REFLECTIONS

Queen's University Belfast

Centre for Educational Development

June 2017

We are exceptional

To Boldly Go: innovative teaching in Engineering and Physical Sciences

By Professor Ian Williams, Dean of Education, Faculty of Engineering and Physical Sciences

Professor Ian Williams

It's probably fair to say that academia has not always enjoyed a reputation for innovation and speed of change. In fact I'm not sure that even today it's considered acceptable to split an infinitive. But acceptable or not, when it comes to innovation we can all surely draw inspiration from the iconic Star Trek's 'to boldly go'.

As the Dean of Education in the Faculty of Engineering and Physical Sciences (EPS) life, for the most part, can seem to revolve around endless policies, strategies and implementations. It is thus with delight that I look forward to the monthly EPS Innovation in Teaching (IiT) Group meetings, initiated by myself and Cathy Craig, Dean of Postgraduates, at the beginning of the current academic year. We are fortunate to have a group of enthusiastic, mostly young, academics with a passion for innovation and a goal to revolutionise the student learning experience. They are already doing wonderful things in their own teaching, and through the IiT Group are spreading these ideas across the Faculty. In addition, the cross fertilization of ideas is leading to new and exciting directions of travel.

It was at the end of one of our IiT meetings that Karen Fraser from the Centre for Educational Development turned to me and said, "This is great! We've got to get some of these wonderful initiatives into the next issue of Reflections." I think that even Karen was overwhelmed by the response, and it quickly became clear that we were looking at a whole edition dedicated to the Faculty developments.

The contributions to this issue split fairly equally into categories which can be classified under three of the key strands of our University's Education Strategy 2016-21. These are dynamic and relevant curriculum and assessment; employability, enterprise and global citizenship; and innovative and flexible delivery. Under the former we have a number of articles that articulate the Faculty's belief in and commitment to project-based learning. The opportunity for students to learn through hands-on application of theory to challenging problems is fundamental to our Engineering ethos, and of course equally valuable and valued in the Science disciplines. Indeed, as some universities at the pinnacle of international league tables set out to offer degrees by Distance Learning, it will be these projects, led by academics who are internationally renowned in their fields of research, which will primarily give our students a unique learning experience on the Queen's campus. And as we move forward there will be more and more emphasis on multidisciplinary project work that addresses the grand challenges of our age – but more of this later.

The Faculty has long championed the embedding of employability and enterprise in degree programmes, pioneering the degree with professional study. Computer Science, for instance, with an intake of about four hundred students per year, is now in a position where virtually all students participate in the year out in industry, with some even choosing to do this as an entrepreneurial activity by setting up their own company. Integral to this approach has been the employability and entrepreneurial skills provision afforded to students during their first two years of study in preparation for engagement with the work placement. This has enjoyed excellent support from the Queen's Careers, Employability and Skills Team, and the range of placement opportunities across a broad range of industries has been enabled by the strong links that the Schools have with employers. Work placement opportunities are available to all Engineering students and to most in the Science disciplines. The Faculty aims to have this option available in all subject areas by 2018-19.

While it may be said that project-based learning and the focus on employability are existing strengths within EPS, the drive towards inclusive use of digital learning is very much an ongoing and developing effort. This is a topic of much current discussion within the IiT Group and elsewhere in the Faculty, an area where there is clearly enormous scope for enhancing the teaching and learning provision, with activities which, from the next academic year, will be supported

by the commissioning of a new virtual learning environment, or VLE. The new VLE forms part of the digital learning initiative underway within Queen's, an initiative that has been well articulated by the Pro-Vice-Chancellor for Education and Students, Professor David Jones, in the June 2016 issue of Reflections.

There is, of course, a well-established history within EPS of using digital technology, with most degree programmes offering students the opportunity to learn a programming language and/or to learn how to use engineering, scientific or statistics packages. In addition to this, we now look forward to the new opportunities becoming accessible through the use of digital technology in teaching and learning, enhanced by the availability of the new VLE. With the right level of support we can anticipate being able to prepare multi-media content that will revolutionise how information is made available to our students. This broader use of technology has enormous potential, and will play a key role in the Faculty's plans to further enrich the whole student learning experience.

Supporting these developments will be two academies, one in software and one in mathematics; themes that not only underpin our academic disciplines in EPS, but whose skills are so sought after by the graduate employers of today. The first course in the Faculty to fully embed the ethos of blended learning will be initiated in 2017-18 under the auspices of the Software Academy. This will be a part-time Masters degree in Software Engineering. All course material will be available online so that students, in their own time and at their own pace, can prepare for the contact sessions which will be laboratory-based. In these sessions, students will learn through real-life applications involving hands-on coding and problem solving activities.

The Mathematics Academy will provide an umbrella for the teaching and learning of mathematics and statistics, as well as an enhancement of employer engagement and outreach to the broader community. Here, also, there will be opportunities to harness blended learning techniques, for example with digital delivery of common mathematical methods being supported by discipline-specific problem solving and tutorial sessions in the classroom.

In all of this the functionality of teaching and learning spaces available within our University will be paramount. It is going to be of utmost importance to develop appropriately located flexible teaching spaces, with the high-level infrastructure necessary to support students bringing their own digital devices, and where a variety of teaching methods can be employed. Similarly for flexible study spaces, where students can develop at their own pace, working alone or in groups, in spaces where they feel they have ownership.

And looking further into the future, the Faculty's vision is looking towards a flagship project, tentatively entitled D-cubed. The D-cubed stands for Dream, Design and Deliver, and the vision is of a large working space for students and staff, where teaching, learning and research will combine in multidisciplinary project work driven by grand challenges. This may still be some way off, and there will undoubtedly be hurdles to be overcome on the way, but within EPS there is a burning desire to make it happen. The IiT group is an exemplar, a group of innovators who have impressed me so much by their leadership, who not only dream of doing things differently, but make it happen. To boldly go….

POP–reflections: embedding outreach and science communication into a project module

By Fred Currell, School of Maths and Physics, and Paul McCrory, Learn Differently

We started working together in 2008 on an EPSRC public engagement project 'Radiation and Us – Visualising the Invisible', with Paul as Fred's project mentor and Fred as the project Principal Investigator (PI). We both felt the science demonstration shows developed by final-year students were the project highlight in many ways, despite them being only a minor component in a project centred on interactive computer simulations (some still running in W5). Reflecting on the low cost of these compared to other parts of the project, the level of student engagement and the benefits for a wide range of stakeholders, POP was born.

What is *POP*? *POP* stands for Physics Outreach Projects. Essentially, they are science communication projects undertaken by final year undergraduate physicists (BSc stream), usually in pairs, with the culmination being performances of 15-minute demonstration shows in local schools. These projects are embedded as an elective component within our final year project module with the *POP* component counting for 20 CATS points at level 3 – essentially students pick *POP* and one traditional lab project, or two traditional lab projects.

We think there could be a lot of scope for running similar projects elsewhere in the University – for example, could Biologists, Chemists, Mathematicians develop BOP, COP, MOP? We've assembled some tips from our experience as we've honed these projects over the years. If you think you'd like to give something like this a go, these should form a good starting place.

Training

- Start with an intensive mini-course on how to deliver science demonstration shows. We do this together in week 3, using typically 20 contact hours.
- Have the students develop and present projects in pairs. This gives them someone to bounce ideas off, it is easier for two to 'fill a stage' and they can provide cover for each other in case of forgotten lines.
- The material is highly interactive and taught in small groups - 6 or 8 seems optimum.
- Get each pair to present a demo to the rest of the group - focus on and discuss presentation style as much as content.
- At the beginning of this training, emphasise this is not a Physics-lite project (substitute your own subject here). The performers will be expected to demonstrate in their written reports a knowledge of their subject in the areas of the show at their own level.
- Give the pairs of students ownership of selection of the topic within certain boundaries. We usually place constraints that it must draw from elements on the A- or AS- physics syllabus and ideally also relate to research in Queen's. Otherwise it is pretty open house. You might even allow pairs to form through negotiation and alignment of project interest.
- By the end of the intense training period the students should be in clearly defined pairs with agreed show themes for each pair. Of course, things can evolve somewhat as the shows are developed.

Show development

- After the intense training, meet as a full group at least once per week. Throughout the following weeks, the pairs should form and develop 4 to 5 demonstrations each, which they should present to the rest of the group as the shows develop. Encourage supportive sharing of ideas in these sessions.
- The show topic can be a clear part of the subject (e.g. Physics of Lasers) or something more synoptic in nature – last year we had Physics of the Circus and Physics of Superheroes.
- Target audience is ideally 16-18 year-olds in local schools taking a relevant subject.
- Encourage the students to use everyday objects for the majority of the demos. This gives the audience something they relate to directly. Of course, it is nice to have the odd demo that draws on the bigger resources of the University, but don't overdo it.
- Earmark a small props budget (£100/pair is more than sufficient) for them to purchase props. Make them aware of University purchasing regulations and get them to buy early (certainly 4 weeks ahead of performance).
- You and the students need to consider risk assessments. Get the students to draft these early on and redraft as their show plans develop. They should consider volunteers' reactions in doing this. Some demos aren't suitable for volunteers after all. Also remember, perceived risk in a demo is fine, significant real risk isn't – you need to be the guardian of the process here. A lot of this comes down to presentation style.
- Find some kind of umbrella theme for the shows and collectively develop a brand for the shows. For example, we have seen "A Physicists Tale, There and Back Again" which started with the underpinning science of light, waves etc, with the final show covering space exploration.

Organising the school visits

- Perform the shows in local schools just ahead of Christmas (week 11 or 12). We originally bussed students

into QUB, but the feedback was that it was hard to get staff cover. Just before Christmas works much better for schools than in the second semester, when they are very exam-focussed. Also, there is a nice pre-Christmas buzz in the schools.

- If possible (and only with the consent of all student performers who went to that school) try to pick schools which some of the performers went to. This provides an existing relationship and a helpful point of reference for the audience.
- Community tasks: get each pair to take on a community task, i.e. something they do for the whole group and award some marks for doing this. Possible tasks include producing T-shirts for all the performers, flyers/posters to be sent to the schools in advance (these activities give the shows a strong collective identity relating to the brand), developing evaluations of the shows and communicating with the schools.
- Block out the whole day for the performance. Travel to the venue as a group, typically with props in a hired van. Allow at least 1 hour for set up.
- Instruct the performers that they should never be alone in the schools, always with another member of the performance team and to always use the staff toilet. You should do the same of course.
- There can be a tension between school teachers' expectations of the audience and the desire of performers to affect the audience behaviour. The teachers often want their class to appear well behaved and orderly in front of the visitors from Queen's, whilst your team want to get 'oos' and 'ahhs' and other demonstrative reactions. It usually helps to brief the teachers beforehand that the goal is to get the audience involved and this is something you are hoping for.

Live shows

- Get the students to develop little busking demos to be used before the shows. They can use these to meet/greet the audience and ask who wants to volunteer to help with demonstrations later onstage. Always get the first couple of volunteers lined up like this in advance, focussing on getting the alpha audience members on your side.
- Nobody *has* to listen to them. The students' first responsibility is to engage the attention of their audiences. Without this, no other potential outcomes can be achieved eg stimulating curiosity; developing interest; communicating concepts; changing attitudes; etc.
- The shows should as interactive as possible. Stress the importance of the respectful use of volunteers. The performers should always "make the volunteers heroes". After all, these people have become the surrogate eyes of the rest of the audience.
- Encourage minimal or no use of PowerPoint. You don't want them to produce a video show - they will always lose to YouTube. The interaction and live demonstrations are the most engaging parts of the shows. PowerPoint might be used to explain something about a demo or to show a short video of something key but not realisable as a demo (e.g. floating in space).
- Build some post-show interaction with the pupils into your performance timetable. This can be one of the highlights. The pupils like to see the demos close up and soon the discussions turn to life at Queen's – they'll ask the students things they'd never ask you or me.
- Encourage some sort of evaluation of the shows' engagement, but avoid the pitfall of the evaluation process taking the fun out of the show. One mechanism we have found effective is to ask the audience questions with their responses being indicated by the audience members holding up one from two or three coloured cards (placed on their seats in advance). A quick photo taken from the back of the audience can then provide some basic numbers for simple evaluation. Students might try to overanalyse these results, so remind them this isn't the kind of data they are used to.

Assessment

- Have the students perform a dress rehearsal about a week ahead of the shows. Use the performance in this rehearsal as one of your marking components. And give the students prompt and honest feedback.
- Have a policy that improvements in the live performances can only take the dress-rehearsal marks up, not down. This both motivates and relaxes the students when they are already somewhat stressed.
- Build the idea of assessed project write-ups into the process and discuss it right from the beginning. This will not be a standard lab write-up, but insist that each student writes up some of the underlying science at their level, not that of the audience, and emphasise that this aspect will be assessed. This approach is your main mechanism to ensure the students doing this module don't think it is subject-lite.

We've found producing POP immensely rewarding and students often observe that they ended up spending much more time voluntarily on this project than with traditional modules. For example, we've even known one participant build a person-sized hovercraft as part of one of these projects! The impact on their communication and self-management skills can be considerable. We heartily suggest you think of adding something similar in your course. We'd be happy to discuss the approach further if you are thinking about doing it.

Please contact **f.j.currell@qub.ac.uk** or **paul@learn-differently.com** for further details.

A section of the audience voting. In this case, the performers prepared and distributed cartoon likenesses of themselves and the audience voted who they agreed with by showing the appropriate likeness.

Psychology and Employability: Past, Present and Future

By Dr Susan O'Neill, Psychology

Background

Dr Susan O'Neill

An increased focus on student employability has been prompted through the publication of a number of key reports (Department for Employment and Learning Northern Ireland, 2011; DfES, 2003; Leitch, 2006). These reports have stressed that the UK's future economic growth and its ability to remain competitive in a global economy is dependent upon increasing the numbers of highly skilled graduates. As part of these reviews, and also identified in research by Knight (2004), employers highlighted that they value the generic skills of team working, problem solving, oral and written communication, creative thinking, planning and organising, being able to work independently, managing projects, leadership, an appreciation of ethical practices and an awareness of the business context. However, they reported that many graduates lacked these generic competences. As a result, higher education institutions have sought to introduce employability into the curriculum and to provide opportunities for their students to gain work experience.

Psychology and Employability

To provide some context, a psychology degree is now the third largest subject at undergraduate degree level in the UK, with numbers increasing significantly over the last number of years from 37,584 students registered in 1998/99 (Trapp, Banister, Ellis, Latto, Miell & Upton, 2011), increasing to over 100,000 in 2014. While its popularity has grown, a psychology undergraduate degree is not a vocational degree in terms of entering a specific profession or career immediately after graduating. To progress to a professional psychology career such as a clinical or educational psychologist, further study is required. However, it appears that only 20% of graduates enter these 'traditional' psychology professions (Lantz, 2011). The remaining graduates can be found in other related fields or areas such as banking, finance, insurance, education, health, social work, advertising, marketing, human resources, research and development (Coulthard, 2014).

Similarly to employers reports, many psychology graduates reported that they did not feel adequately prepared for the world of work. In a recent British Psychological Society's Careers Destination Report (Coulthard, 2014), while many graduates saw a significant value in their psychology degree, they were critical that their course did not actively prepare them for employment. More specifically, they reported that they were unable to make the link between the generic skills they were developing as part of their undergraduate degree and how these may be applied in the context of work. This led Akhurst (2005) to argue that the core generic competencies being developed throughout a psychology undergraduate degree needed to be made explicit so that students are more clearly aware of what they are and how they are being developed. In response to these findings, the BPS recommended that psychology degrees 'incorporate more generic practical employment skills modules to the third year of degree courses to better prepare graduates for work' (Coulthard, 2014, p.11).

Employability challenges for School of Psychology

In 2012, the School identified a number of problems when examining undergraduates' opinions on future employability:

- Students over-estimate the likelihood that they will end up working as a psychologist (as identified earlier, only 20% go on to 'traditional' careers in psychology);
- Most do not begin to prepare early enough for postgraduate employment.

From the literature and responses from our students, a number of challenges were evident. Firstly, students needed to be encouraged to consider their employability much earlier than they do. Secondly, it was evident that they needed to be encouraged to consider a much broader range of careers. Thirdly, opportunities needed to be provided to enable students to become explicitly aware of the range of generic, as well as subject specific, skills they were developing throughout their course. Fourthly, opportunities for work experience where students would have the opportunity to practise their skills and develop their psychological knowledge were needed. This challenge culminated in the creation of an employability programme that encompasses the three years of undergraduate study, developed by staff at the School in association with two occupational psychologists employed as outside consultants.

School of Psychology's Employability Programme

First year students are given a series of lectures and career talks that briefly introduces them to the notion of employability beyond their degree and to a variety of careers open to psychology graduates.

In second year, students complete a taught employability module which helps them to examine their vocational interests, analyse their strengths and development areas through activities that encourage self-reflection on the range of skills they are developing as part of their degree. A series of lectures and lab classes are delivered that help students understand key considerations in career selection through the application of various theories, to understand their own role in managing their career, to improve their understanding of motivation in the workplace by introducing them to a number of relevant theories, and to look at good practice in goal setting based on psychological models. In addition, students are presented with lectures that aim to familiarise them with aptitude tests, assessment centres, interviews, and other selection techniques used by many organisations. As part of this module, students are required to select a graduate job outside of the psychology profession that interests them and which they feel provides a potential match with their interests, knowledge and skills. They then develop an action plan to help them close any identified skills gaps and work towards obtaining the type of job they have selected as being of interest to them. An employability portfolio is completed and assessed at the end of the module.

In third year, students have the opportunity to apply for an optional work-based module (the Insight Programme) which allows them to work with a graduate employer for 15-20 days. Wrennal and Forbes (2002) had noted that finding placements for psychology undergraduates is more challenging than in other disciplines:

It is difficult to place unqualified students in work positions needing professional qualification and expertise and even 'shadowing' professional psychologists is extremely difficult because of ethical problems and client confidentiality.

However, the Insight Placement module was able to successfully provide work placements for our students within a wide range of organisations through focusing on the transferable skills that can be used rather than the application of psychological knowledge. The module is assessed by creation of a portfolio, reflective diary, and a poster presentation. In order to include an element of application of psychological knowledge, the students must identify and write about opportunities to *potentially* apply psychology in the context of the placement organisation in the portfolio.

The Insight Programme has proved extremely successful and the number of student placements has increased from 19 in 2012/2013 to 52 in 2016/2017 across 43 organisations from the private, public and third sectors. The growing success of the Insight Programme is a testament to the benefits a psychology undergraduate student can bring to an organisation in terms of skills, knowledge, ideas and enthusiasm. In return for offering the opportunity of work experience, a student undertakes a project for the organisation that gives them the opportunity to apply many of the skills developed during their degree. These have included evaluation of a new service, designing customer feedback survey, identifying gaps in resources, creating new webinars for service users, and leading employee satisfaction surveys, to name but a few.

Feedback from students

"The time I had available (on placement) has allowed me to not only gain skills that will be incredibly useful in applying for future employment but to become more confident in my understanding and application of psychological theory as well as becoming more aware of how diverse the jobs for psychology graduates can be."

"During my placement, I was able to apply many of the skills I have acquired from psychology, including, ICT, research and analytic skills. Other relevant skills included communication and interpersonal skills within the office and the community, as well as creative thinking abilities, developing new and innovative ideas for the organisation's logo design."

"On the whole, I would recommend the placement to any student looking to improve their employability skills as well as gain experience and a greater understanding of their own strengths and weaknesses in psychology and in the work place."

In response to the increasing success of the Insight Placement Programme, which has received a commendation from the British Psychological Society, the School has introduced a new pathway for psychology students: a BSc Hons Psychology with Professional Placement. This is a four year programme that will allow students to undertake a 12 month paid work placement between their second and final year. The introduction of the new pathway is evidence of the School's continued commitment to ensuring our students are adequately prepared to begin working towards successful future careers.

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Psychology Insight Programme Student Poster Presentations

By Dr Katrin Dudgeon, School of Psychology

The final poster presentation session of the Psychology Insight Programme Placement Module for L3 Psychology students took place on 14th December 2016 in Riddel Hall. The poster presentations allowed our students to showcase their work whilst on placement. We had great projects and a wide variety of organisations from the private sector, public sector and community sector taking part in the Insight Programme last year. It was a wonderful opportunity to learn more about how Psychology can be applied in the workplace.

Our students' work had a real impact, for example:

Amy Burns was placed with the QUB Wellbeing Service. Amy contributed to the Resilience And Wellbeing (RAW) Project. She provided detailed information on mental health issues relevant to the student population, which formed the basis of the newly designed website of the QUB Wellbeing Service.

Claire Acheson was placed with the Child Brain Injury Trust, a charity that provides non-medical support to families in the UK affected by child brain injury. Following the review of existing resources, Claire identified what was reported by her mentor to be a very significant area for development: the impact of acquired brain injury on the whole family (siblings and parents). Claire then created a Webinar, based on UK research information, which has since been adopted by Child Brain Injury Trust.

Bronagh Stewart's placement involved working with both Guide Dogs NI and Diabetes UK to examine the impact on well-being among people who have been diagnosed with diabetes and who also have sight loss. The subsequent report written by Bronagh has been submitted for inclusion in the upcoming Vision 20/20 conference. Diabetes UK is planning to present the results of the study at their own conference and will be undertaking changes at an operational level as a result of the findings.

Well done to all our students that went out on placement!

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The Psychology Insight Programme Placement Cohort 2016

Creating a Dialogue-Based Tutorial in Questionmark

By Dr Ian O'Neill, Electronics, Electrical Engineering and Computer Science

"Very large numbers of students on key pathways," "restructured Academic Year," "more year-long modules," - just a few of the developments at Queen's that encouraged this lecturer to see if assessment technology might be used inventively to enhance the student (and lecturer) experience in a challenging academic environment.

My aim was to re-create in software, in a simplified form, the kind of person-to-person, question-and-answer exchanges that characterise tutorials in small groups. In this case, the tutorial would be implemented in Questionmark, an assessment package that is familiar to staff and students at Queen's, and a proven means of evaluating work and providing feedback.

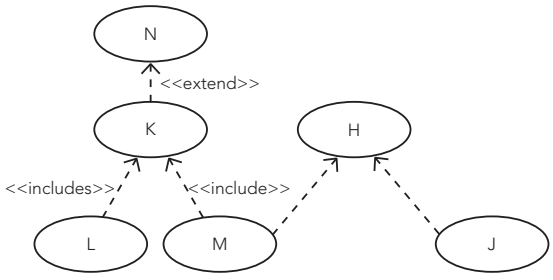
With its bias towards structured, text-based interaction, Questionmark leads to a tightly constrained dialogue, but dialogue nonetheless. It enables tutors to compose, with relative ease, sets of written questions and possible answers. The tutor can also build feedback into the system, comments that are displayed whenever the student chooses an answer, or a combination of answers.

Questionmark can make especially good use of the pattern of ticks that result from an open-ended 'multiple response question' ("What can you tell me about this diagram?"), where the student is allowed to select freely from a generous selection of correct and incorrect answers. Just as an experienced tutor would do, the system responds to the pattern, offering tips on what went well – or more importantly, on what went wrong and why, when the pattern of answers is indicative of a common misunderstanding of a concept, technique or terminology. The system can also pose a follow-up question that gives the student the opportunity to try again, or that focusses just on the area of weakness. Of course, all this presupposes that the control logic of the tutorial is correctly authored and tested, so that the system mimics the behaviour of the experienced tutor: in Questionmark terms, each tutorial is an 'assessment' with subtle, conditional 'Jump Blocks' that take the student, under a particular set of circumstances, to relevant follow-up 'Question Blocks'.

In creating my Questionmark tutorial, I set out to convey the sort of constructive feedback that I would give Level 2 Software Engineering students when they are learning to interpret Use Case Diagrams, a form of UML[1] notation that is used to represent important relationships between sets of requirements for a computer system. Use Case Diagrams require only a small set of symbols. However, having taught and found value in the Use Case approach for several years, I am aware that Use Case Diagrams pose difficulties, some of which arise from the specialised terminology associated with the diagrams, and some from the quite subtle messages conveyed by the different arrow styles and labels in the diagrams themselves.

With the benefit of experience, the tutor can predict and have the system react to such problems when they occur. For example, in the Use Case tutorial, when the students' incorrect answers resulted from a misinterpretation of the symbols of the UML, Questionmark gave them feedback on their overall answer combination, then on each of their answers individually, before asking them to choose from the symbol-related answers again. Once the narrow, symbol-related answers had been mastered, the system would return to the broader question: "What can you tell me about this diagram?"

'Automated tutorials' like this have the advantage that they give students an opportunity to revisit topics whenever it suits them, particularly during those year-long modules. Students can test their grasp of concepts as they are introduced, or during their preparation for formal assessment many months later. It is more than convenient self-service. In the context of large and growing class sizes, a suitable means of automating some of the more routine student-tutor interactions is of benefit to tutors and students alike, freeing tutors' and students' time for face-to-face discussion of more challenging topics, and probably more interesting ones.



A simple use case diagram

The first reactions to the Use Case tutorial were certainly very favourable. As one student on the Software Engineering module put it: "*Brilliant idea – wish there was one [tutorial] for each topic.*" So, a good start, and a challenge to provide more! As technologies for learning evolve – exploiting text, speech, and indeed multiple modes of interaction – we can expect to find many more occasions when computers can usefully play their part as virtual tutors.

Please contact **i.oneill@qub.ac.uk** for further details.

1 See: Booch, Rumbaugh and Jacobson *The Unified Modeling Language [UML] User Guide, 2nd Edition, Pearson, 2005*: and Dennis, Wixom and Tegarden, *Systems Analysis & Design – An Object-Oriented Approach with UML*, 5th Edition, Wiley 2015.

Learning about Engineering Disasters while Enhancing Communication Skills

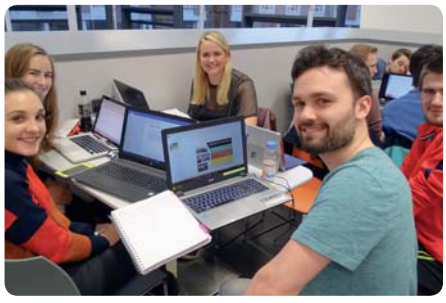
By Dr Debra Phillips, Natural and Built Environment

First and second year Civil Engineering students in the School of Natural and Built Environment at Queen's University of Belfast (QUB) participated in a Disasters and Hazards Exercise on 13-15 December 2016, which was sponsored by Henry Brothers (Magherafelt) Ltd.

This student–based learning exercise was developed by Professor Allen Jennings at QUB in 1994. Over the past 22 years, disasters have been used in this event to identify hazards and determine technical and human causes. Impacts on civil engineering practice are also examined, so that students learn to appreciate the responsibilities of engineers and other professionals. Students were placed into groups and investigated three disasters and their associated hazards. The groups were advised during consultation sessions with engineering faculty, external practising engineers, health and safety professionals in the engineering and construction industry, and a representative from the Health and Safety Executive (Northern Ireland) who bring a wealth of experience to the exercise. These meetings ensured that the students understood the importance of their findings and helped them focus on the activity. Students gave group presentations and prizes were awarded to the best groups and best individual speakers.

The coordination of the event was led by Dr Debra Phillips.

Please contact **d.phillips@qub.ac.uk** for more details.



First and second year Civil Engineering students at QUB work in groups to learn about engineering disasters.

Guest Lectures at Top Universities of China

By Dr Huiyu Zhou, School of Electronics, Electrical Engineering and Computer Science

During 8-11 November 2016, I joined the University Roadshow Programme of the British Council with the support of Catherine Li and Andrew Norton, and presented guest lectures at three prestigious universities of China: Beijing Institute of Technology (BIT), Dalian University of Technology (DUT) and Harbin University of Engineering (HUE).

Each lecture session, entitled *"Mouse behaviour recognition"*, lasted one hour and was well received by undergraduate and postgraduate students and teaching staff in these universities (attendance: 10+ from BIT, 150+ from DUT and 50+ from HUE).

I started with the background and values of monitoring mice in labs using multimedia resources, and then described the challenges and issues in the automated monitoring of mice. As an example, I disaggregated a mouse behaviour recognition system designed in a research lab into several functional components, and then interpreted each component with new research findings. I finished the one-hour lectures by presenting comparison results against several state of the art techniques established in the community.

The lectures added impetus to the ongoing collaboration between Queen's University Belfast and top universities of China, and I have been invited to contribute to the curriculum development and summer schemes in these universities.

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Dr. Huiyu Zhou's lecture at Dalian University of Technology (Panjin Campus), 9 November 2016.

My Teaching Strategy in Lecturing in Mechanical Engineering Modules

By Yasser Mahmoudi Larimi, Lecturer, School of Mechanical and Aerospace Engineering

In recent years there have been on-going discussions about philosophy and engineering on the one hand and the application of the philosophy of education to the engineering curriculum on the other hand[1].

Engineering that covers a range of topics from nanoscale to the scale of universe is a continually evolving subject. Sometimes it is not clear which method of teaching (e.g. experiment based on visual learning, presenting oral information or combination of both) is the most effective at leading the teacher and students toward the teaching goals[1].

I believe that as a lecturer in Engineering, my role is not simply to introduce students to the procedures of how to solve engineering problems. In other words, adopting a "*give them the answer and get out*" approach reduces student involvement and motivation even further. Instead, I try to guide them to reach conclusions using their own knowledge in physics and mathematics in an interactive teaching environment. My main focus is to teach the student how to link properly mathematics and physics in order to solve fundamental engineering problems. When the students learn how to solve a fundamental physical problem themselves, this increases substantially their interest in learning. When I bring their interest up to this level, I then need to broaden the students' knowledge beyond the lectures. This is done by introducing them to different aspects of the problem, and other real applications of the theory that they have learned. For example, in the Heat Transfer course, I teach students the theory of Fourier's law for ''Heat Conduction" and show them how to solve the relevant partial differential equations. This theory can be used to explain very interesting yet fundamental phenomena such as ''why water inside the balloon boils, but the balloon never pops, while a balloon with only air pops" or ''why the candle flame cannot burn the paper money when it is wrapped around a bronze rod".

It is also useful to remind the students of the transferable skills sets that they are developing. For example, they may be doing huge mathematical tasks and learning different techniques of solving mathematical equations, but I remind them that these will also help them to better understand the world around us. For example, in the Fluid Mechanics course, when I teach students the theory of ''*Archimedes' principle and Buoyancy*", it is interesting to relate this theory to answer the question '' Why does the diet coke float in water, while the classic coke sinks?".

In conclusion, I believe that for me as a Lecturer in Aerospace and Mechanical Engineering, the key elements of having a good teaching session are (i) attracting students' attention by asking a conceptual question e.g. a physical phenomenon that happens in reality relevant to the theory that will be covered in the session; (ii) breaking the engineering subject down into manageable and simplified parts (i.e. the underlying physics and relevant mathematics to analyse the problem); (iii) encouraging an active learning environment particularly for parts dealing with solving the mathematical equations; (iv) constant reminders of the big picture and link between the theory, mathematics and the conceptual question being asked in step (i); (v) fixing common faults and detecting pitfalls of students, and (vi) continual encouragement.

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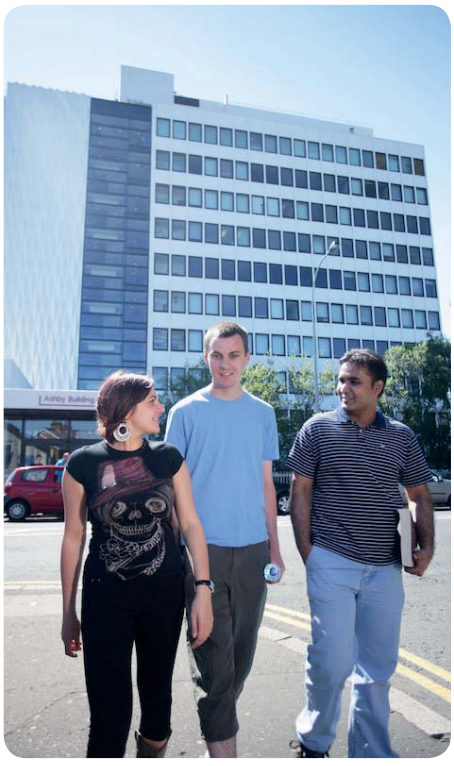
Yasser Mahmoudi Larimi, Lecturer, School of Mechanical and Aerospace Engineering



1 Heywood J., Grimson W., and Korte R., Teaching philosophy to engineering students, in Proceedings Frontiers in Education Conference, 39th IEEE, pp. 1-6, October 2009.

Evolution of "Design, Build, Fly" Activity for Teaching in Aerospace Engineering

By Marques, S., Butterfield, J., Soban, D., Murphy, A., & Price, M, Mechanical and Aerospace Engineering

Projects in Higher Education involving practical, hands on activities are an effective means to provide motivation and promote transferable skills which are attractive to employers. Project work also provides the practical reinforcement of taught materials, improving learning and effectively linking feedback to learning outcomes. Assessment can be used to direct student learning by informing and orienting them as to what the important elements of the module are, making the provision of more timely feedback an important element of this approach.

Although practical experience in the students' academic field promotes the more vocational aspects of their discipline, research and project supervision is probably the most complex and subtle form of teaching in which we engage.

Aircraft Design 3 is a pre-final year module offered to MEng students. This module, which was running for a number of years up to 2009, had been showing signs of misalignment with the aforementioned academic reasoning. From 2010 onwards, changes were implemented based on student feedback, staff observations and ambitions. Module feedback and teaching reviews were used as the basis for making improvements for the next academic year. Module feedback was supplemented with comments received as part of the Student Staff Consultative Committee. The Module Review process was used to assess educational needs based on a review of all the data available. Having identified weaknesses, the module was formally changed year on year. The following paragraphs detail the main changes, made on the basis of this review process.

2011 & 2012: The class was presented with the specification for the American Institute of Aeronautics and Astronautics *Design, Build, Fly Competition*. This required the development of a remotely controlled aircraft to carry golf balls. Students built the aircraft from scratch in a newly assigned design lab. A certified pilot was used for the flight test which enabled students to reflect and improve on their design for their final flight. Students were assessed based on technical reporting and presentations (50%), as well as aircraft performance and pilot rating (50%).

2013: The British Model Flying Association (BMFA) *Electric Lift Challenge* specification was used. Aircraft were tasked with carrying a payload of water and Queen's entered the competition. Further improvements were evident in build quality and aircraft performance. Queen's won the overall prize competing against other UK universities.

Illustration 1: 2013 BFMA Electric Lift Challenge QUB entry and winner

Illustration 2: 2014 BMFA Payload Challenge QUB entry

Illustration 3: 2016 BMFA Payload Challenge QUB entry - 3rd place

2014, 2015 & 2016: The BMFA '*Payload Challenge - Quantity*' specification required the aircraft to carry a payload of tennis balls. During this period, the School invested in a prototyping lab and students had improved access to CNC laser and hot wire cutters, as well as a 3D printer. Innovation was added to the assessment criteria (10%) to encourage diversity in aircraft configurations. This saw the introduction of new materials and techniques led by students (e.g. fibre-glassing, gear-boxes) and a more diverse range of aircraft concepts. Efforts to motivate students by setting the assessment against an upper expected performance level of 200 balls proved unpopular. In 2016, Queen's entry at the BMFA event, resulted in third place with 186 balls.

Currently, students are designing an aircraft to fulfil the *IMECHE Unmanned Aerial System Challenge*. Requirements include: navigating a prescribed course, image recognition and dropping a payload at a designated target. The mission complexity was translated in a new and diverse range of concepts, wider use of different materials (composites, aluminium alloys) and 3D printing technology. This year will see the introduction of telemetry systems, which will provide flight data and further opportunities for students to reflect upon their application of aerospace sciences. To cover the assessed elements, the module includes bi-weekly team meetings and presentations, including formative feedback from staff and students. Students are encouraged to develop prototype testing phases leading to a final manufacturing plan and build. In the final assessed fly off, teams compete and aircraft performance makes up a significant proportion of the final mark.

In conclusion, educational theory and observations by staff led to re-

configuring the module to deliver a better learning experience and align it with accreditation requirements. Improvements across the quality of student outputs, satisfaction, competencies and learning outcomes were observed. Peer assessment reinforced staff views on relative working contributions within groups.

Nevertheless, a number of issues require attention: student groups tend to move straight from conceptual design to manufacture without any significant detailed design phase; in good reports, the articulation of designs has improved significantly, the use of computerised techniques (CAD, FEA, CFD etc.) and their subsequent validation through physical tests is now common, others have failed to fully articulate design decisions rationally. Overall, the net result is still an upward trajectory in terms of aircraft performance and student learning.

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Internationalising the Curriculum: engaging with the wider world

Dr. M. Satish Kumar, School of Natural and Built Environment

Dr M Satish Kumar

In 1879 in a Select Committee of the House of Commons a witness declared:

"Geography, sir, is ruinous in its effects on the lower classes. Reading, writing and arithmetic are comparatively safe, but geography invariably leads to revolution" (Cooke, 1998).

Internationalising of higher education means the process of integrating an international/intercultural dimension into teaching, research and service of the institution (Back, Davis & Olsen, 1996). This calls for:

- The inclusion of international case studies;
- Exploring how knowledge can be construed differently from culture to culture;
- The recognition of international students as a valuable educational resource;
- Thinking about what is different in the content of taught material, how it is taught and assessed, how the structure is organised in terms of materials;
- Consideration of how to present a global outlook, and at the same time provide a grounded sense of reality at the local level;
- Assessments that are designed to reflect student engagement with complex real world tasks and problem solving so that they develop intercultural and global competence.

Internationalisation has become an agenda for sustaining Higher Education and for contributing to the development and economic wellbeing of a nation and its citizens. It is about the imparting of a global learning experience in a given space and time context. In a sense it is about preparing graduates to become responsible citizens and contribute constructively in a globally connected society.

Globalisation of economies and societies had accelerated the emergence of 'internationalisation' as an agenda for the Higher Education sector to succeed. An emerging area of focus was the internationalisation of the curriculum, transnational education and digital learning. At the same time, international student mobility, international research collaboration, and international strategic partnerships were given priority within such an agenda.

Jane Knight's definition is adequate in defining the concept of internationalisation of higher education. Thus internationalisation is an intentional process with the clear purpose of integrating international, intercultural or global dimensions into the function, purpose and delivery of the HE curriculum and programme. This in essence will enhance the quality of educational experience for the pupils and teachers and thereby allow space to make meaningful contributions to society. This calls for the removal of barriers to the Internationalisation of education and research.

Internationalisation therefore is a process rather than an end in itself, and is based on a specific desire to impart and promote an equitable and high quality global learning experience for all students studying in UK universities. This idea embodies quality driven research and education, which is sustainable and impactful. It focuses attention on teaching, learning and research. Such an approach will ensure that graduates and staff are globally and locally relevant.

Internationalisation enables learning from the world. Internationalisation of higher education entails changes to the institutions to take advantage of internationalisation. It also implies increased engagement with staff, students across all levels of the HE sector which has relevance on the learning experience provided by the institution. Finally, an informed curriculum will enable clearer alignment and integration to the HE principles of the institution.

The key purpose of internationalisation as an agenda is to foster intercultural engagement across diverse socio-cultural groups. It also enables a global learning experience thereby facilitating mobility across institutions and regions. Such an approach provides a framework for endorsing inclusive and ethical agenda with embedded global social responsibilities. This will strengthen confidence to address global challenges, which is increasingly being manifested across the regions of the world. In a way, internationalisation of higher education will play a crucial

role in shaping global societies by addressing its challenges. The values of internationalisation of Higher Education therefore are, Ethics, Equity, Respect, Openness, Reciprocity and Empowerment.

There is an implicit understanding that internationalisation can only succeed when it is inclusive in its design, without being elitist, and focusses on curriculum and learning outcomes. Internationalisation therefore becomes the sole means towards enhancing quality rather than focusing on mere rent-seeking outcomes from the students. Successful implementation of the internationalisation agenda calls for the following:

1. Resolving the challenges associated with credit transfers, degree mobility and institutional compliances across programmes. This calls for placing increased emphasis on work placements/ internships for international students. Innovative ways in fostering university-industry partnerships by facilitating co-design in curriculum development and the delivery of programmes.
2. Fostering intercultural learning opportunities for both academic and non-teaching staff and students. This has been referred to as 'internationalisation at home'. The sustainability of internationalisation as an agenda is largely dependent on fostering intercultural education and training. Internationalisation also provides scope for the development of blended and digital learning across curricula and programmes. At the same time, removal of institutional impediments towards successful research collaboration helps optimise opportunity and synergy. Higher education as a public good therefore calls for greater engagement with innovation and entrepreneurship. It is geared towards:

- Providing critical transferable skills;
- Creating awareness of capabilities and entitlements, which enhances employability options among graduates;
- Equipping graduates to take advantage of the labour market opportunities;
- Building research and educational leadership by constantly aligning key institutional priorities to meet the demands of globalised communities.

Internationalisation strategies in higher education therefore calls for a repositioning of institutional strategies, which are in line with the changing international demands and imperatives identified by the key consumers of market. This alignment is geared towards potential students and future employers. Are there potential conflicts between internationalisation targets on the one hand and the higher education policies in terms of Quality Assurance and curricular reforms?

Recognition of these challenges is a way forward in the first instance. The question is whether the internationalisation agenda compromises academic values and principles enshrined in the university's charter?

Thus focusing on *Core Competencies* will be invaluable in fostering intercultural education and practices. The key competencies acknowledged for attaining the goals of internationalisation are: capable students who have requisite skills and demonstrate effective intercultural behavioural empathy. Here, ability to work and contribute effectively in an intercultural context within a 'globally orientated curriculum will be critical for the successful implementation of the internationalisation agenda of the institution. Global perspectives embedded in a curriculum will lead to the creation of global citizens. Here, the translation of strategic perspectives at the level of the classroom and at the grassroots level is the key challenge to the realisation of this theme. Study abroad is seen as a good way of encouraging greater intercultural awareness. At the same time, the gap between aspirations of the institutions and the outcomes as expressed by international students stand to scrutiny in this ever-changing world. The way around this is to focus on core competencies, which go to support effective intercultural behaviour. Internationalisation in effect is crucial for contributing responsibly to a globally interconnected society. Embedding social responsibility towards addressing global challenges, promoting intercultural engagement, and supporting global learning experiences are all key to the successful implementation of the internationalisation of Higher Education.

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Meeting Employers through Speed Networking

By Dr Kathryn Fee and Dr Jonathan Cole, School of Mechanical and Aerospace Engineering

The School's annual speed networking event for Stage 2 students seeking work placements was held in the Ashby in November 2016. Eleven companies, including Thales, Schlumberger, Survitec, Sensata and EY, and previous placement students attended to share their experiences of engineering placements, and a busy and engaging afternoon ensued. Employers valued the personal format of the event and the opportunity to interact with students all from a particular discipline. Momentum and focus were maintained since students had only a limited time with each employer so they were motivated, prepared and ready to chat and ask questions. This event forms one session in the School's bespoke employability module for Stage 2 students. The module runs over ten weeks and covers topics such as interview skills, psychometric testing, assessment centres, international opportunities and reflective practice, with external contributions from Jaguar Land Rover, Montupet and Terex amongst others. Students have appreciated the module's relevance, practical application and the interesting talks from visiting companies. The numbers of students undertaking a sandwich placement have increased substantially over recent years, with the Stage 2 employability module believed to be a major contributory factor.

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Students and employers discussing placements at speed networking event

Web Mapping and Spatial Visualization for Teaching, Learning, Presentation and Outreach

By Lorraine Barry, Dr Jennifer McKinley, Dr Will Megarry, Conor Graham & John Meneely,

Centre for GIS and Geomatics, Natural and Built Environment

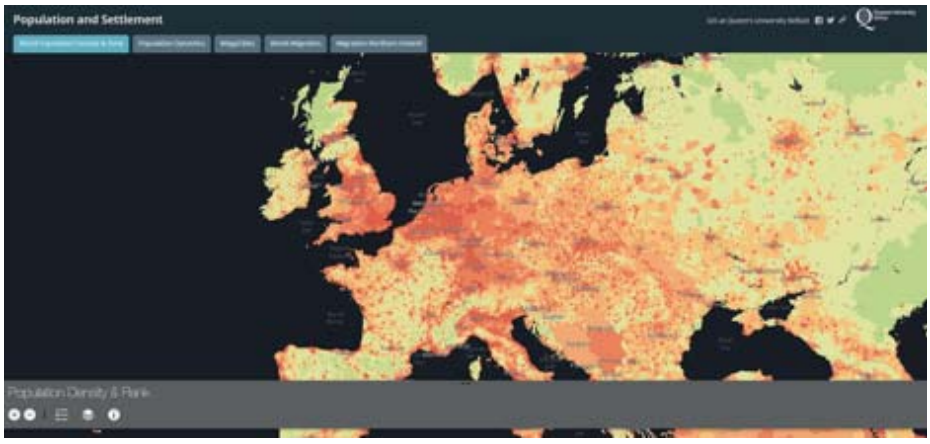
The Centre for GIS and Geomatics within the School of Natural and Built Environment specialises in teaching and research related to the science of geographical information (GIS). Geography is everywhere! Increasingly data gathered around the world on movements, trade, retail, population and the environment contain a spatial or location component. Smarter use and analysis of spatial data can have an enriched impact on many disciplines including, but not limited to, economics, engineering, biological sciences, epidemiology and public health, planning, sociology. The Centre for GIS and Geomatics collaborates with a wide variety of university departments and external organizations such as local government departments, local councils, emergency services, museums... to enrich research and decision-making through a digital and computer science based form of geographical enquiry.

Within the science of GIS, web mapping has developed within the last few years to become an important tool in presentation, learning and marketing. The combined developments within both geographical information science and computer science methods has provided a powerful platform to elevate data, analysis and outputs from paper or static images to public and interactive web applications with a focus on the where, with high capacities for integrating linked content on what, when, why, and who.

The Centre for GIS and Geomatics has integrated web mapping capabilities into research, student learning, student presentation and outreach work which allows for the creation of web apps for group teaching, independent learning, live demonstration, crowd sourcing new information or for future referral. Web mapping applications have been successfully used to lead student group activities for a number of STEM events with local schools. The Centre led a practical workshop recently with St. Patrick's Academy in Dungannon to promote the benefits

of web GIS for learning in geography GCSE topics of population, settlement and migration. The web app is available at: http://go.qub.ac.uk/GCSEPopulationSettlement .

A further GIS and web mapping workshop was hosted by the Centre at Methodist College Belfast on the use of open spatial data to explore and analyze local surface landscape and geology. The outreach work also extends to customised GIS workshops such as those hosted by the Centre for the Northern Ireland Science Festival in 2016 and 2017. Members of the public have the opportunity to map, analyze, create web apps and learn more about spatial science.



Web mapping for learning in GCSE Human Geography

Embedding Entrepreneurship into Engineering Degree Programmes

By Dr Karen Rafferty, Professor Roger Woods, Dr Neil Buchanan and Dr Sandra Scott-Hayward, Electronics, Electrical Engineering and Computer Science

Innovation is seen as a key aspect and aspiration for the UK economy and central to the UK government's policy on economic development. It is the core driver for Catalyst Inc. (formerly Northern Ireland Science Park) which aims to establish one of the most entrepreneurial economies in the world. Electrical, Electronic and Software Engineers are in an ideal position to contribute to this drive as they can offer technical innovation - but does this innovation focus and drive exist?

It is our belief within the School of Electronics, Electrical Engineering and Computer Science, that if we are to increase innovation, it is important we enthuse our students about the potential it can offer. To do this, we drove to embed innovation and entrepreneurship in the core curriculum of the courses we teach. However, we didn't just want to talk about these topics, we wanted students to experience them! There is no better way to achieve this than to let the students experience the challenges of creating their own innovative products and then attempt to develop a company based around these ideas and fully understand the commercialisation cycle. And so, the module which we now call '*Engineering Entrepreneurship*' was created and has grown extensively since its conception over ten years ago.

The module actively challenges students to identify a market opportunity, create a new product that is related to their electrical/electronic /software engineering background, and then go through all the stages of creating a company, developing a product, creating branding and also producing a detailed financial and business plan. The students are helped in this process through a series of seminars by leading experts in innovation, finance, intellectual property, branding, marketing and investment who also provide the teams with face-to-face meetings to provide detailed advice on the progress of their product ideas. Sounds straightforward – but it is anything but!

Engineering Entrepreneurship

Students self-select teams of five to six. Each team needs to identify a 'pain' which can then be used as a driver to form the basis of a product. This new innovative product either provides a solution to a customer pain/irritation or forms the basis of a 'vitamin' that does not necessarily address a need, but enhances the customer's lifestyle or experience.

The teams have to organise their individual roles within the company by identifying who will be the chief executives, technology officers, marketing and finance personnel. They are encouraged to meet at least weekly with the module staff and to document these meetings to ensure a rigor of decisions made. The role of the Course Directors as 'critical friends' is vital as it challenges the students to address the key issues and any deficiencies in their ideas or company development.

Idea generation

The most challenging aspect is the identification of the product idea and can take up to several weeks. Student teams start initially with identifying a number of ideas but these are flawed as the students tend to think of the technology solution rather than customer need. After an initial brainstorming meeting with the Course Directors, students are then sent away to think of five separate ideas by talking to a wide collection of friends or family. Some of them

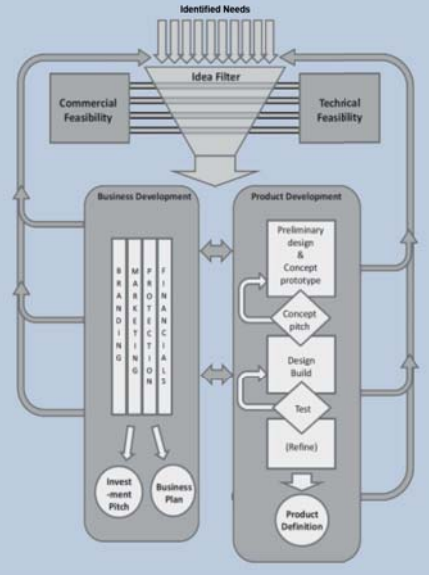


Diagram 1 Funnel of ideas

may have company or commercial interests and so will have a completely different outlook. For example, a friend's comment that he couldn't understand his daughters text which said 'C U ft SU' led to the creation of an embedded systems product for a smart phone which allows the user to convert txt speak into text and vice versa (Of course, 'C U ft SU' means 'see you at the front of the Students' Union').

This innovative step is the hardest for the students to deal with, and also the module staff! At the beginning of each academic year we have no idea whether the students will be able generate that killer idea! Normally this is actually impossible within the first few weeks and so it falls to module staff to give the students some harsh feedback. We highlight this in Diagram 1 shown as the funnel of ideas. During this stage, students will need to have 40 to 50 ideas in order to develop a decent product.

Module progress

As the teams start to filter their ideas, they will also start to identify their individual roles within the company

Title	Role	Attributes
CEO	Key person, main author of business plan	Dominant personality, can get things moving
COO	Reports mainly to the CEO. Will govern the operations of the business (and the team)	Organised and motivating
CTO1	Key technical person, helps creates demo, main author of technical report	Techie, good technical vision
CTO2	Main demo person, co-author of technical report	Techie, probably needs specific knowledge e.g. software
CMO	Company image, product definition, logistics of operation, plans market aspects	Helps if can be innovative and artistic, thinks "outside box"!
CFO	Creates finance vision for company, plans finance, market info., product generation	Needs to understand finance, to be good with numbers.

Table 1. Team responsibilities

Title	Assessment	Percentage (%)
Company pitch	Dragon's Den' panel, comprising experts from local industry, Catalyst Inc., investment organisations	20
Business plan	One of the course organiser and a member of 'Dragon's Den' panel	40
Feasibility Report	Assessed by a member of technical academic staff and a course organiser	25
Peer assessment	Peer assessment, moderated by the group progress assessed weekly by course organisers	15

Table 2. Assessment

by identifying who will be the chief executives, technology officers, marketing and finance personnel. This is critical and they are encouraged to profile their team into the candidates who will best fit as outlined in Table 1.

They are encouraged to meet at least weekly, once with the module staff and to document these meetings to ensure a rigor of decisions made. The role of the Course Directors as 'critical friends' is vital as it challenges the students to address the key issues and any deficiencies in their ideas or company development. The underlying focus is to get them to apply agile project management techniques where success will become apparent as the project progresses.

The key focus for the project becomes the company pitch to a 'Dragon's Den' panel, i.e. a series of experts from local industry, Catalyst Inc. or investment organisations. They put the student company ideas through rigorous examination so their ideas must stand up to full scrutiny. This is usually assessed in week 18 and forms a clear focus for groups from which the business and technical reports will flow.

Assessment

The assessment is largely based on the students' ability to create a realistic company and is dominated mainly by student ability to create a convincing commercial company. However, as the students are engineering students, feasibility forms a core portion of the project and so it is also assessed in the form of a Feasibility Report. The assessment breakdown is outlined in Table 2.

Module Success

A lot has been made of the need to get the students to pitch their ideas to a 'Dragon's Den' panel and if the pitches stood up to scrutiny, then surely these ideas would go beyond the scope of the project. Indeed, this has been the case, and there have been a number of examples of students progressing their ideas and entering and winning funding competitions. This includes:

- *Buteos* with an innovative smartphone-based product for hitching a caravan or trailer who were runners up in the 2012 25k Awards;
- *Uto*; The Sous Chef who had developed an innovative approach to new forms of cooking, was a finalist for the Santander Universities entrepreneurship awards in 2013;
- *Sleep State Labs* who cleverly puts your phone to sleep when you do, won the 2014 Dragons' Den.
- *Kairos* who have developed low cost solutions for electric car charging, were runners up in the 2014 Dragons' Den.
- *Snapit* have developed an electronic wristband which can break nasty habits and remove addictions. *Eleso*, have developed a smart refuelling solution. Both these teams were runners up in the Invent 2016 competition, with a total prize fund of £33K. The teams also appeared on prime time BBC TV's "Made in Northern Ireland".

Student Comments

"We thought the module was good, something different compared with the normal university modules. It encouraged us to meet up with various experts such as: patent attorneys, lawyers and product designers and really allowed us to take ownership of our product. It encouraged us to believe that starting our own business really was a viable option and something to be considered when leaving university especially with all the contacts and the help which we received during the module and afterwards."
CEO - Snapit

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Enhancing the Student Learning Experience using a Non-proprietary Virtual Synchronous Learning Platform

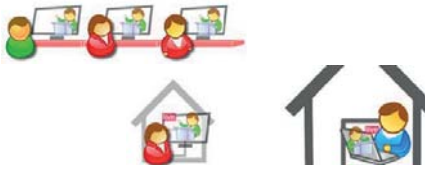
By John Busch, School of Electronics, Electrical Engineering and Computer Science

The core subject of software development is programming in order to produce robust and scalable software solutions. Learning programming can be difficult, and some students, maybe even most, will struggle. The science of programming can be easily taught because it is how things work, the syntax and the logic. It's the art of programming that students find the most difficult, the ability to programme a solution to a certain problem. The deployment of the Virtual Synchronous Learning (VSL) platform tries to solve this by allowing the student cohort to learn by doing during a lecture.

It is widely agreed that an active learning environment promotes higher learning and thinking[1]. Learning programming is about doing rather than listening, and the *sage on the stage* format of presenting programming concepts, skill and processes will result in poorer student understanding and in turn performance[2]. By removing the physical design restrictions of the traditional lecture venue, and allowing the learner to be in an active and authentic environment during a lecture, the student learning experience can be enhanced and a deeper understanding of the art of programming might be achieved.

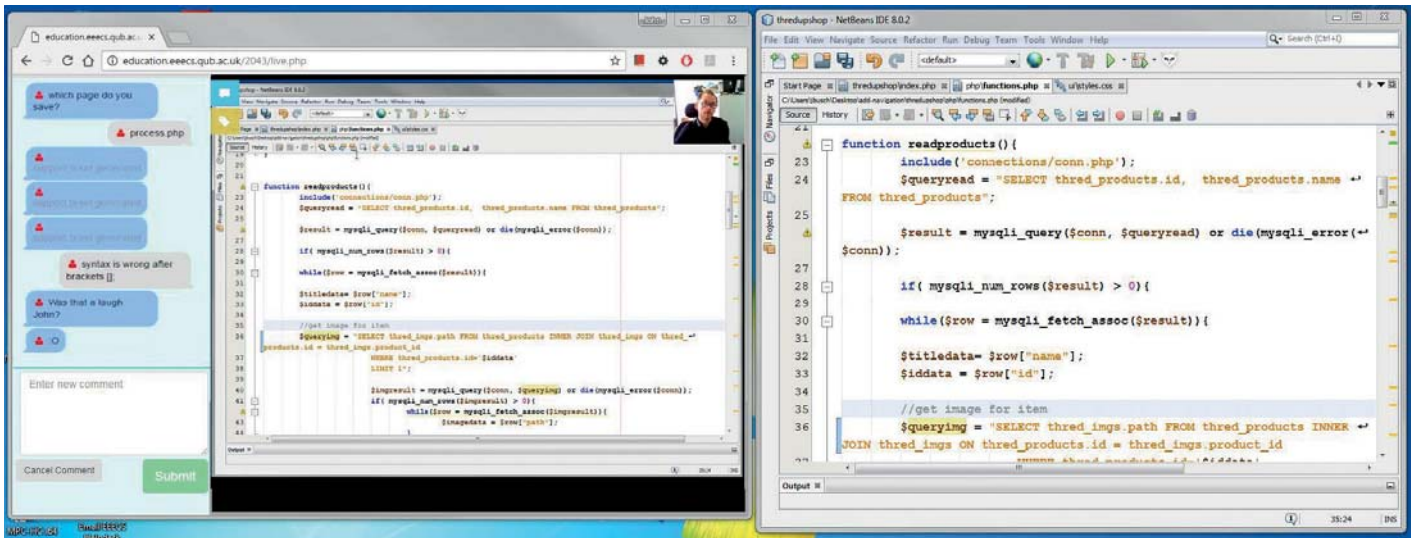
Virtual Synchronous Learning Platform

At the start of the 2013-14 academic year, a web-based platform was deployed to support the delivery of an undergraduate level 2 web programming module. The students were situated in front of a PC, either on-campus or off-campus, rather than in front of the tutor within a traditional lecture theatre. Earlier educational technology terminology might have defined this as a webinar, although current research into the pedagogic methodology has evolved, and is now being identified in such terms as: live virtual classroom, multi-access learning and blended synchronous learning. More importantly, they report that students had a positive if not better learning experience using live synchronous technology to deliver content[3]. These case studies relied on small sample sizes and used proprietary/commercial software. The VSL platform uses a large student population with open source software.



Students participate with the web-based VSL platform on-campus or off-campus

The platform streams a live synchronous screencast of the lecturer's PC along with a talking head of the tutor. Communication from students to tutor is implemented using a web-based instant messaging feature. Broadcasting a synchronous screencast of the tutor's desktop allows delivery of learning content



VSL User Interface (UI), left-hand side is the VSL broadcast and instant messages

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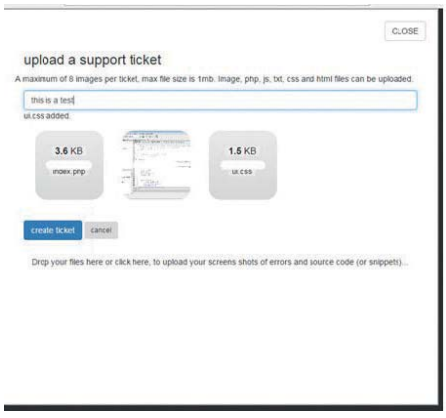
2 Robins, A., Rountree, J., & Rountree, N. (2003). Learning and Teaching Programming: A Review and Discussion. Computer Science Education, 13.

3 Irvine, V., Code, J. and Richards, L. (2013). Realigning higher education for the 21st century learner through multi-access learning. Journal of Online Learning and Teaching, 9(2).

to focus on doing. By moving the student into an authentic learning environment, they can write code that is presented from the streaming screencast and interact by attempting to solve programming challenges set during the lecture.

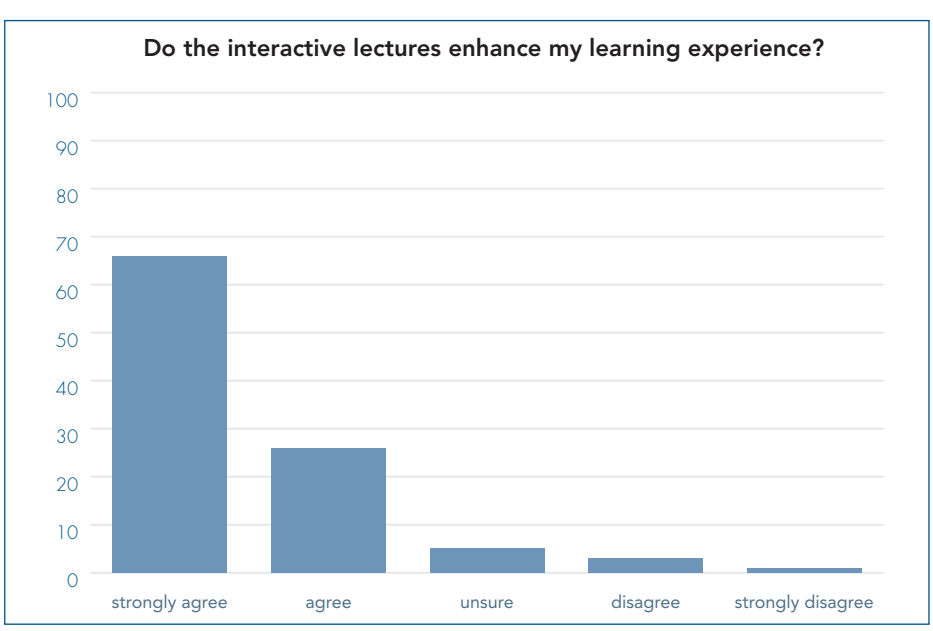
Supporting over 100+ students during a virtual synchronous lecture on programming would prove challenging for one tutor to manage. The platform addresses this by allowing participants to create a support ticket. A student who has run into difficulty can share their source/code files with the rest of the cohort. A URL is then displayed, which directs a user to the ticket. Their peers or tutor can view the problem files and communicate an appropriate solution using the instant messaging feature.

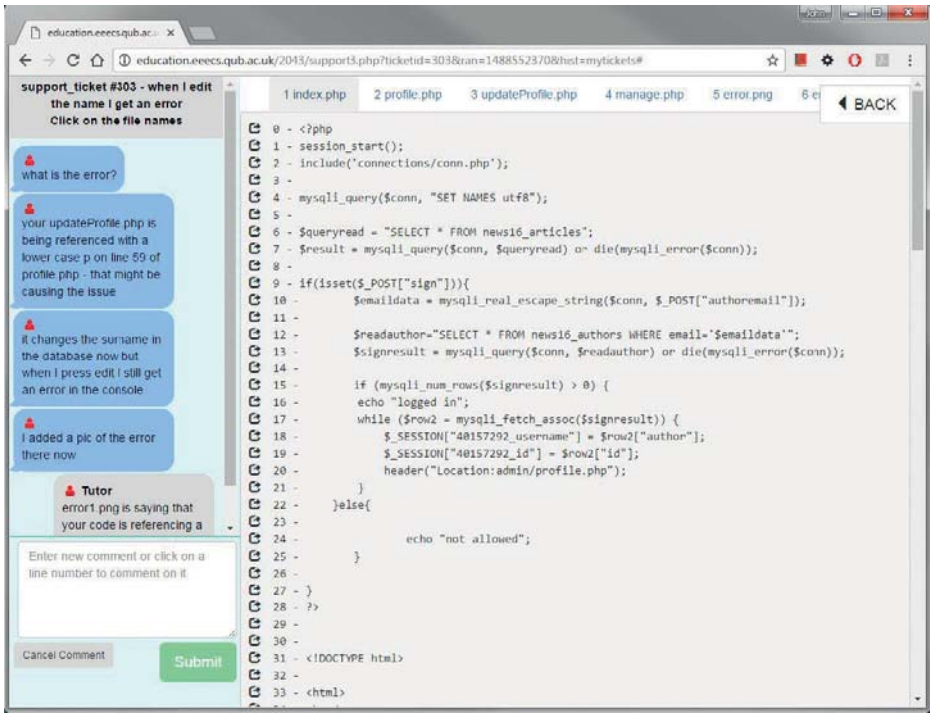
Creating a support ticket via the VSL platform



By encouraging students to solve each other's coding and programming errors, the platform is creating a peer to peer learning community, whether the participant is on or off campus. Learning communities help nurture a student's own personal learning and achievement[4].

The platform also records the tutor's streamed screencast which is then made available to students. Interestingly, the recordings are a very popular feature. Current research shows that students' attitudes towards the recording of lectures are positive when they are rich in content, and will avoid recordings that are passive e.g. lecturer reading from slides[5]. In addition, richer content from lecture recordings can potentially have a positive effect on student performance[6]. This could help explain why students view this feature with such high value. The VSL promotes demonstration and problem-solving of content rather than a chalk and talk approach.





Support ticket UI for peer to instant message

Student Experience

The student cohorts that experienced the VSL responded very positively to the new approach to lectures and are very willing to use this blended approach in their studies. Evaluating this approach over the years (n = 345 students) results indicate that 91% of students rated the approach as offering a positive learning experience. With the use of modern streaming technology and one source software, it is possible to allow students to study in a more flexible, interactive and blended environment. The platform allows any lecturer/tutor to screencast their desktop to the student population on or off campus.

Please contact **j.a.busch@qub.ac.uk** for further details.

4 Huijser, H., Kimmins, L., & Evans, P. (2008). Peer assisted learning in fleximode: Developing an online learning community. *Australasian Journal of Peer Learning*, 1(1), 7.

5 Danielson, J. et al., (2014) Is the effectiveness of lecture capture related to teaching approach or content type? Computers and Education, 72.

6 Pale, P., Petrović, J. & Jeren, B., (2014) Assessing the learning potential and students' perception of rich lecture captures. Journal of Computer Assisted Learning, 30(2).

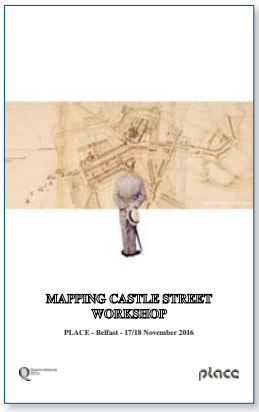
Mapping Castle Street Workshop

By Dr Agustina Martire, School of Natural and Built Environment

In November 2016, I ran a 2-day workshop entitled 'Mapping Castle Street: an interdisciplinary workshop about the character of the street', in the Planning Landscape Architecture Community Environment (PLACE) NI. The workshop, which was facilitated by PLACE NI and sponsored by Queen's University Belfast, aimed to produce a provocative urban study of Castle Street.

The workshop involved researchers and students as group leaders and participants from a diverse set of disciplines, namely History, Geography, Planning, Sound, Sociology and Architecture and throughout two days of intense work in four groups, we explored Castle Street. The groups were led by Dr James Davis and Anna Skoura (History), Conor McCafferty and Matilde Meireles (Sound), Dr Agustina Martire and Steven Donnelly (Aspirations/Planning), and James Hennessey (Perceptions/Ethnography).

At the end of two days of exploration, a series of maps and images were produced and communicated at a short presentation which was attended by a broad set of practitioners, policy makers and students from Queen's University, Royal Society of Ulster Architects (RSUA), PLACE, the City Council and the general public. These images challenged the prevailing ideas of the character of Castle Street and invited viewers to understand the Street under a different perspective, with the aim of broadening the interpretation of urban streets beyond the common tools of built environment disciplines.



Dr Ken Sterrett responded to the presentation with a set of new challenges for the project to be carried forward.

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Water and The City

By Dr Urmi Sengupta, Natural and Built Environment

The Level 2 undergraduate planners engaged in the Water & the City project in the autumn semester, focusing on envisioning schemes for four waterfront sites from Belfast City Centre.

The theme for the project was inspired by the Lagan River and its economic, social, cultural and aesthetic role in the city and its urbanism. Water, as a natural element, helps to soften the urban landscape and its significance has witnessed a revival in recent decades. Students developed schemes on these waterfront sites to make a place of "distinction, permanence, and connection", proposing both built-form and exploring the architectural aspects of water. They planned a series of spaces along the water that are neutral, compact, delightful, vibrant, safe and secure. The project was devised as a creative learning process to develop creativity and imagination in our students, using real sites and real life challenges. It brought together academics and practitioners, and was delivered through both studio-teaching and outdoor-learning, capturing the essence of our environment, what is valuable to us and what we look to enhance.

For further information please contact Dr. Urmi Sengupta (**u.sengupta@qub.ac.uk**)

Urban oasis in Sirocco site with high quality public space enclosed by mixed use development

Student vision to create an 'eco village' along Lagan River

Students' motivation to learn: Knowledge learning vs. score obtaining

By Dr Xiaolei Zhang, School of Mechanical and Aerospace Engineering

Teaching, according to the Oxford dictionary, is defined as imparting knowledge instructing someone as to how to do something. All educational purposes can be defined in two ways: (i) teacher-driven which indicates what it is intended that the teacher will do, and (ii) learner-driven objective which indicates what a student is supposed / will be able to do.

The ultimate purpose of teaching has been discussed by Ballantyne, Bain and Packer (Ballantyne, Bain et al. 1997), who claim that good teaching should be defined having a stated aim for what the students are going to learn or be able to do at the end that they couldn't do in the beginning, and that successfully achieves the aim. This learner-driven purpose expresses good teaching in terms of aims and achievements rather than in terms of using particular methods, where the learning objectives should always gauge the demand of the students. It addresses the relationship between teaching and learning, which means that the only definition for good teaching is to achieve good learning.

The learner-driven objectives vary with different types of learners. For example, for an engineering university student, it is most important that the student is educated in a way that enables them to go out into the practical world and demonstrate the knowledge and techniques they have learnt in university. To evaluate these objectives, assessment (e.g. examination) plays a critical role in directly testing the learning outcomes. It can be treated as a way of communication between the teaching staff and the learners (students). However, the function of assessment needs to be carefully considered (Kember, McNaught 2007), because, if the assessment plays a role that pushes the student learning way to assessment-driven learning, in which the student over-cares about the assessment result and ignores the original aims of learning, that would mislead the learning in another, undesired way. Thus the assessment needs to be carefully designed to encourage the desired type of learning. Kristina Edström (Edström 2008) investigated the barriers of using course evaluation as a tool to improve student learning. Results of interviews with faculty and student representatives in the Royal Institute of Technology (KTH) indicated poor results performed by the teacher-focused evaluation, and thus a constructive alignment is needed, as proposed by the author.

One of the main problems of using examination to assess student performance, as identified by Professor Mazur (Mazur 1997) at Harvard University, is that a disturbingly large fraction of students develop strategies for solving standard textbook problems without achieving the most basic understanding of the concepts. This is a common trend in different courses, even though the exact percentages at which different researchers draw the line for what they see acceptable understanding vary.

To solve the mismatch between conventional problem-solving teaching and student ability for conceptual understanding, Mazur et al. (Mazur 1997, Fagen, Crouch et al. 2002) developed an evidence-based, interactive teaching method, called as "Peer Instruction". Thus flipping the traditional classroom teaching method has been shown to be more effective than more traditional lecture-based teaching methods. Yet, there are limitations with this interactive teaching method when compared with traditional lecturing (Costin 1972) and especially with large size class due to time-consuming and management difficulties (Nicol, Boyle 2003).

Problem-solving based learning (PBL) has been used as a successful strategy for higher education in engineering (Perrenet, Bouhuijs et al. 2000), chemistry (Pedrosa, Neri et al. 2005) and geography (Spronken-Smith 2005). However, it should be highlighted that the problem to be addressed within the PBL approach is a conceptual understanding based problem, and the mismatch between understanding the concept and solving the textbook problem still exists. The engineering students learn and try to understand the concepts only if they are really interested, otherwise, passing the exam, obtaining a higher score and a better job are what the students are after. This brings up a question of whether the motivation of an engineering student is to learn or to merely pass the exam?

It is generally accepted that four components that affect a student's motivation (Hubackova, Ruzickova 2013) (Duta, Panisoara et al. 2015) are: (i) **Student's personality and learning methods**; (ii) **Teacher's personality and the teaching methods**; (iii) **Subject matter with its systemic and material contents**; (iv) **Factors that can be influenced by neither teachers nor by students**, for example, the exam system, the University's cultural environment, etc. By overviewing these four factors, the student's personality and self-motivation is critical but the influence of the teaching style cannot be ignored (Lambert, Tice et al. 1996).

There are three elements of student motivation: internal, external, and negative motivation (Acat, Kösgeroglu 2006), which are determined by various factors such as study process, learning

approach, resources and problems (Yardimci, Bektas et al. 2017). As shown in Figure 1, the main reason for study or learning during intrinsic motivation is the individual's pleasure and satisfaction (Ryan, Deci 2000), while in extrinsic motivation, the extrinsic award becomes the main driving force of the individual to get important results. The negative motivation or amotivation is due to problems that emerge when the individuals cannot find a connection between their situation and the undertaken task/ activities (Yardimci, Bektas et al. 2017).

In higher educational systems, the motivation, resources and problems need to be analysed by important natural indications. One important finding from the student's motivation theory is that students on a problem-based learning programme (PBL) perform better than those on a traditional educational programme, which indicates the effect of the educational system on the learning motivation. It is concluded that the PBL educational system is more effective at helping students to acquire learning skills, mainly by increasing the students' intrinsic motivation.

One good example of a PBL approach is the flipped classroom (Nouri 2016). Compared with transmittal educational models, the flipped classroom model is a more flexible, effective, active, and student-centred teaching strategy (Nouri 2016). The traditional lecture, in which the professor is normally the "*sage on the stage*", transmitting knowledge to students (King 1993), has been strongly criticised. However, it still stays as the predominant strategy in higher education system. The essential element of the flipped classroom model is that the students read the lecture materials in advance at home and engage in teacher-guided problem-solving discussions during the class, with an obvious benefit to improve the efficiency of students' learning.

As a summary, the essential of good teaching is actually to ensure good learning, which is a decisive learner-based aim of teaching. Moreover, the learning outcomes need to be assessed in various way. By considering the functions of assessments, there is potential that the assessment will be over-emphasised by the student, which may mislead the learning objective to assessment-driven learning. As in an engineering-based school, the students normally are more interested in the score they can gain, and further, what salary they can earn after graduation. Based on the theory of three types of student learning motivation, the internal motivation is the one that all teaching staff can work on. A Problem-based learning approach, such as flipped classroom model, is a possible solution to help realise problem-based learning/teaching.

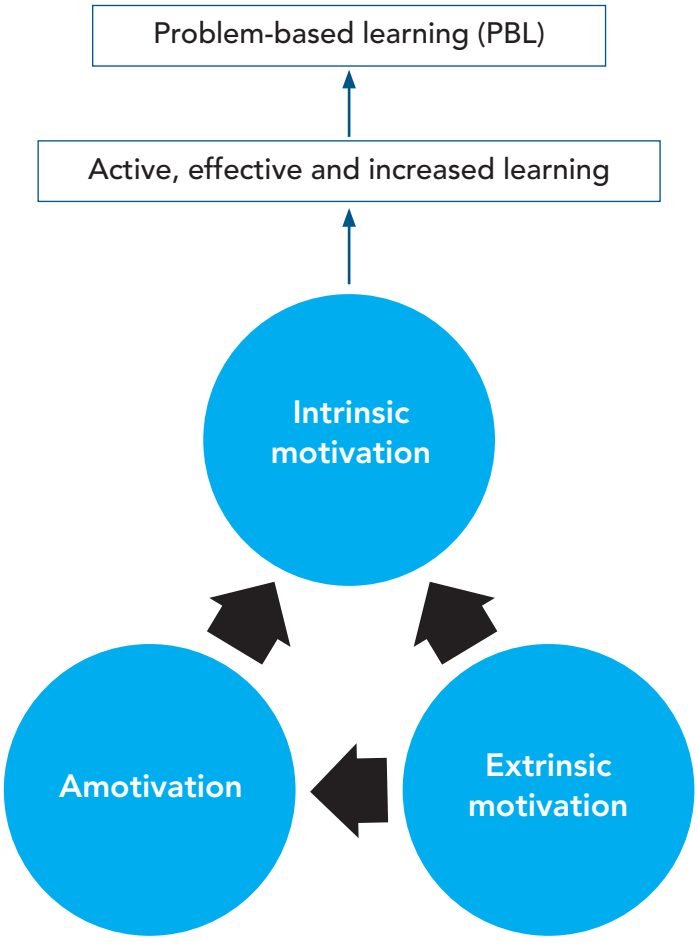

Figure 1. The three elements of students' motivation, and how are they related to active learning and problem-based learning.

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Street Society

By Professor Ruth Morrow, School of Natural and Built Environment

Street Society is a weeklong design event facilitated by staff from the School of Natural and Built Environment. It was founded in 2010 by Ruth Morrow, Professor of Architecture, as an annual outreach project, to bring clients from not-for-profit community and voluntary sectors together with talented students of architecture, to produce something remarkable and stimulating in five days.

Street Society 2017 and 2016 have been part-funded by the Department of Communities in support of the Urban Villages Initiative, which sits within Northern Ireland's Executive. The Urban Village Initiative cites Street Society as contributing to its strategy for community consultation and engagement.

Street Society annually involves 100-120 students: a mixture of 1st year undergraduate architecture students and 1st year masters students and some other disciplines, working in small teams with local community organisations across all five of the Urban Villages in Northern Ireland: West, North, East and South Belfast and Derry/Londonderry as defined by the Executive. They are in areas of high deprivation and where the knock-on effects of sectarian divisions remain tangible, but they also represent the areas of Northern Irish society with the most potential.

The chief purpose of Street Society is as a place of shared learning. The students learn from one another and from the clients; and the clients gain insight into the process of design and the value of their built environment. This open learning design process does not result in deliverable architectural solutions: instead it is focused on demonstrating possibilities, capturing ideas that exist at community level, cultivating others; and exposing value through direct engagement. The process places students and the interested community as partners in the process. Ideas, needs and aspirations are voiced, listened to and, with skill and youthful passion, translated into visible and visual proposals.

The students are located for the week within the community and for that time we operate as a *dispersed university* where students are '*present and productive*' across local neighbourhoods: present in their listening and observations; and productively demonstrating their understanding and creative engagement: visually capturing ideas, releasing new potentials and new futures. Behind the scenes the process is supported by an extensive handbook managing all aspects of Health and Safety, ethical issues and checklist guidelines for the masters students, guiding them through the process of project management and risk assessment.

This year we were able to employ five masters of architecture students to work over the preceding weeks to meet with community representatives, identify locations and draft up briefing documents that set the scene for their student peers. These five individuals developed a strong set of skills throughout the process and have in turn become passionate ambassadors for Street Society.

Street Society can not, and does not want to, compete with practicing architects nor community consultation processes. The outputs of Street Society are sketches, plans, 3-D images, maps, models, artifacts and ideas: some of which may become embedded in community business plans, informing funding bids, or inform more strategic level thinking within the Urban Villages Initiative. But the really valuable outcomes are richer awareness of, and new relationships within and between communities, statutory bodies and, of course, future built environment professionals. We understand Street Society as supporting dialogical engagement with the built environment at street level.

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Pitt Park Project, East Belfast Urban Village - the students worked with various communities groups and representatives to consider the Bonfire Site in Pitt Park on the Lower Newtownards Road. The aim was to propose ways that would create a positive and robust space for the bonfire yet also accommodate year round activities and artefacts.

A Toolkit for Sharing Best Practice

by Charlie McCartan and Paul Hermon, School of Mechanical & Aerospace Engineering

QUALITY ASSURANCE AND ENHANCEMENT MARKETPLACE FOR HIGHER EDUCATION INSTITUTIONS
www.cross-sparring.eu

A key target of the European Commission is to improve European education and training and specifically the quality and relevance of higher education. External evaluation and self-assessment are defined as key roles. In September 2014, eight European universities began a collaborative EU funded Erasmus+ project and have now created a new, lean process to help improve the quality of Higher Education. This process of reflective self-evaluation enhances the quality of programmes through peer alliance and cooperation. The project is designated QAEMP (Quality Assurance and Enhancement Marketplace). The School of Mechanical & Aerospace Engineering at Queen's was one of the project partners.

Paul Hermon

Charlie McCartan

QAEMP has comprehensively explored the quality assurance processes associated with various aspects of learning in Higher Education Institution (HEI) programmes to develop its new, lean process, which is defined by **four steps** and illustrated in Fig. 1:

1. **Self-evaluation**. Each institution involved self-evaluates one of their programmes against 28 criteria. These criteria were produced based on the exemplary practices of many self-evaluation frameworks, including institutional standards and processes, national standards and processes, regional and global accreditation schemes and the CDIO standards. The self-evaluation culminates in the identification of several priority criteria that each institution wants to improve on their chosen programmes.
2. **Pairing**. The self-evaluations and the priority criteria identified are entered into the QAEMP marketplace. A pairing algorithm matches two institutions based on their respective self-evaluation scores. It ensures there are significant differences in criteria that matter to them and hence they will be able to help each other in these areas.
3. **Cross-sparring**. Each institution visits the other with the goal of learning from and inspiring each other.
4. **Enhancement**. Each institution prepares a development plan for their respective programmes and institutions based on their cross-sparring experiences.

In **step 1**, the questionnaire consists of an honest self-evaluation of a programme against 28 criteria using a general maturity model with six

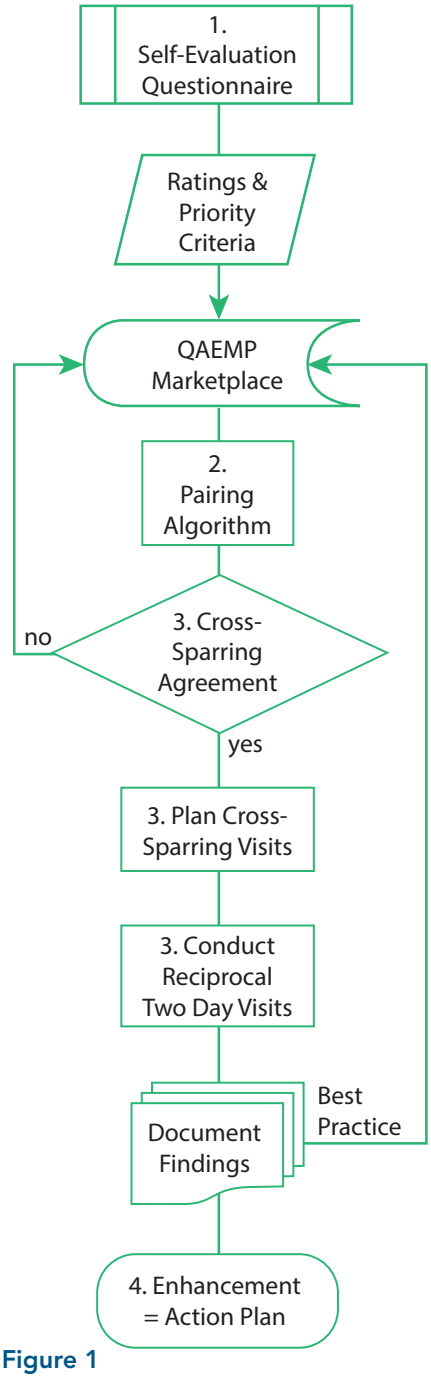

Figure 1

levels. This self-evaluation framework is based on these 28 criteria, which are grouped under 10 themes as shown in Table 1. A measurement rubric has been developed for each

criterion, using a maturity model rubric, which comprises six levels, with general expressions adapted to suit each criterion as shown in Table 2. Ratings, along with argumentation and indicators to justify the scores, are the output of the self-assessment questionnaire. Each institution uses this data to identify their own priority criteria areas where they wish to improve. The data for each institution is fed into the QAEMP marketplace, via a web-based portal.

Table 1. Programme Criteria Classification

Theme	Number of Criteria
Programme Philosophy	1
Programme Foundation	4
Learning and Teaching	5
Assessment and Feedback	2
Skills Development	4
Employment	2
Research	1
Student Focus	4
Faculty Development	2
Evaluation	3

Table 2. Generic Criterion Measurement Rubric

Level	Description
5	Continuous improvement and development are evident
4	Evidence of implementation and evaluation are available
3	Implementation is underway
2	A plan to implement change has been produced
1	There is an awareness of the need to implement change
0	No intention to change

The self-evaluation is best carried out by a small team of staff involved at the curriculum design level of the programmes under consideration. The expectation is that the self-evaluation can be completed in less than one day. This reflective process in itself can be a valuable tool as part of a quality enhancement process, but the project enables further benefit through the cross-sparring' process in step 3.

In step 2, a computer algorithm pairs institutions in the marketplace based on their ratings and priority criteria selections. Paired institutions come to a mutual agreement that they wish to continue to the cross-sparring phase.

For the cross-sparring process in step 3, plans are drawn up for the respective visits of each of the partners. These plans involve:

- Reviewing their priority criteria and limiting to 5 criteria on which to focus during each visit.
- Drawing up a detailed timetable of activities for each visit to examine the practice in each priority criteria area.

Each partner then travels to the other's institution to see first-hand how criteria are managed / delivered. These two visits help ensure a depth of understanding and knowledge is gained. A single pro-forma document for each institutional visit is completed by both parties together.

The cross-sparring process seeks to make feedback of the peer evaluation more collaborative, concrete and objective, thanks to critical but discrete sessions where specific objectives can be discussed. The role of the sparring-partner is to help keep focus on the objectives, learn from the experience and stimulate reflectivity. This approach is beneficial both for the institution being evaluated, which will get a more objective view on its strengths and potential improvements, and for the sparring-partner who might identify best practices for their own institution. Each partner makes reciprocal visits so that the roles of the partners are reversed.

After both visits each institution compiles an action plan for the self-improvement of their programme, based on their cross-sparring experience and insights gained.

Who is it for?

- Anyone interested in *programme level development* in higher education.
- Deans, Programme Directors, Teachers, Educational Developers, Quality Assurance officers...

Benefits

- Tools for continuous improvement
- International benchmarking - critical friends
- Compatible with formal quality audits
- Not overly demanding in terms of time or paperwork

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Work-integrated learning as re-mapping the spaces and places of learning?

By Dr Niall Majury, School of Natural and Built Environment

Dr Lestyn Barr, Dr Donal Mullan and Dr Helen Roe briefing geography undergraduates on a research project at Estellencs, Mallorca.

It is increasingly commonplace for university students to have opportunities for real world, practical experiences during the course of their programme. These opportunities were once most closely associated with disciplines such as the health sciences, engineering and teaching, where professional accrediting bodies required and defined particular types of work integrated learning (WIL) (e.g. clinical placements and practicums). However, for other disciplines, such as literature, politics, history and geography, WIL is increasingly being embedded within curricula to increase students' employment prospects upon graduation. In these types of disciplines, WIL comes packaged in a variety of forms, and experiences vary across disciplines, HE institutions and level of study. However, they share in common 'the intentional integration of theory and practice knowledge', one that may, or may not, include a placement in a workplace (Orrell 2011, p.1).

For geography, my discipline, a diverse set of pedagogic practices have become framed as WIL and are now codified within benchmarking documents and accreditation requirements. Fieldwork (Kent, Gilbertson, & Hunt, 1997) and capstone projects (Clark, 1995) are long established practices, complemented recently by various forms of service learning (Brail, 2013), internships/placements (Eden, 2014) and problem-based simulations (Cornelius, Medychkyj-Scott, Forrest, Williams, & Mackaness, 2008). In December last year, Geography at Queen's became one of the first undergraduate programmes within the Russell Group to attain professional accreditation. In its feedback, the Royal Geographical Society's review panel noted in particular the provision of opportunities for fieldwork and a strong emphasis on experiential learning. These include participation in staff-led research projects (GGY2057 – International Fieldwork), partnering with community-based organisations in our service-based learning module (GGY3065 – Geography at Work) and problem-based simulated learning experiences (such as making a market in shares, modeling the impact of climate change or undertaking a geoforensic investigation of a crime scene).

These learning experiences are bound together by a disciplinary commitment to engaging with a world of difference, and also share in common an understanding of the relevance of what is taught in the classroom for everyday practice (Solem, Foote, & Monk, 2013), graduate employment (Arrowsmith, Bagoly-Simo, Finchum, Oda, & Pawson, 2011), and citizenship (Yarwood, 2005). For students, they

typically highlight their appreciation of: "hands on experience" (Pawson, 2016, p. 24); engaging with "the real world" (Fuller, Edmondson, France, Higgitt, & Ratinen, 2006, p. 96); the process of discovering that issues are "more complex than I imagined" (Miller, 2013, p. 53); the opportunity to be "able to use what you've actually learnt"; scope to add "something for the CV" (Pain et al., 2013, p. 35); and "neat bite-sized accounts to serve up to job interviewers" (Pain et al., 2013, p. 36). These ways of framing and articulating their experiences suggest not only cognitive gains (geographic knowledge and skill development), but also important utilitarian gains (skills and experience prized in the workplace) and affective experience (personal self-awareness and emotional maturity).

So, while for some WIL is approached all too cautiously in terms of re-mapping the spaces and places of learning within HE, for geography at Queen's, and increasingly elsewhere, it offers an opportunity to re-affirm a form of praxis best described as 'engaged scholarship', through which a range of general and discipline specific professional competencies are supported. This builds upon, I would argue, longer standing radical critiques within the discipline on what 'geography' ought to be, bringing 'knowledge, emotion and action together' (Monk 2001) and resonates with recent sector-wide initiatives within higher education for universities to be seen to be engaged (Watson, Hollister, Stroud and Babcock 2013) or edgeless (Bradwell 2009).

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Undergraduates on GGY2057 (International Fieldwork) engaged in a research project on processes of 'super-gentrification' (Lees 2016) and the politics of 'cleansing' the barrios de la ciudad in Palma de Mallorca, Spain

An essential aspect of an honours degree programme in geography is the role of fieldwork and other forms of experiential learning in the development of knowledge, understanding and curiosity about the great differences and dynamics in cultures, political systems, economies, landscapes and environments across the world, and the links between them (QAA 2014)

Digital Assessment in Mathematics beyond Multiple Choices

By Gabriele De Chiara, Gleb Gribakin and Malachy Montgomery, School of Mathematics and Physics

Many colleagues who teach Pure and Applied Mathematics and Theoretical Physics, have long been concerned with numerous elementary mistakes in differentiation, integration and simple algebra made by third- and even fourth-year (crème de la crème MSci) students. We blamed slipping A-level standards, lack of understanding on part of the students, and the system where students could make mistakes in almost every other line of their exam scripts, and yet score 50% while not getting any final answers correct! We grumbled and complained to each other at examiners' meetings, introduced some remedial lectures in our first-year modules, provided re-cap material at higher levels, but to no avail.

The recent change in the structure of the academic year and assessment gave us a chance to try something new. Inspiration came from a first-year module *Essential Mathematical Skills* taught by the School of Mathematical Sciences at Queen Mary University. This is a zero-credit module that tests student competence in basic arithmetic and algebra by means of an intelligent multiple-choice exam. Passing this module is compulsory for progression to the second year for students on Mathematical Sciences programmes. Moreover, and this is the crux of the matter, to pass this module the students need to answer at least 12 out of 15 questions correctly, i.e., score at least 80% in one of the number of sittings offered throughout the year.

In our case, we have introduced similar assessment in the two main first-year mathematics modules, PMA1020 Numbers, Vectors and Matrices, and AMA1020 Analysis and Calculus. We use an open source digital tool *NUMBAS* (https://www.numbas.org.uk) to offer computer based assessment to more than 150 level 1 students in weekly sittings.

Traditional tests based on multiple choices often suffer the common flaws of being predictable, with correct answers being relatively easy to spot. Other options require the solution to be numerical but do not allow for answers in the form of algebraic expressions. The novel approach, implemented through *NUMBAS*, requires students to typeset their answers as formulae. *NUMBAS* interprets the student's solution and compares it with the correct answer. This allows mathematics instructors to test students' knowledge in topics like calculus and linear algebra, similar to traditional pen-and-paper examinations. Another advantage is the capacity to randomise questions of a particular type, by selecting them from a large set. Additionally, random numerical values are used in a variety of questions, making it impossible for the students to memorise the answers.

Of course, setting up the tests was a considerable investment of staff time, including wide participation of our colleagues and PhD students in the initial testing (and debugging) of the tests. Beyond that initial period, the automated nature of this type of assessment and low workload associated with running it, has enabled us to set a high pass mark (80%), still a bit lower than in the Theory Test for drivers!) The high pass mark is mitigated by the opportunity for the students to take the test multiple times without incurring a penalty. (Once passed, the test mark contributes 10% to the final module mark, irrespective of the number of attempts taken by the student to pass). As can be seen from the data below, a number of students passed the test at the very first attempt. Others had to do more revision and remedial work (with staff offering clinic sessions as necessary), before passing.

The graphs below illustrate student progress in the two computer tests. The PMA1020 test that examines student knowledge of basic arithmetic and algebra, was the first to be rolled out early in October 2016. It proved relatively easy, allowing about 80% to pass at the first attempt. (An attempt for the full class consists of four weekly sittings, as dictated by the size of the computer lab that can hold up 40 students, i.e., about 25% of the class at a time.) By the end of December 2016, over 90% of the class passed the test.

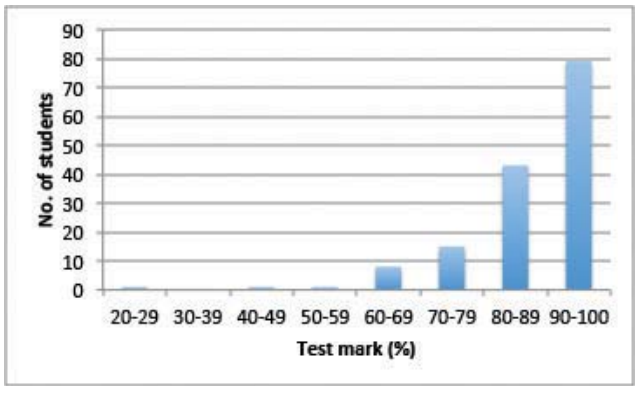

Figure 1: PMA1020, distribution of the marks in the students' first attempt

The AMA1020 computer tests on basic functions and calculus, proved to be significantly more challenging. Only 23 students (i.e., about 15% of the class) passed it at the first attempt, with

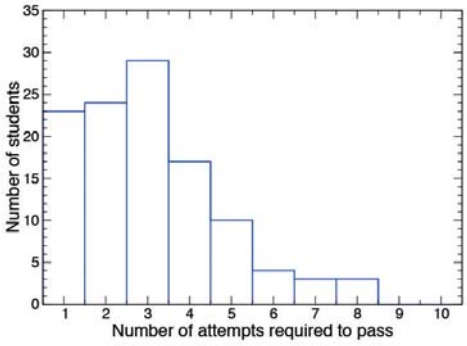

Figure 2: AMA1020, distribution of the number of attempts required to pass

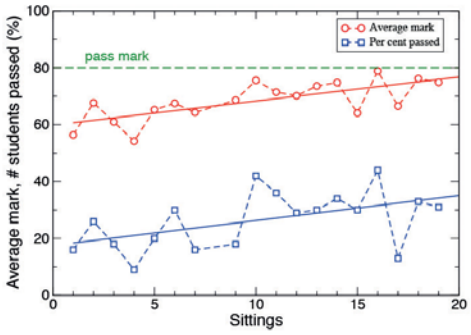

Figure 3: AMA1020, progress of the students' marks and passing rate against the number of sittings

about 50% of students requiring more than three attempts.

At the time of writing (March 2017) the students had been offered a total of 19 sittings, and many have attempted the test multiple times, passing after 5, 6, 7, or even 8 attempts! What is important, however, is that even when the students fail, their marks from one attempt to the next improve on average, as can be seen from the increasing average mark and pass rate (i.e., percentage of students passed) in a given sitting. This shows that the students continue to work on acquiring the knowledge and skills that we require.

The computer tests described here were used to ensure basic competence in Pure and Applied Mathematics. We believe that NUMBAS or similar digital platforms (and, crucially, high pass marks) can be also employed in other disciplines, e.g., biology, chemistry, engineering, computer science and economics, where the lecturers want to ensure that the students possess a certain minimum amount of knowledge and skills that they can use with high confidence.

To come back to the starting point, we need to wait a few years to see if these tests have helped the student make fewer mistakes and get higher marks in their Level 3 and 4 exams.

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Mathematics and Physics Teaching Centre

By Professor Hugo van der Hart, Maths and Physics

The opening of the new Mathematics and Physics Teaching Centre in September 2016 gave students and staff a "quantum leap" in dedicated teaching facilities. Undergraduate mathematics students now have dedicated space to carry out investigations, ranging from computational finance and data mining to numerical analysis. Physics students have purpose-built laboratories on two floors, with new equipment allowing them to explore the physics underpinning Nobel-prize-winning research. The ground floor contains new lecture theatres, small group teaching rooms and a student meeting area, with a working subatomic particle detector at its centre.

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Using Technology to Advance the Student Experience in Geoforensics

By Dr Alastair Ruffell, School of Natural and Built Environment

Geoforensics: enhancing the undergraduate student experience within the classroom with speakers, near and far, from the world of professional practice

In December 2016, Geography at Queen's became one of the first among its Russell Group comparators to secure professional accreditation for an undergraduate programme from the Royal Geographical Society (RGS). In commending a strong case for accreditation, the Accreditation Review Panel noted the 'interesting range of modules that offered students a chance to study aspects of geography not seen elsewhere' such as the Year 3 Geoforensics module. The module is unique in the UK and Ireland and is based on research and humanitarian/ criminal investigation casework carried out by the module coordinator and colleagues in Queen's and around the world.

An issue with the provision of this module is the problem of cost (in time and money) when bringing guest speakers to talk to and interact with the students. Forensic scientists and search and rescue personnel find it hard to commit their time, so in this module I use Skype as an interactive means of accessing these specialists. I have a range of lecture slots available, and when the key person is free, they provide an interactive class with the students.

Common questions raised by colleagues about this approach to enhancing the student experience within the classroom, include:

- What happens when the technology breaks down or the specialist is unavailable? *I ask for the Powerpoint ahead of the session, and have reserve material of my own on the topic, in case;*
- How do the students react to speaking to a screen? *I asked my students this, and they commented that they mainly interact with each other through screens (smartphones, tablets), so what is the difference?*
- What advantages does this provide? *The students commented that they realise we live on the Atlantic fringe and Belfast is not London or New York and were grateful they could interact with world experts.*

This said, I am always looking for potential synergies to capitalize on between the delivery of Geoforensics and other initiatives such as Geography research seminars, collaborative research projects and forensic casework. So, where possible, I do nonetheless bring into the classroom two or three experts each year. For, as useful as Skype is in augmenting the student experience, 'being there' enables other forms and qualities of human interaction and communication that technology cannot, in my estimation, completely replace.

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Award Winning Medical Physics Teaching: Repurposing Research Tools

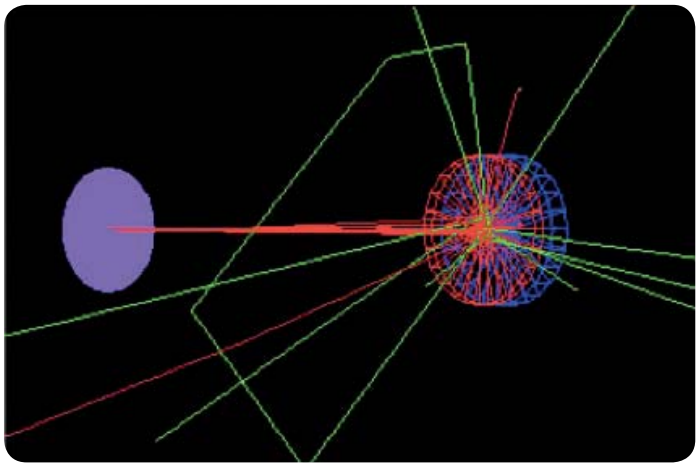
By Fred Currell, Balder Villagomez Bernabe, Malachy Montgomery (School of Maths and Physics), Joseph Perl (SLAC, Stanford, Califonia, USA), Liz Thomas (School of Natural and Built Environment)

'Never collaborate with someone with whom you wouldn't enjoy a glass of beer' was the sage advice from one of our colleagues sometime back. Topas_edu is an award winning and now freely available teaching package which we have up to now delivered to over 60 final year MSci students as part of their Medical Devices and Applications module.

One of us (Fred) had already dabbled in using medical physics research tools in undergraduate teaching when his close friend and collaborator (Joe) came to visit and train Fred's group in using a new research tool his team had developed with $3.5M National Institute of Health funding. Not only were Fred's team delighted to be beta-testing this cutting-edge tool, Fred also knew he could build great courseware around it. A couple of chats over beer and *Topas_edu* was born.

Understanding the details at work when radiation travels through patients is a highly expert and software driven task – it draws upon several different areas of physics and results must be applied many times over to predict the behaviour. One of the major techniques to analyse problems of this nature is Monte Carlo simulation, which provides the bridge from fundamental physics to observed behaviour. In such a simulation, whenever an interaction can occur between radiation and matter, one uses a spin of a roulette wheel to determine the outcome from a number of choices. In practice, the roulette wheel is a random number generator inside the computer, the available choices are formulated in terms of weighted probability and there is a lot of heavy-weight maths involved; but basically with enough spins of the roulette wheel you get a good picture of what will happen, founded and deeply rooted in the basic physics at work.

Some years ago, a collective of helpful people (including Joe) put together an ever-growing toolkit to help people implement this technique for themselves. The toolkit is called *Geant4* and the paper which announced it is the most highly cited high energy physics paper ever – yes, this is mainstream, high impact science used to help design the Large Hadron Collider, many, many space missions, and lots of hospital hardware and procedures.



Part of the graphical output of a student simulation of a linac head. Linacs are used in hospitals worldwide in the treatment of cancer. Using Topas_edu, students were able to investigate their behaviour building up from the basic physics at work.

The drawback is that this package (and others like it) is hard to use, requiring significant know-how and programming expertise. Joe's team in producing *Topas* removed most of these issues for researchers. *Topas* is a friendly wrapper for *Geant4*, helping researchers in the medical field become much more productive. They simultaneously made it feasible for undergraduates to learn the technique in only a few hours of contact time.

Fred and Balder (PDRA in Fred's team) developed courseware called '*Principles of Medical Physics through Topas*' while Joe developed a special educational version of the software. Malachy put the whole lot into one lovely package, a bootable USB stick. Pop it into your computer, boot it up and hey-presto! - you've got a cutting edge medical physics research simulation tool in front of you.

Our educational approach was not really to emphasise teaching Monte Carlo radiation simulation of itself, but rather to have the students develop a range of computational experiments through which they uncover key principles of medical physics, learning the Monte Carlo technique as a bi-product. The students get to build key bits of medical apparatus in simulation and then get to play with it to see how it functions. They find this approach highly engaging – after all, when did you last get to shoot a high-energy beam of particles at a slab of lead and see the wonderful shower of particles produced, even in the virtual world?

Having developed the teaching package, we wanted to evaluate it but had no idea how best to do this. Enter Liz, Fred's wife. Liz is a British Academy Postdoctoral Fellow (QUB's and Ireland's first and only actually) whose research involves focus group work. She offered to apply this expertise to work with some of the students who had done the course. We funded a lunch for the students and the feedback was better than we could have ever expected with remarks like:

"I would be at home ... and an idea would pop into my head and I'd have to come back in to try it."

"Although it was a lot of work it was also a breath of fresh air, because playing with it almost was fun."

"It allowed you a lot more freedom to take an idea and run with it, you're not just doing an assignment and getting the right answer in the end, you're having the tools to be able to think outside the box and think how would this apply to a real-life situation, ... more creativity."

Joe gave a presentation summarising both the educational package and the focus-group feedback to the American Association of Physicists in Medicine in a special educational session. We were delighted to win the Association's educational innovation of the year award vindicating our belief in the approach.

Things seem to be going full circle as only this week Fred was at a UK research council funded event where several other UK researchers were beseeching the team to put on a special training workshop for UK researchers. The new Maths and Physics teaching centre could be the ideal space for this event – we are just thinking about it now….

And what wider lessons of thoughts are there for research-active educators from other disciplines? Well, first of all, look at your research tools, especially those developed in an open and sharing environment, they might be ideal platforms for innovative teaching. Secondly, don't be scared to challenge the students hard, put the right tools in place and they will thrive. Finally, definitely collaborate with those you like to socialise with, it makes the whole thing so much more fun.

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