postgraduates how to teach in common learning scenarios. Our trainees engage in microteaching during these sessions where they explain the learning objectives, tasks and modes of assessment to each other. All trainees participate in table marking with sample manuscripts during these workshops, enabling postgraduates to appreciate the importance of and subsequently practise assessing consistently. Finally, postgraduates learn how to give constructive feedback (verbal and written) that allows our undergraduates to learn from their comments, feeding forward to subsequent assignments. Over the course of the programme, our postgraduates are assigned a mentor who they initially shadow, and, following this, who provides feedback on the performance of our trainees. A vitally important part of our training is enabling our postgraduates to become reflective teachers. We facilitate this by asking our trainees to create a personal teaching portfolio where they reflect on the teaching, assessment and feedback that they provide, allowing them to identify and develop skills directly aligned with the Vitae Researcher Development Framework. This training course could serve as a model to train postgraduates how to teach undergraduate cohorts in other disciplines and institutions.<sup>1</sup>

“Made me more enthusiastic towards teaching and highlighted some skills development I would never have considered.”

[1]: Hurst, G.A. and Smith R.A.W. (2015) “Inclusive postgraduate teaching in the Department of Chemistry” *FORUM*, 38, 12-14.  
<https://yorkforum.org/2015/04/14/inclusive-postgraduate-teaching-in-the-department-of-chemistry/>

### **Coming full circle: Chinese joint degree graduates as Laboratory Teaching Assistants on their former BSc degree programme**

*Julie Hyde*

I would like to share with the audience about the three months laboratory teaching this year, 2016 at NJTech in China. The practical programme is very intense and I

have Graduate Teaching Assistants (GTAs) to help me out in the laboratory which has been very successful. But this academic year, two of our BSc graduates from the joint Sheffield Chemistry (3+1) degree programme were employed at NJTech to help me out. Did this work? Did they speak to the students in Chinese or English? How were their teaching skills? Find out what happened in China during in this short presentation.

### **A new school teacher fellow model**

*Kristy Turner*

Bridging the gap between school and undergraduate study is an important consideration for all higher education institutions. Since September 2015 the school of chemistry at the University of Manchester have been sharing a member of teaching staff with a local secondary school. This presentation will discuss the highlights and challenges of this approach and its potential as a model to ease transition to higher education for students and increase understanding of students' prior learning amongst academics.

### **Using online quizzes for low-stakes assessment motivates Biochemists to practice calculations**

*Hazel Corradi*

Finding ways to motivate undergraduate Biochemists to practice calculations is a perennial problem. Those that have not done A-level maths or physics often lack confidence and skill, even in very basic calculations. This is partly due to having done less maths, but sometimes because they feel they have not done well in maths in the past and therefore cannot do it. Increasing student motivation requires a multi-pronged approach but is always aided by assessment that incentivises students to engage with the topic. In our context, this is particularly important as the additional maths support is not a credit bearing unit in its own right, but only a small part of a skills unit. Additionally, because we cover school-level material the topics lack the motivational influence that comes from novelty. Therefore we use automatically marked low stakes weekly assessment, combined with a final test under exam conditions where students must get 100%, to ensure engagement with the maths support offered. The questions for all the tests come from the same large randomised database to allow students to practice different versions of calculations they struggle with. The final test is not time limited to emphasise that persevering and achieving mastery in all topics is more important than working fast or scraping a pass by selective learning. We show that with this design we achieve a high level of student engagement with both the weekly assessment and additional practice quizzes, resulting in an improvement in performance in the final test.

### **New Directions Update**

*Derek Raine*

Update on relaunch of the journal *New Directions in Physical Sciences*

**YikYak: A social network too far?***Simon Lancaster*

Most student evaluation of teaching is by end of course evaluation forms based more-or-less loosely on the NSS and where we are grateful for every qualitative statement to complement the near useless Likert data. We are encouraged to distribute Post-It notes to receive mid-module qualitative evaluations in which we prompt students to tell us what to start, stop and continue. The anonymous location-based app, YikYak has swept university campuses and provides an unprecedented window on the student psyche. This is simultaneously powerful and terrifying. Do you really want to know what your students think about your every session?

**R-D-L Me This***Matthew Mears*

Students often enter physics courses at higher education with a background experience of "spoon fed" learning yet academic staff expect students to engage in self-directed learning. The "Revise, Do, Learn" (or R-D-L) method presented here provides a first intermediary step between "spoon fed" and independent learning. A small to moderate positive effect ( $d = 0.38$ ) was found between subsequent cohorts that, when considered with the minimal time and effort required to implement the method<sup>1</sup>, provides an "easy win" for improving student learning.

**Visualizing Russell-Saunders terms: an activity with quantum numbers***Paolo Coppo*

Getting students excited about spectroscopy at undergraduate level can be a bit like finding water in the desert. Concepts like microstates and energy terms are often too abstract to stick and easily lead to misinterpretation. A classic example is the red emission of europium (III) ions, which involves a  $^5D-^7F$  transition. How many graduates are convinced this is an electron moving from a  $d$  to an  $f$  orbital?

This activity discusses the electronic structure of a transition metal ion and how this changes when the same ion is surrounded by the ligand field in a coordination complex.

The activity is aimed at providing students with a method to understand combinations of electrons in orbitals, how these might not be degenerate even within a set of degenerate orbitals and how electronic transitions visible in an absorption spectrum can be easily visualised and understood without the need for abstract concepts.<sup>1</sup> In the process, the meaning and importance of quantum numbers is reinforced.

1) *P. Coppo, J. Chem. Educ. In press.*

**New C/PBL Material – The Analytical Chemistry of Platinum Recycling**

***Kevin Parker***

KKI Associates and the University of Huddersfield and developing a 5-10 credit UG module based around Analytical Chemistry and the re-refining of platinum and related metals.

Refining waste platinum metals (such as used catalytic convertors) present a number of challenges to analytical chemists. Accurate quantitative measurement of the desired metal is fundamental to the economics of refining plants – a few % of experimental error in determination can represent thousands of pounds of value. Both customer and refiner may carry out multiple tests using different methods to give themselves the best commercial ‘deal’. The determination may have to be done with low level heterogenous material and with highly concentrated solutions. The refining process is does not give 100% yield and the refiner carries out a ‘stock take’ every few years where they analyse the highly toxic but quite precious ‘sludge’ in the bottom of their tanks. Finally the whole process needs to pass rigorous environmental standards requiring the detection of very small amounts of water-based or gaseous (e.g. osmium tetroxide) effluent.

**GRASping opportunities for our students**

***Glenn Hurst, Avtar Matharu***

The Green Chemistry Centre for Excellence in the Department of Chemistry embarked on a Greener Reagents And Sustainable Processes (GRASP) educational S-Labs project funded by HEFCE to embed green and sustainable chemistry principles within the undergraduate curriculum. Using a students as partners approach, we analysed all the reagents and solvents our undergraduates use and identified those that are particularly hazardous according to the Global Harmonised System of Classification and Labelling. Our undergraduates identified and substituted alternative green reagents and solvents as part of activities that were incorporated as assessment points within their degree programme at stage three. The GRASP projects were an ideal opportunity to provide students with a glimpse into green chemistry research as well as helping to prepare them for graduate studies and scientific employment.

To enhance the employability skills of our undergraduates, we employed students to work in our laboratories to further contribute towards the implementation of greener experiments within our degree programme. Future employability in the chemical sciences will require knowledge of green and sustainable chemistry: “Manufacturers are snapping up chemists who can make their products more environmentally friendly.”<sup>1</sup>

Our students engaged in high level critical and creative thinking by asking questions such as:

“Do we need to make this much product?”

“What happens to it at the end?”

Students even examined the green credentials of silly putty where they identified the conventional crosslinking agent has the potential to disrupt the reproductive system<sup>2</sup> and were able to find a green alternative, which is useful to demonstrations, outreach activities and lab experiments.

We empowered our students to disseminate their work as an invited talk at an international S-Lab conference and they GRASPEd the opportunity with both hands! This project will benefit hundreds of undergraduates giving them a deeper understanding of green chemistry and a safer working environment.<sup>3</sup>

1: Cernansky, R. *Green Fefill. Nature*, 519 (2015) 379-380.

2: Hurst, G. A., Bella M. and Salzmann, C. G. *Journal of Chemical Education*, 92 (2015) 940-945.

3: Hurst, G. A. and Matharu, A. S. *FORUM Learning and Teaching Magazine*, 40 (2016) 24-25.

### **The use of coversheets to promote dialogue in feedback assessment**

***Alice Collier***

Students and tutors often have different perceptions of the feedback process,<sup>1</sup> which can make providing effective feedback a problematic issue. One approach to solving this issue is to make small changes to how feedback is provided, to help engage students and create a dialogical process.<sup>2</sup> This oral byte will introduce our first attempts of using coversheets for our 1<sup>st</sup> and 2<sup>nd</sup> year undergraduate laboratory assessments to help promote a feedback dialogue between student and tutor.<sup>3</sup> The coversheet asked students to reflect on how they had used previous feedback and on the strengths and weaknesses of their piece of work. They were also given the opportunity to ask the tutor for comments on specific areas of their assignment. Initial results will be presented which highlight the variable nature of both what students are looking for in feedback and the level of their understanding and engagement with assessment criteria.

(1) Carless, D. *Stud High Educ* **2006**, 31, 219.

(2) Nicol, D. *Assessment & Evaluation in Higher Education* **2010**, 35, 501.

(3) Bloxham, S.; Campbell, L. *Assessment & Evaluation in Higher Education* **2010**, 35, 291.

### **Synthesis 'by proxy' – a reasonable adjustment?**

***Laura Patel***

In order to gain some experience of synthetic chemistry one of our first year students, who cannot enter the lab on health grounds, has this year been conducting his synthesis experiments 'by proxy'. This involves verbally instructing a lab assistant in real-time and observing the reactions and processes via a video stream. Is this a reasonable adjustment to a chemistry degree programme? Feedback from the student on his experience, and reflections, from various viewpoints, on whether and how the learning objectives of the lab have been met will be considered.

## Poster titles, Fri, 11:00-13:30, Garden Court

### Assessing Final-Year Practical Work Through Group Projects

*Philippa Cranwell*

With increasing student numbers and increasing pressure on resources, innovative ways for the provision of final year projects are increasingly required. One way of achieving this that the Department of Chemistry at the University of Reading has recently explored is the use of group projects to assess final year practical work. Students work in teams of up to 5, and are presented with a problem that they need to investigate. In the spirit of a true research project, the answer is unknown and the work is open-ended. The students' output is assessed through a variety of means including a literature review, an assessment of their practical ability, their teamwork, a group presentation and a group report. The projects were successful, with all students completing the work to a satisfactory level. The poster will try and outline some of the issues that we faced, and the steps that we have taken to alleviate some of the issues in the coming years.

### Generation of online tools to support learning.

*Fiona Dickinson*

This poster discusses a range of online tools that are currently used to support students' in their learning of advanced (year 3 & 4) courses.

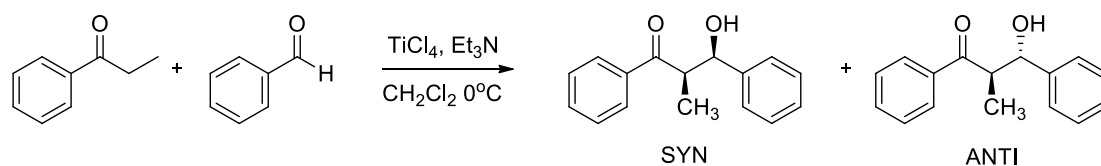
The use of formative MCQs and peer discussion in lecture slots has been shown to benefit students' understanding, however it is a time consuming paradigm. Longer format workshops have been abandoned to allow time for peer learning exercises, and the workshop content has now been moved online not only as worked model answers, but now also workshop videos. These workshops are being further developed to introduce a level of interactivity and feedback to students.

Increasing 'lecture capture' is used, and there can be a tendency for students to repeat watch in what they believe is effective learning or revision. Instead summary 'bites' based on the 'Vingettes' format of Lancaster, are prepared, which also may be used to provide single topic flipped material.

Both of these methods have anecdotally proven popular with students, and allow more effective use of the timetabled sessions.

### A TiCl<sub>4</sub> mediated aldol for FEHQ level 5 organic labs

*Michael Edwards, Laura Hancock, Graeme Jones and Matt O'Brien*



The aldol reaction is a pivotal reaction in organic chemistry studied as part of every Chemistry course in the land. Within our FEHQ level 5 labs we have developed a

modern  $\text{TiCl}_4$  mediated aldol reaction which challenges the laboratory and analytical skills of the undergraduate in a number ways;

1. The use of  $\text{TiCl}_4$  requires strictly anhydrous conditions with an inert atmosphere – and let's face it smoking  $\text{TiCl}_4$  looks scary.
2.  $\text{TiCl}_4$  reaction mixtures require careful work-up to avoid the formation of emulsions.
3. The reaction proceeds with high diastereoselectivity which can be observed and measured by  $^1\text{H}$  NMR of the crude reaction mixture.
4. The diastereomeric mixture can be separated by column chromatography allowing isolation of the pure major diastereoisomer.
5. The  $^1\text{H}$  NMR spectrum of the major diastereoisomer is challenging to interpret with interesting features and the stereochemistry of it and the minor diastereoisomer can be deduced from the proton coupling constants.

In addition to the experimental details we present staff and student feedback on the experiment, explain how we manage the safety side of undergraduate use of  $\text{TiCl}_4$ , and describe what happened, despite the safety measures, the day it went wrong.

### **Transforming the year 1 chemistry learning experience**

*Suzanne Fergus and Stewart Kirton*

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.

Innovations and interventions including a chemistry diagnostic test, think aloud research protocols on fundamental diagnostic questions, online collaborative question creating using Peerwise and a novel laboratory competency assessment approach will be evaluated and presented.

### **Analysis of Students' Higher Order Thinking Skills (HOTS) in Solving Chemical Kinetics Questions**

*Habiddin, Elizabeth Page*

Questions given to students to identify their understandings after science learning, particularly chemistry learning generally only follow what is presented in lectures and textbooks which commonly provide just one solution to each problem. This is intended just to verify what students have learned (Nakhleh, 1993). The emphasis on Higher Order Thinking Skills (HOTS) question type is generally less concerned. However, the crucial role of teaching and evaluation of HOTS in science education has been confirmed from many literatures. Therefore, the change of paradigm of chemistry learning in university from Lower Order Cognitive Skills (LOCS) to Higher Order Cognitive skills (HOCS) should be promoted both in teaching & learning and in assessment (Zoller, Fastow, Lubezky, & Tsaparlis, 1999). HOTS, such as critical thinking skills and problem solving ability are essential for future study and employability because this type of question will challenge students to think deeply

and critically. Therefore, teachers at all levels are recommended to encourage their students to deal with tasks involving HOTS (Zohar & Dori, 2003)

The aim of this study was to identify students' HOTS in solving chemical kinetics questions. Identification of students' HOTS in this paper is an additional part of the author PhD research project. 57 chemistry students in Year 1 at the University of Reading, studying a fundamental chemistry module participated in this research. Each concept that was investigated is represented in two types of questions: conceptual and algorithmic questions. By comparing students' answers to both types of questions, students' HOTS are revealed. This study shows that students' HOTS are not as well developed. In some HOTS questions, only a small number of students gave analytical answers. It seems that students are not familiar with questions that demand critical thinking skills to be solved.

### **International Group Work for Sustainable Development**

*Katherine Haxton and Richard Darton*

Sustainable Development and Global Citizenship are inextricably linked yet often fragmented throughout undergraduate chemistry programmes, with a little bit of content here and there. At Keele we have benefitted from a recent redesign of the curriculum allowing for the creation of a face-to-face Sustainable Chemistry module for our students. Through a teaching agreement with Nanjing Xiaozhuang University in China, the module is also delivered via distance learning to 2<sup>nd</sup> year students who will undertake their 4<sup>th</sup> and final year of study at Keele. This module covers a range of topics centred on chemistry's role in sustainability, including energy, food and water security, global health challenges. It places chemistry in a broader societal, political and cultural context, and brings in much from other scientific disciplines. In 2016, the modules were timed to allow the UK and Chinese students to interact electronically with each other and engage in group work tasks to gain understanding of alternative viewpoints and how sustainability was viewed in the other country. This also provided an opportunity to allow Keele and NXU students to interact prior to the NXU students joining our 3<sup>rd</sup> year in 2017/18 where they will meet our current 1<sup>st</sup> years. Group work is generally viewed as challenging to run but also an authentic and important part of undergraduate education. International group work with cultural, language and other barriers is a particularly daunting prospect but in this poster we will share what we have learned by doing it, and what we would recommend in the future. We will share student feedback from both institutions and make recommendations for how this type of enormously beneficial learning experience can be more widely used, particularly through social media.

### **Assessment feedback in forensic science, a first year undergraduate student and staff perspective**

*Anna J Kirkham*

Assessment feedback plays a key role in the learning cycle, in supporting and monitoring progress. Published literature highlight differing views on which aspects and approaches to feedback make it useful to students. The perception of feedback by students is also addressed as part of the National Student Survey.



The main aims are to investigate perceptions of what constitutes 'good' feedback with first year forensic science undergraduate students, taking an introductory chemistry course. To investigate how the student and staff perceptions align or differ.

Data was collected through questionnaires, a focus group and interviews. Separate questionnaires were used for students and staff, containing a mixture of scale of agreement questions, tick box questions and open discussion questions.

The main themes emerging from the student data were that feedback should be feedforwards to the next assessment and be constructive.

The main themes emerging from the staff data on most valuable aspects were that feedback to students should provide guidance and be individual, with one to one meetings put as valuable but impractical. The main barriers to giving feedback were time and student numbers.

Student and staff perceptions aligned on a number of aspects of feedback that are either useful or unhelpful. Areas where the perceptions differed were around the use of praise, type of comments and amount of comments given.

The data collected will be used to contribute to improvements in the quality of feedback and hence improve student's perceptions of feedback within the module, course and the school.

As the main focus is assignment feedback, not assignment content, the findings could be extrapolated to other subjects and cohorts.

## **PURPLE PENS: ENHANCING ASSESSMENT LITERACY AND FEEDBACK THROUGH STUDENTS WRITING THEIR OWN FEEDBACK**

*David J McGarvey and Laura Hancock*

In Chemistry it is common to employ regular, paper-based assessments (e.g. problem sheets, class tests). In our experience of marking such assessments, we observe many common errors/misconceptions leading to the same feedback being written repeatedly. This time-consuming process is exacerbated by large class sizes, and rapid turnaround times often preclude the provision of rich feedback, which is further compounded by insufficient student engagement with, and internalisation of, the feedback.

The UK Quality Code for Higher Education (B6) articulates indicators of sound practice for effective assessment [1] and advocates engagement of students in self/peer-assessment to develop assessment literacy and understanding of standards [1]. The use of dialogic feedback cycles provides practical examples of such approaches [2].

We have recently trialled a time-saving self-assessment method to enhance assessment literacy and feedback in selected 1<sup>st</sup> year Chemistry assessments. The elements of the approach comprise (i) tutors surveying completed assessments to inform the feedback to be provided (ii) return of the unmarked work together with a purple pen under controlled conditions (iii) interactive tutor-led assessment, during which students mark and write feedback on their own work with the distinctly coloured pen (Figure 1) (iv) collection of the scripts to review marking and (v) return of the work within a subsequent timetabled session.

## Student learning approaches “to and through” a chemistry degree

*Alexandra Tyson and Jacquie Robson*

Facilitating the transition from student to scientific thinker and independent learner is not only important for the science and higher education sector but is vital for producing engaged, informed, employable and responsible participants in society. Successfully helping students to transition to university in the first year is pointless unless students are able to successfully transition through university and emerge the other side as a scientific thinker and employable graduate.<sup>1,2</sup> This project is focused on understanding how chemistry students at Durham University approach their studies both on entry and in the third year, in order to map the transition through the degree.

### References

1. V. Talanquer, H. Sevian, *Chem. Ed. Res. Pract.*, 2014, **15**, 10
2. D. Phillips, *University Chemistry Education*, 2001, **5**, 59

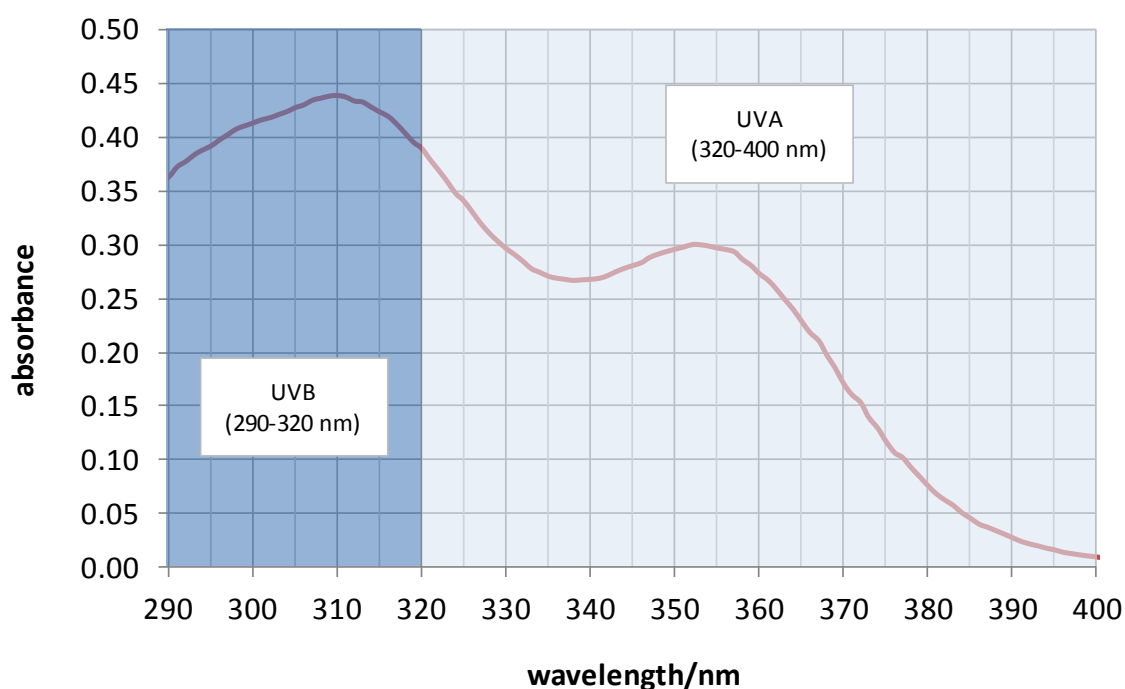
## SUNSCREENS AND UV METRICS: A SKILLS-RICH CONTEXT-BASED UNDERGRADUATE CHEMISTRY PRACTICAL

*David J McGarvey*

The sunscreens industry is global and is an active area of applied research and development [1]. Although there is widespread familiarity with sunscreen terminology, myths and misconceptions persist amongst the public and the media [2]. UV sunscreens are ubiquitous fine-chemicals that provide an authentic and varied context for undergraduate chemistry teaching [3]. In this work a readily adaptable, economical and transferable skills-rich undergraduate chemistry practical based on sunscreens, and which differs significantly in perspective and activities from an earlier published version [3], is described. The practical promotes the development and practice of a range of practical, IT and data-analysis skills (Table 1) alongside learning of the definitions and measurements of sunscreen metrics (SPF, UVA/UVB ratios etc., Figure 1) through the use of an industry tool, the BASF sunscreen simulator [4]. Students work with leading UV-filter ingredients as well as off-the-shelf high-street products.

<p><b>Practical Skills:</b></p> <ul style="list-style-type: none"> <li>✓ Serial dilutions, volumetric glassware, micropipettes</li> <li>✓ UV-VIS spectrophotometry</li> </ul>	<p><b>IT Skills:</b></p> <ul style="list-style-type: none"> <li>✓ Plotting linear graphs and UV spectra in Excel</li> <li>✓ Estimating UVA/UVB ratios from UV spectra in Excel</li> </ul>
<p><b>Mathematical Skills:</b></p> <ul style="list-style-type: none"> <li>✓ Interconversion of %(w/v) and molarity, back-calculations.</li> <li>✓ Simultaneous equations: to determine UV-filter concentrations in a high-street product from UV spectral data.</li> </ul>	<p><b>BASF Sunscreen Simulator:</b></p> <ul style="list-style-type: none"> <li>✓ Estimation of SPF and UVA metrics based on the students' measured sunscreen concentrations</li> <li>✓ Variations between global regions.</li> </ul>

Table 1. Summary of the range of learning activities students are exposed to.



**Figure 1.** UV absorption spectrum of a diluted (>10,000 fold) solution of an off-the-shelf sunscreen (SPF 20, UVA \*\*\* (Boots Star Rating)).

Full details of the practical will be described alongside examples of student data and feedback.

1. Osterwalder U, Sohn M and Herzog B (2014), Global State of Sunscreens. *Photodermatol. Photoimmunol. Photomed.* 30, 62-80.
2. Osterwalder U, and Herzog B (2009), Sun protection factors: worldwide confusion. *British Journal of Dermatology*, 161, 13-24.
3. McGarvey, D J, Investigating Commercial Sunscreens (2007), *Education in Chemistry*, 44 (4).
4. BASF Sunscreen Simulator (<http://www.personal-care.basf.com/europe/by-market-segment/sun-care/basf-sunscreen-simulator> accessed 19<sup>th</sup> June 2016).

### Designing an Experimental Design Simulated Lab: a Framework and Exemplar

Chaiyakorn Srisakvarakul, Dr. Kathleen Quinlan, Dr. David Harris

In research, data credibility is largely determined by experimental design. Unfortunately due to time/cash limitation, undergraduate laboratory practicals are often linear and protocol-driven which are ill-suited for students to practice designing experiments. A promising substitute is the use of experimental design simulation (EDS) software which creates a virtual laboratory for students to plan and test their experimental design strategies. However, current biochemistry education literature lacks both examples and a framework for effective EDS production.

Here we devised a novel framework for designing and evaluating EDS, based on existing evidence on pedagogy and e-learning, and present a proof-of-concept prototype (<https://learntech.imsu.ox.ac.uk/SPR/>). For students to engage in learning, an EDS must be technologically robust with good usability, and students must also be motivated to learn. Additionally, the instructional medium should trigger experimental design decision making processes. This requires five core features, including (1) a mathematical simulation of the experimental instrument that can calculate output data given user input, (2) a data display that Variety in Chemistry Education Physics Higher Education Conference 2016 supports further data manipulation, (3) a control panel providing students with all possible options of action within an experiment, (4) a random answer generator with range covering all feasible values the answer could theoretically adopt, and (5) a simulation of actual experimental conditions (e.g. limited resources, stochastic errors added onto the results).

This framework was applied to create a surface plasmon resonance EDS for second year Oxford biochemistry undergraduates. At present, a stable version of the core features has been achieved and rigorously tested technologically and for usability. Next, the EDS will be used to measure students' performance on a set of specific experimental design skills (e.g. performing three replicates per sample, using a broad sampling strategy) which are logged within the software.

### **Understanding Misconceptions – Exploring A Dual Processing Theory Approach**

*Anna K Wood, Ross K Galloway, Judy Hardy*

Physics and Chemistry students are known to have intuitive ideas (often called misconceptions) about the world which are at odds with the canonical scientific description. There is disagreement in the literature about whether or not misconceptions hinder the learning of science. Understanding the role that misconceptions play is therefore important as it affects the teaching approaches used.

Here we present evidence that Dual Processing Theory may be helpful for thinking about misconceptions. Dual processing theory refers to a collection of models in cognitive psychology which describe two systems of thinking: system 1 which involves intuitive and non-reflective thinking, and system 2 which is more deliberate and requires conscious effort and thought. The tendency for someone to override system 1 thinking and to engage in reflective, system 2 thinking can be measured using a three item test called the Cognitive Reflection Test (CRT). Each item on the CRT has an intuitive (but wrong) answer which must be rejected in order to answer the item correctly. We therefore hypothesised that performance on the CRT may involve similar cognitive processes to answering the Force Concept Inventory (FCI), a commonly used multiple choice test which measures understanding of Newtonian Mechanics, and which includes distracters known to correspond to students' intuitive ideas (misconceptions). We gave both the CRT and the FCI to 148 first year physics students at the University of Edinburgh and found that students who scored more highly on the CRT also did

better on the FCI. We also found, however, that the normalised gain on the FCI was independent of CRT score. The implications will be discussed.

### **Post-16 & Early Years Undergraduate Learning & Teaching Activities Using Web-Based Worldwide Research Resources**

*Peter Hoare*

We have collaborated with several worldwide research organisations to develop web-based interactive learning resources for chemistry.

This poster will outline the features and activities available for each of these free resources which introduce key chemistry concepts:

1. Cambridge Crystallographic Data Centre, UK (CCDC) - learning exercises using real 3D crystal structures;
2. Protein Data Bank in Europe, UK (PDBe) - learning resources for basic protein structure and function;
3. WebMO, US - with this user-friendly browser-based interface, perform simple computational calculations linked to basic chemistry concepts.

Supervised by a former secondary school chemistry teacher with over 20 years experience, now working in a UK University, these exercises have wide applicability and were all peer-produced by either Nuffield Foundation Research Placement students (yr12 secondary school) or stage 4 MChem project students in the School of Chemistry at Newcastle University.

### **A technology-enhanced advanced practical**

*Simon Coles*

Increasing undergraduate numbers are putting considerable pressure on the ability of an average-sized department to provide a research-led experience for latter stage undergraduates. Accordingly, we have developed a module comprising a series of 'advanced practicals' – these are small group exercises more akin to a research experience than the teaching laboratory.

One of these practicals provides hands-on, instrument-based experience of advanced characterization techniques, centered around the concept of solid-state polymorphism. This requires a detailed knowledge of molecular and crystal structure gained by advanced analytical techniques normally considered as the preserve of a research facility. Glycine is the material studied, as two different polymorphs are readily grown in the laboratory in the timeframe of the practical. Powder and single crystal diffraction techniques are primarily required and implemented via the unique approach of the students themselves using benchtop instruments dedicated to teaching, as opposed to more complex and difficult to access research instruments. Students are also required to conduct complementary analyses, such as DSC, IR and hot stage microscopy in order to put the diffraction experiments into context and fully probe the solid state behaviour (which includes a temperature dependent phase transition).

Furthermore, the instructions for performing the practical are delivered via an adapted Electronic Laboratory Notebook system where, for each specific aspect

of the practical, students note their intentions, actions, observations, and inferences. Assessors can access the notebooks and provide targeted online feedback for each individual section. Evaluation of the approach (J. Chem. Educ, 2016, 93, 131-140) is based on interviews and surveys with the first 65 students that performed the practical.

### **Holistic development of L6 laboratory module**

*Helen Coulshed*

Research methods is a yearlong 30 credit module that runs in the third year of the chemistry and chemistry with biomedicine courses (BSc and MSci). In 2016/17 will be the third time this lab based course has run at King's. The main aim of the course is for students to gain necessary practical experience to prepare them for their 9 month individual 4<sup>th</sup> year research projects.<sup>1</sup>

25% of students do not intend to stay on for the 4<sup>th</sup> year, many choosing to leave chemistry altogether. This course needs to cater for their needs as well as those intending to stay for the MSci. I will be talking about the use of reflective questionnaires that encourage students to identify skills associated with group work as well as self-assess their contributions.<sup>2</sup> I will discuss the use of competency based questions, and whether peer-assessment can be used successfully.

1 C. McDonnell, C. O'Connor and M. K. Seery, *Chemistry Education Research and Practice; Chem.Educ.Res.Pract.*, 2007, **8**, 130-139.

2 D. Taylor, A. L. Rogers and W. R. Veal, *J. Chem. Educ.*, 2009; 2009, **86**, 393.

### **Collaborative Transnational Degrees –Interested?**

*Julie Hyde, Jamie Wright, Elizabeth Page, Philippa Cranwell, Katherine Haxton, Gita Sedghi, Daniela Plana*

Sheffield, Reading, Liverpool and Keele are all offering joint chemistry degrees with China. Typically the UK degree is delivered at the Chinese University in part, then completed in the UK where the students graduate not with one but two degrees, one from the Chinese and the other from the UK institution.

This type of degree is gaining popularity with Chinese students who believe the opportunity of obtaining a UK degree is valuable for their future career pathway. Initially students need to gain a good command of English and improve throughout the degree to ensure they have a good understanding of the subject matter. Not only must they be able to read and write, it is necessary for these students to be able to communicate well. This type of degree is clearly a challenge and they must achieve the required chemistry and English standards before they can travel to the UK to complete their degrees.

During this joint presentation, each University will speak about their own programme and the challenges they have had or are having through the delivery and their plans for the future.

We have a group of us who meet to share ideas and support each other. There are differences in setting up a degree with a foreign country but if these are known at the start of the process, together with possible problems it will be easier for other

universities to set up joint degrees for their own courses. We would welcome to hear from our physics colleagues who would be interested in sharing experiences.

**Hands on marking or electronic submission of pre-labs. Was using moodle helpful in the delivery of pre-labs to the Chinese Students?**

*Julie Hyde and Jamie Wright*

This talk will focus on trailing pre-labs electronically for Chinese students at NJTech in China. The marking of pre-labs is a demanding resource but we all value the opportunity to give feedback to our students. For the NJTech students the added need for them to practice writing their answers in English is also important. Marking or electronic submission, which to choose? Both year 1 and year 2 NJTech students carry out 6 practicals during the academic year in China resulting in 600 hundred scripts on the horizon to mark, a new way of delivery needs to be considered and that is only the pre-labs! What a dilemma, the opportunity to write the answers had always been a significant draw in the early days of the programme but with an increase in student numbers this style of delivery was reviewed and electronic pre-labs needed to be trialled. Based on the original paper scripts and we were keen that the pre-labs should not just be multichoice the planning was carried out, but the setting up would take some time. And how can we ensure the students still write their answers? Was it a success, how easy was it to translate the paper questions based to electronic questions, was multichoice the answer? Did the students feel the value of the new methodology? Will this delivery continue? Evidence based research will help decide on the next step.

**'Engaging Physics' – reflections of a pilot module to enhance student communication and employability skills**

*Wendy Sadler*

Cardiff University School of Physics and Astronomy has a long history of outreach and engagement activity including an award winning spin-out company (science made simple) specialising in outreach. Last year the Director of this company was appointed as a lecturer and she developed a new module called 'Engaging Physics'. The course aimed to introduce 1<sup>st</sup> and 2<sup>nd</sup> year physics and astrophysics students to a range of skills required for engaging a wider public with the physical sciences. Students got involved in creating pieces for radio, writing popular magazine articles and creating and pitching a mock grant bid for IOP Public Engagement funding. This session will outline the innovative content and learning outcomes of the module and discuss the feedback received from students on the course. It is hoped that the course will eventually be rolled out to all the seven schools of the College of Physical Sciences and Engineering and we are keen to share experiences with other Schools who may run (or be considering running) similar courses. We will reveal the mistakes that were made as well as the successes and skills gained according to the students on the course.

## **Alternative Assessments and Real-World Science**

*Alison Voice*

This presentation gives an overview and practical details of final year assignments designed to engage students in applying their knowledge to real-world situations, in preparation for their life after graduation. This includes writing a Press Release, pitching ideas for funding in writing and video, and attacking open-ended real problems. The activities involve a wide variety of skills including teamwork, communication to lay and expert, peer assessment and shortlisting.

The talk will showcase the activities, the way they are introduced to students, the marking criteria used, and examples of student work. With increasing focus on graduate employment, learning outcomes and alternative assessments it is hoped this will spark discussion and sharing of ideas.

## **Student Perceptions of Transferable Skills Development – Initial Findings**

*Dylan P. Williams & Sandeep Handa*

This Leicester based study is a follow up to the Higher Education Academy study on transferable skills required by chemistry graduates.<sup>1</sup> The main research question posed was ‘Does the importance that chemistry undergraduates place on transferable skills change during the course of an undergraduate chemistry degree?’. The key aim of this project is to collect an evidence base which measures the impact of different teaching approaches on student attitudes towards these skills.

This presentation will present the findings of the first year of research which includes a discussion of questionnaire responses from students in years one to three (169 responses) as well as the findings of a related side-project which focuses specifically on the impact of Context and Problem Based Learning (C/PBL) activities on student confidence levels in key transferable skills (119 responses). The presentation will also include an overview of how the project will be expanded in the 2016/17 academic year.

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.

## **Does the laboratory have a place**

*Thomas Wilson*

Advances in pedagogy and technology are driving international change in educational practice. Most changes have focused on lectures and lessons, e.g. flipped delivery (Seery, 2015), question-based learning, and increased engagement (Freeman et al., 2013).

Less attention has been paid the teaching laboratory, a core component of chemistry education since the 1800s (Blick, 1955), and one which presently demands considerable time and financial resources at many institutes worldwide (Reid & Shah, 2007). The laboratory has been endorsed as a “vital part of science education” (HCSTC, 2002; para 40) by government, and researchers share a similar view (Grant & Jenkins, 2011; Taber, 2015).



However, in practice, the laboratory may not affect students' conceptual and attitudinal developments as educators desire or expect (Abraham, 2011). Students themselves may also be unaware of how the laboratory impacts their conceptual, attitudinal, and motor development (Galloway & Bretz, 2015). At least in part this shortcoming is due to instructional design and delivery. Laboratory materials often resemble a "cookbook, in nature" (Domin, 1999, p.109), where students simply follow a procedure, not on understanding the rationale or mechanisms.

This talk will discuss results from recent mixed-methods research at the University of Southampton on the role of the laboratory in introductory and undergraduate chemistry. Results suggest students did not perceive the laboratory to contribute to their chemical studies to the extent, or in the same way, as other components, e.g. lectures. Some students even perceive the laboratory to detriment their other studies.

This research has led to the development of Labdog , a novel web-based software designed to promote conceptual development in the lab. The design principles of Labdog, in relation to both literature- and empirical-findings, form the basis for a discussion on the presently prolific shortcomings of the laboratory and how these can begin to be addressed.

[1 http://edtechandchem.ghost.io/introducing-labdog/](http://edtechandchem.ghost.io/introducing-labdog/)

[1 http://www.labdog.co.uk](http://www.labdog.co.uk)

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