Welcome Note

Welcome to the 2014 edition of the Higher Education Group Newsletter, the first edition to be issued entirely electronically. I would like to present this as a positive innovation, a change that embraces information technology to bring us firmly into the 21st century. However, that would not be entirely the truth. There is something reassuring in the printed word and, old fashioned though I may be, I would have preferred to retain the traditional format. Unfortunately, costs have risen in everything we do and the printed Newsletter is just one of the casualties. Hopefully, we can secure an increase in the budget allocated to the Group this coming year and maintain the full range of activities we have traditionally organised.

That is the bad news. The good news is that we have an excellent programme of meetings coming up, starting on 10th December in London. Antje Kohnle of meetings is organising a meeting on Innovative Approaches to Assessment (see back page for details). Next year we have meetings on engagement and that age-old difficulty in physics education, computing. What makes HEG meetings so enjoyable for me is the range of views and experiences expressed in both the presentations and the ensuing discussions, so please contact the organisers if you would like to contribute. Also, if there is a topic that you would like to see addressed at a future meeting, please email me at d.sands@hull.ac.uk.

As I write this, the new academic year is nearly upon us: a new year, a new set of students and a new set of challenges. If your plans for the year include new ideas in assessment, engagement or computing, I hope to see you at one of our meetings, but whatever the year holds for you, I wish you and your students every success.

David Sands
(University of Hull)
Chair of the HEG

The Teaching of Environmental Physics - IOP Higher Education Group and Environmental Physics Group Meeting

4th December 2013, IOP Headquarters, London

With the increasing importance and profile being given to environmental science and its impact globally, the IOP Higher Education Group in partnership with the IOP Environmental Physics Group (with financial support from the HEA) organised a workshop to explore how environmental physics was delivered in tertiary institutions. The aim of the meeting was to highlight current best practice in the delivery of environmental physics and provide exemplars of how environmental topics could be incorporated more widely into an undergraduate physics programme. There was a strong emphasis on the physics content and wider societal issues, such as communicating scientific ideas, and broader ethical issues that can be covered within a physics degree.

As climate change and alternatives to fossil fuels become increasingly important societal challenges, physics graduates should be equipped to tackle these issues on the basis of a sound physics background. To this end, the workshop gave participants exemplars which showed how environmental physics is currently incorporated into undergraduate physics degrees. Examples included stand-alone modules at different levels as well as bespoke broad interdisciplinary courses. The meeting exploited its breadth of expertise to facilitate a broad and open-ended discussion and provided networking opportunities. Staff from institutions across the UK were able to share practical examples and experiences of teaching environmental physics to a wide range of different students and at different levels.

The morning session consisted of presentations that were broader in scope than single modules. Matthew Owens (University of Reading) gave an overview of a new BSc course in Environmental Physics which is due to start at Reading in October 2014. The fundamental physics concepts are to be taught through environmental applications and examples. Other elements include a strong focus on laboratory work and data analysis and the use of context-based learning.

A stimulating presentation by Gordon Aubrecht (Ohio State University) highlighted how the lack of scientific knowledge amongst the general public often led to misunderstanding and entrenched views on a wide range of environmental topics. He discussed how we, as physicists, should engage with the wider environmental debate. It is not sufficient to use scientific language which can often confuse rather than clarify the overall discussion. When teaching about the environment, the issues of framing, confirmation bias, plausibility, temporal and spatial proximity, response times and scales play a key role. The importance of incorporating these ideas within the undergraduate teaching environment was a key point.

The afternoon session began with a talk by Peter Hughes (Westminster Kingsway College) who described the role of the Environmental Physics Group and the history of environmental physics research and teaching in the UK. He described how environmental physics had successfully been incorporated in the A-level syllabi by several exam boards in the 1990s but now it has been removed from the curriculum. He stressed the enthusiasm of school students when tackling environmental physics issues on work-based placements which helped students transit across the secondary-tertiary boundary. The presentation also gave an overview of environmental physics in physics degree programmes across the UK.

The meeting continued with two presentations describing how environmental physics could be incorporated into a physics programme through individual modules. Tony Arber (University of Warwick) teaches power generation to physicists as a 2nd year optional module taken by about 100 students. The module explains the physics behind power generation using topics that students have previously covered and shows how to apply them to environmental issues. This forms the basis of the examined content. Wider ethical and societal issues are discussed in class but are not examined. The wider aim of the course is to enable students to make informed decisions on power technologies. Stefan Hild (University of Glasgow) covers similar topics in an elective module taken by students in year 4 or 5. The course is split 70% final exam and 30% case study. The latter is based on actual examples and is expected to include continued on next page
moral and ethical issues. Both of these elective courses make use of topical issues in the news to enhance the lectures and generate discussions.

The meeting finished with the speakers engaging with the audience via a panel discussion. A key point highlighted in the discussion was that the nature of science is an important area but it is one in which we don’t train our undergraduates enough. A wide-ranging discussion on where environmental physics fits into a typical physics degree programme ensued. The discussion included how environmental physics could be a mechanism for incorporating the scientific method and scientific communication in general in to the curriculum. Teaching environmental physics was perceived to be well-suited as a means of providing stimulating physics applications and as a tool for including discussion of wider societal issues.

**Tom Hase**
(University of Warwick) and
**Antje Kohne**
(University of St Andrews)

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**The White Rose Industrial Physics Academy**

Physics-based businesses directly contribute 8.5% of the UK’s economic output, more than £77 bn per annum (1). Including indirect spending, this figure rises to more than £220 bn. Despite this significant contribution to the UK economy, technical industries struggle to recruit sufficient numbers of physics graduates. Physics graduates are often unaware of technical careers; unlike chemistry, there is no obvious ‘physics industry’. In addition, many of the skills required by students to succeed in industry may not be sufficiently developed during their degree.

To address these issues, HEFCE, the Universities of York and Sheffield and supporting companies are funding the 10 year, £5M project ‘The White Rose Industrial Physics Academy (WRIPA)’. The Academy, which started in March 2014, is led by academics Thomas Krauss and Kate Lancaster at York and Aloistair Buckley and David Mowbray at Sheffield. The aim of the Academy is to better prepare students for a career in technical industry and to encourage a greater fraction to take up technical careers. Hence, a key aspect of the Academy is a strong interaction with technical industry. This is achieved via industry’s direct participation in student projects and events, and representation on an external advisory board. The Academy has been established by the Universities of York and Sheffield, but aims to bring in other partners in due course; the Universities of Leeds, Hull and Bradford have already indicated their intention to join.

The Academy has four main strands: (i) Industry-led projects and internships.

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**Enabling All Students to Achieve Their Full Potential**

26th February 2014, IOP Higher Education Group and HE Academy Meeting, University of Manchester

The Higher Education Group of the IOP held a one-day meeting in Manchester on 26th February 2014 to discuss the means of ‘Enabling All Students to Achieve Their Full Potential’. The meeting was organised locally by Marion Birch and supported by the HE Academy (HEA). To introduce the meeting, Paul Yates (HEA Discipline Lead for the Physical Sciences) gave an update on recent developments such as the re-launch of the New Directions journal, the Innovative Stem Graduate Debate and the extensive HEA meeting schedule for 2014.

**Peter Main** (Institute of Physics) discussed the issue of the participation of women in physics education in ‘Women in Physics: the leaky connections’. He pointed out the importance of the well-known ‘scissors chart’ which shows girls outperforming and out-participating boys at GCSE and A-level but as one progresses to the professorial level there is a crossover and then a drastic percentage reduction in the number of participating women. Interestingly, as the number of girls doing A-level Mathematics has steadily increased since 1985 (to now stand at ~40%), the engagement in Physics has barely changed standing at 21% (in 2012); and none of the many initiatives that have been launched to tackle this has worked. In 2012, physics was the 18th most selected A-level for girls but the 3rd for boys. All school students who study physics at A-level go to university. The IOP study, ‘It’s Different for Girls’, looked at progression to A-level from KS4. The headline statistic was that about half of the state-funded co-ed schools in England and Wales did not have any girls doing A-level physics! The big difference, particularly in the maintained sector, is whether a girl attends a co-ed school or not, there being roughly double the likelihood of a girl selecting A-level physics in a single sex school so clearly the school culture must play a large part in this. In the ‘Closing Doors’ survey, the IOP looked at six of the most gendered subjects to see if types of secondary education were exacerbating or correcting gender stereotyping. It found that 81% of state schools were exacerbating the problem. The conclusion is that to improve the specific position of physics in a school, you have to change the culture across all subjects. Recent research (TISME [Targeted Initiative on Science and Mathematics Education] and the ASPIRES project on science aspirations and career choice) underlines the importance of intellectual capital (e.g. the influence of close family friends) over enrichment and outreach activity. The IOP developments will include work done within the highly successful Stimulating Physics programme. The new ideas include helping confidence and relationship building, improving the classroom experience (to increase active participation), and changing the school culture (initially as a pilot within a school and likely to involve Ofsted which recognises the importance of gender equality). Peter moved on to the longitudinal study of students who had studied physics at university that included data from 40% of UK departments.

At Bachelor’s level, graduate men are more likely to go into employment, and graduate women more likely to continue their studies or enrol in teacher-training. The distribution of destinations for Masters courses (MPhys/ MSc) shows little gender difference although there is a still a graduate salary gender pay gap of 3.3%, roughly half that at the BSc level. Women with first class degrees have a roughly similar spectrum of salaries to men with upper second class degrees. Although they are, if anything, better qualified on average (and more likely to register) than men to take on the fourth year of a four year integrated masters, fewer women choose this route; it should be noted however that their overall drop-out rate on physics courses is smaller than for men. Research is needed into this, e.g. is there an unappealing aspect of advanced physics (e.g. long laboratory hours, lack of major/minor degree options)? Peter’s conclusion was that there are barriers that have been identified by the studies that he described and that these can be overcome, even if one single reason cannot be given for why more girls don’t do physics.

Niels Walet (University of Manchester) presented work he had done with Marion Birch and collaborators in the UK, giving An Update on Gender Differences on the Force Concept Inventory (FCI). Manchester has been using the FCI since 2008, testing the students on arrival at the University and then
This strand ranges from summer projects and internships to industry-led final year projects (following the IOP’s ‘Group Industrial Projects’ model) and year-long undergraduate projects via a year in industry scheme. In addition to exposing students to real-life problems, this teaches important group working skills. York has run group industrial projects over the last two years and Sheffield will introduce them from the 2014-15 academic year. The Academy aims to increase the number of students who take the industrial group project module and the range and number of companies offering projects, to the extent that half of all students directly engage with industry in some way during their undergraduate career. (ii) Teaching laboratory development. This aims to move away from labs where students complete experiments using pre-set equipment. There will be more emphasis on students building up equipment, interfacing to computers and instrumentation in general. Significant use will be made of LaVIEW, which is used extensively in industry and research labs to control equipment and acquire data. Experiments will be designed to support taught material much more directly. (iii) Development of generic skills. There will be further development of existing modules (for example Sheffield currently offer a final year module ‘Physics in an Enterprise Culture’ which will be revised based on input from industry and aims to develop direct industrial participation) and the introduction of new modules to teach problem-solving and enterprise skills. Industry will have a strong input to these developments. (iv) Joint events. The profile of technical industries will be increased and the capabilities of physics students showcased to industry by organising a range of joint Sheffield-York events. These will include recruitment events, careers events, entrepreneurship workshops and company visits. An inter-university physics challenge will be conducted annually. Students will also be encouraged to participate in outreach to schools in order to highlight the attraction of technical careers to the next generation of students. Although the Academy is focused on universities in the local Yorkshire and Humberside region, it is very keen to work with other universities in the UK. This could involve the adoption of material and ideas developed by the Academy or the development of new ideas. If you are interested in exploring how you can work with the Academy, please contact the project manager Andrew Hirst andrew.hirst@york.ac.uk. The Academy inaugural event will be held on 19th November, in York. It will be attended by representatives from industry, academia and the student body. If you are interested in attending, please contact Andrew.

David Mowbray
(University of Sheffield)

mid-semester (pre- and post-instruction). Female students score roughly 15% lower than male students, even with students with stronger entry qualifications, a gap not really mirrored in examinations of the same material. This has also been reported in the UK (at Hull and Edinburgh) and at US universities. All of these institutions use highly engaging teaching methods: peer instruction; tutorials; co-operative problem solving. The question arises as to whether the test itself is gender-biased so Niels and Marion looked at the questions where the gender difference was most marked (and remained post-instruction e.g. questions 14, and 21-23), and set about recasting them. There seemed to be a small change on question 14 but a significant change on questions 21-23 although the study suggests question 13 might be the most discriminatory (“Does a contact force maintain its effect post-contact?”). Averil Macdonald (University of Reading) posed the question: Is my daughter making a huge mistake studying science? Averil’s daughter has a close family of practicing physicists which represents concentrated intellectual capital, and therefore makes for an interesting case study. Averil’s daughter is very well qualified and has had a wide variety of high quality work experience. However, she may be hampered by good looks in being judged (even unconsciously) as a serious scientist. Averil described the Victorian obsession with phrenology and the relation of physical characteristics to behavioural tendency. She suggested this manifests itself today as unconscious patterning which leads to gender bias. Another important factor is that though there is a lot of effort devoted to persuading girls to do science, little effort is expended to keep them in STEM-related careers. Indeed, other non-STEM professions proactively attempt to divert STEM students e.g. into finance, marketing and business. So female students are taking a pragmatic approach to the career landscape, and move away from the subject into areas where they perceive (and are told) they are more highly valued.

One motivation for the meeting was the recent release of Chapter B4 of the UK Quality Code for Higher Education. Harriet Barnes (QAA) described the construction of this chapter which is called Enabling student development and achievement. All higher education providers in the UK sign up to deliver their programmes to the requirements of the whole Quality Code which, though administered by the QAA, should be thought of as owned by the sector. It was launched in 2011, evolving out of the Academic Infrastructure. Each chapter of the code has three key components: expectation; indicators of sound practice; and explanation. The expectation for Chapter B4 is that ‘higher education providers have in place, monitor and evaluate arrangements and resources which enable students to develop their academic, personal and professional potential’. The idea of ‘enabling’ is now recognised to have a broader scope than what was covered in the Academic Infrastructure, and should include learning resources and other mechanisms put in place to facilitate student achievement. Input to the wording of the chapter was offered by a range of professional bodies. This has led to a strong focus on transitions into, through and out of higher education, together with a clear definition of responsibilities so that every student will perceive a seamless integrated approach to support for their studies. A strong theme is that solutions should not be ad hoc and specific to individuals, but thought out in advance to ensure general inclusivity and accessibility. Harriet stressed that the QAA should not be seen as a prescriptive organisation; it publishes reports and toolkits to help universities put the principles of the code into practice. Harriet concluded by looking forward, particularly to the revision of subject benchmark statements and qualifications frameworks and was happy to receive offers of help from members of the physics HE community.

Lucy Hadfield (University of St Andrews) tackled the question of attracting students from non-traditional or challenging backgrounds into courses within higher education which have taxing entry requirements. The Gateway to Physics and Astronomy programme at St Andrews targets students from low progression schools or ‘deprived areas’, students who are young carers, or have been in the care of a local authority, or students who reside in an area that falls under the University’s rural access scheme. Geography was quite a barrier for many applicants and so the scheme meets travel and accommodation expenses for visits and interviews. These are essential to increase the students’ likelihood of making a success of the course. The scheme began in 2010 and the Gateway students have integrated well with the rest of the cohort. However they have their own Gateway modules: these afford them less choice but give them extra practice and reflection in maths and physics, whilst developing general learning skills (presentations, problem-solving, lab skills through inquiry-based labs).
The 2014 Physics Higher Education Conference (PHEC) took place in the picturesque city of Durham on the last Thursday and Friday in August. Ever since the demise of the HEA Subject Centres, PHEC has been held jointly with the Variety in Chemistry Education conference and the benefits to both the physics and chemistry education communities was evident in the opening keynote lecture given by Professor Simon Lancaster (University of East Anglia). In a challenge to the conventional lecture, Simon looked back to some extent on his own journey in education but also acknowledged the contributions that some physicists have made to his current thinking. Simon is a very engaging and amusing speaker and it is no wonder that students value his teaching.

The following day Antje Kohnle (University of St Andrews) gave the physics keynote lecture. Antje spoke about using simulations in teaching quantum mechanics, which has been an area of interest of hers for some time. The new curriculum in quantum mechanics sponsored by the IOP, to which Antje has been a major contributor, was on show to some extent. As well as being intrinsically interesting, Antje’s talk was a case study in how to do education research. The rest of the conference was given over to the usual mixture of oral bites, five-minute presentations that give a flavour of the kind of work that people are doing, regular presentations in physics or chemistry oriented sessions, and workshops. Two workshops that I attended were really very informative: the first was on team-based learning (TBL), which looks to be a very effective method of promoting conceptual understanding through group work, and the second was on the Teaching Fellow Network. Teaching Fellows are increasingly being employed to deliver teaching in large departments, particularly it seemed to foundation year students, and the workshop highlighted some of the excellent work being carried out by this group of people as well as some of the difficulties they face around professional and career development.

I came away from the conference struck by the imagination shown by many of the participants in their approach to various aspects of teaching. There is some fantastic work being done up and down the country and PHEC provides a natural forum for its dissemination. The chemists still make up the largest contingent, by some way, but there is no sense that physics education lags behind chemistry education. There is plenty of scope, therefore, for PHEC to expand and I hope that many of you reading this will consider contributing next year.

David Sands (University of Hull)
Chair of the Higher Education Group

Student feedback on the scheme has been very positive and attainment good so the pilot has been extended to other schools within the University. Aneez Esmail (University of Manchester) tackled the relative under-achievement of ethnic minority students in higher education, a significant national problem, in his presentation ‘Mind the BME gap’. He discussed possible explanations: (conscious and unconscious) racism; socio-economic background; lack of a family background with university study; the level of parental involvement; subject choice; a need to work; and expectation levels. Aneez described an analysis of the performance of Manchester students that showed differences in the size of the gap between subjects, and a global analysis of national figures including cases where the gap is much wider. He stressed the necessity of bridging the support gap between school and university, support that is personal and face-to-face. As an example, early identification of students who needed help in developing study skills (such as critical analysis, constructing an argument, language/essay skills) had been effective at several institutions.

Mark Hughes (University of Manchester) has long been involved in helping students with Asperger’s Syndrome (AS). In his talk on this subject he described some induction videos that have been made at Manchester for students who fall within the autistic spectrum. They constitute a series of ‘distraction-free’ programmes that students watch prior to arrival at university. The videos are kept simple and direct (avoiding rapid cuts and gimmicky) and introduce a student to: a mentor who will be supporting them through their time at university; the town and university life in general; and specific aspects of pastoral care (e.g. the Disability Support Office). The videos anticipate issues that might make a student with AS anxious e.g. a lift being out of action or the need to wait in a reception area. Mark also described the resource pack that he had compiled with a team of colleagues at the University of Hertfordshire. The resource pack is one of the most requested toolkits distributed by the HEA.

Wayne Stimson (University of Hertfordshire), a third year astrophysics undergraduate, presented a video he had made to explain the challenges faced by dyslexic students studying physics. Wayne showed the difference in his effectiveness as a learner between sessions in which he had access to materials in advance and those without. He highlighted that active engagement in the class was only possible in the former case. Wayne went on to describe and demonstrate the smart pen and paper that he uses in classes. The pen records an audio track of the teaching session synchronised with his personal note-taking. The enhanced material can then be reviewed at a later date at the student’s own pace.

David McDonagh is a third year student on an innovative interdisciplinary degree, Natural Sciences, run by the University of Leicester. He gave some reflections on undertaking a problem-based learning degree and the student’s perception of the role of a university. David described some examples of problem-based learning in action and showed how a good over-arching problem (e.g. what would happen if Earth was on Mars’ orbit and vice versa) breaks down into smaller parts that lead the student laterally across the curriculum. The focus is on inquiry-based group work and this forces the student to go beyond passive learning. Optional extension tasks are a means of looking deeper into a subject, allowing the student a large measure of freedom in approach, and these can garner extra credit. More importantly perhaps, they develop students’ research skills, particularly the ability to find and critically evaluate technical material. David suggested that universities should think beyond traditional repetition of lecture courses (since many fine ones are available online) to PBL-driven models similar to the one he described.

James Collett (University of Hertfordshire)

Mark Hughes delivering his presentation on helping students with Asperger’s Syndrome. Photo courtesy of James Collett.
The Leicester Centre for Interdisciplinary Science at Ten Years

The Interdisciplinary Science programme at the University of Leicester grew out of a desire at the IOP to find new ways of delivering undergraduate science programmes in higher education in order to arrest the decline, at the time, in student numbers entering STEM subjects. The IOP set up a working group, chaired by Professor Mick Brown (University of Cambridge), to commission market research on various strategies, out of which an interdisciplinary programme appeared to be the clear favourite. Launching such a programme at Leicester was made possible by the external funding received initially through the HEFCE FDIT4 projects, later through our joint Centre for Excellence in Teaching and Learning with the Open University and finally with the support of the IOP through the Integrated Sciences and Stimulating Physics programmes. It is now ten years since we admitted our first cohort of students and the programme (renamed Natural Sciences on the recommendation of one of the many external evaluations) is now funded entirely through the University. That we have survived is perhaps in itself a cause for celebration, but this piece is not a ‘plug’ for the University of Leicester. What I want to do is to describe briefly why I believe in the structure and pedagogy we have developed as a potential model for HE.

Universities, or more particularly their academic staff, are subject to a range of ever increasing pressures: research assessment, teaching evaluation, increased student numbers, increased accountability, public engagement, and entreaties to find additional sources of income. The pressures are not going to go away, so the responses need to be able to create viable structures. Rather than asking everyone to multi-task more, this, in my view, can be better achieved through the appropriate division of labour: something that seems to be happening to some extent in an ad hoc fashion with the creation of ‘teaching dominant’ posts.

The Centre for Interdisciplinary Science is a teaching centre with no discipline research mission. The Centre employs a team of teaching fellows (TFs) whose role is to deliver the core teaching for the Centre’s Natural Sciences programme. The pedagogy of the programme is research-based learning, but the model is applicable to any pedagogy including the traditional lecture-based approach. Our TFs have a development and pedagogic research responsibility, which we regard as part of the professionalisation of their roles (they are not lecturers on the cheap), but this is not an essential feature of the model. The main face-to-face contact with students is therefore with qualified teaching staff whose job is to support their learning. Academic research staff from across the University science departments contribute ‘guest lectures’. In our model we have two such guest lectures a week over the three years of the programme giving a total of 120 hours of face-to-face lectures (in flipped classroom style), an average of 2 lectures per academic per year. We regard this as the minimum not replaceable by on-line content. Academic staff also supervise projects in years 3 and 4, but the total involvement is relatively small and hence delivered with considerable enthusiasm, to (largely) engaged students, not as an extended distaction from their research. We also employ additional demonstrator help in laboratories.

The management of the Centre is handled by a departmental administrator. This includes tasks often assigned to academic staff, including the roles of timetabling, examination officer, admissions officer, VLE maintenance and so on. This is a more efficient use of resources than the use of research academics for these roles.

The cohort is currently small, about 20-25 students in each year group, which brings us to the issue of scalability. At its current level the return of the programme to central funds is in line with other science departments; i.e. the direct costs are an acceptable fraction of fee income. Given therefore that the programme is viable at its present level, an increase in student numbers would enhance its viability, since, with the exception of lectures and administration, which become more efficient, teaching resource requirements scale directly with student numbers.

The structure supports a virtuous circle in the following way. We know that students are largely attracted to institutions on the basis of their reputation and that ‘reputation’ in this context generally means their standing in research. It is likely that developing and maintaining such research standing is best achieved if leading researchers are not too overburdened by teaching and administrative duties. However, once students have enrolled, their experience is largely determined by the quality of the teaching. It is likely that developing and maintaining such teaching quality is best carried out in the main by staff whose employment is not dependent on the production of discipline research of international quality. Specialist teachers can maintain good teaching, and hence the income from teaching, for the many students attracted to the institution by the output of its specialist researchers.

So, on our tenth anniversary, what I think the IOP has helped us deliver is a not just a degree programme in interdisciplinary science, but a working example of how university education could be more effectively structured.

Derek Raine
(University of Leicester)
This year’s GIREP/MPTL (Groupe Internationale de Recherche sur l’Enseignement de la Physique/ Multimedia in Physics Teaching and Learning) conference was held in Palermo, Sicily. It was attended by 266 participants from 41 countries. There appeared to be fewer delegates from the UK this year than previously. There were 11 plenary lectures, 11 symposia, 15 workshops, 7 oral sessions (each consisting of 4 or 5 twenty minute presentations), plus two poster sessions.

During the opening ceremony the President of GIREP, Marisa Michelini (University of Udine, Italy) presented the 2014 GIREP Medal for Lifetime Achievement to Jon Ogborn. The medal is conferred for long and active involvement in GIREP and the development of physics teaching. Jon Ogborn is Emeritus Professor of Science Education at the Institute of Education, University of London and is an Honorary Fellow of the IOP. He played a significant role in the development of the Nuffield Physics ‘A’ level and led the Advancing Physics Project.

A common theme throughout this year’s conference, which was articulated by many of the presenters, was the need to move away from content focused curricula towards one which emphasises the process of physics thinking. This was very much the theme expounded by the first plenary lecturer, David Hammer from Tufts University, USA, in his talk entitled ‘Teaching Physics as a Pursuit’. David argued that physicists enjoy having problems or confusing situations to solve and that there is no other sort of physics than inquiry-based physics. To say that there is, he argued, is like talking about immersion-based swimming. He questioned why the physics education community continues to think the goal of teaching and learning is a body of physics knowledge, and suggested that it is a challenge to notice, understand and respond to students’ reasoning, but we ought to be assessing not students’ conceptual achievement, but rather their process or pursuit.

Francisco Esquembre (University of Murcia, Spain) gave the second plenary talk entitled ‘How can teachers create simulations for tablets (and why should they do so)’. This was a very interesting presentation which introduced a new major version of the Easy Java Simulation (EJS) modelling tool which can be used to create Java simulations for computers (existing feature) and JavaScript simulations for computers, tablets and smartphones (new feature). Francisco introduced his talk by asserting that there are three
factors involved in the motivation of students: (i) curiosity – we need to stimulate students’ curiosity, (ii) control – students need to feel that they are controlling what they learn and (iii) co-operation – students need to work together. Simulations can help motivate students in two different ways (i) by providing them with challenging animated problems which have been created by teachers, i.e. the more usual way used for lower level courses, and (ii) at a higher level, challenging the students to create simulations themselves. He then proceeded to demonstrate three excellent examples of simulations that had been produced by third year undergraduate students. The students had effectively to develop mini computer games and in the process they had been challenged to apply some tricky physics concepts. The first example was of Tarzan using a rope to swing himself across some water. This was modelled as a simple pendulum followed by free fall as he landed on the other side. Initially the students considered the rope to be massless but then they were required to make the model more realistic by taking the centre of mass of the pendulum into account. The second example was a ‘teacups’ fairground ride involving a number of cup-style spinning vehicles mounted on a circular turntable-like floor. The students were challenged to model the motion of the teacups both with and without friction, and also to investigate the effect of the positions of the passengers within the cups. The final example involved modelling the SynKope ride, another fairground ride which consists of a giant rotating disc on the end of a pendulum which reaches 90km/h, and goes to a height of 35m at an angle of 120°. Passengers are fastened around the circumference of the disc. Students had to model various scenarios including the determination of the safety perimeter if passengers were to lose their shoes or drop their mobile phones. EJS is free for non-commercial use and further information can be found at www.um.es/fem/ EjsWiki/.

As someone who has used Eric Mazur’s Peer Instruction teaching technique for many years now, I was delighted to have the opportunity to hear him speak. Eric Mazur is the Balkanski Professor of Physics and Applied Physics at Harvard University, and his plenary talk was entitled ‘Understanding by Design’. He also referred to his ‘T rojan horse’, a team and project based approach, to disguise the physics. He emphasised three requirements: (i) alignment of goals to students’ needs and expectations, (ii) a change in approach and (iii) a redesign of the learning space. He also referred to the Dudley Herschbach lecture that he had given at Harvard in October 2013, entitled ‘Assessment: The silent killer of learning’, which is available on YouTube and well worth watching. We know that it is the assessment which drives the students’ study techniques, and yet current assessment methods used in physics education still focus on memorisation. We continually state that students should be able to problem-solve but we don’t assess this properly. Eric argued that in real life, you generally know where you want to go, and the problem is to determine how you get there, i.e. the process or procedure, whereas most problems that we give to students are textbook problems which just require them to apply a known procedure to determine an unknown numerical answer. Real problem solving is erratic and often requires trying different paths, some of which won’t work. However current teaching methods do not encourage students to take risks or make mistakes, and students become frightened of doing so.

Eric mentioned another book entitled ‘Understanding by Design’ by Grant Wiggins and Jay McTighe which advocates learning outcomes, rather than content, as the starting point for course design. It wasn’t immediately obvious to me how this differs from the standard Biggs’ Constructive Alignment model of course design, but I have yet to read the book. Commenting on the design of the learning space, Eric argued that lecture theatres are for performances and force students to be passive, whereas flat spaces enable students to be active and interact with one another. Eric’s new course has three components: (i) information transfer (which takes place prior to the class), (ii) in-class activities and (iii) projects. In-class activities include estimation, reflection, readiness assessment, learning catalytics, tutorials and experimental design. There is a great deal of team work involved in the course which encourages social responsibility and professionalism in terms of participation, punctuality and engagement. Although there are no formal exams, the course is assessed via peer assessment, the students’ conceptual understanding gains as measured by the FCI (Force Concept Inventory) are significantly greater than those obtained in traditional courses.

I presented the results of our latest investigation of the gender difference on the FCI, where we altered the context of some of the questions to make them less male-oriented. Contrary to earlier work by Laura McCullough (Wisconsin-Stout University, USA), we found that the significant gender differences seen with the FCI remain independent of context. In the same session Hideo Nitta (Tokyo Gakugei University, Japan) presented a paper on gender differences in Peer Instruction. He had found that fewer female students give the correct answers to clicker questions before discussion than male students.

Antje Kohlme (University of St Andrews) gave an excellent final plenary lecture on ‘Research-based interactive simulations to support quantum mechanics learning and teaching’ in which she led us through some of the interactive simulations which have been developed as part of the QuVis Quantum Mechanics Visualisation project (www.st-andrews.ac.uk/physics/quivis). The simulations support model-building by reducing complexity, focusing on fundamental ideas and making the invisible visible. They promote engaged exploration, sense-making and linking of multiple representations, and include high levels of interactivity and direct feedback. Some simulations allow students to collect data to see how quantum-mechanical quantities are determined experimentally. A recent collection of QuVis simulations is included in the IOP’s New Quantum Curriculum (http://quantumphysics.iop.org) which consists of freely available resources.

Another interesting contribution from the UK was a presentation by Ivan Ruddock (University of Strathclyde) on ‘Imaging in Gradient Index (GRIN) Fibre’. He described the extension of the basic undergraduate experiment on ‘thin’ lens parameters to include ‘thick’ lenses and then the use of a short length of GRIN fibre as a novel alternative for such a lens along with a demonstration of its ability to transmit an image. In a second paper, Ivan also presented an overview of the HOPE (Horizons of Physics Education) academic network; a report on HOPE was published in the November 2013 Higher Education Group Newsletter.

The next GIREP-EPEC (European Physics Education) Conference will be held in Warsaw, Poland, from 6th-10th July 2015. The next MPTL conference will be held in Munich, Germany, from 9th-11th September, 2015.

Marion Birch
(University of Manchester)
The UK Teaching Fellow Network

The UK Teaching Fellow (TF) Network is based at the University of Leicester and was established in December 2012 with the help of the IOP and the HEA following a meeting at the IOP. The intention was that “Teaching Fellow” should include all academic staff appointed to teaching-only or teaching-dominant roles; and while nominally focused on Physics, the Network has welcomed all STEM disciplines. The Network is intended to help build a community of teaching staff in universities, with the aim of sharing good practice and discussing different perspectives on the role. The HEA funded the establishment of a web site that hosts the TF Forum (Hurkett, 2013). One of the other aims was to gather information on the range of conditions of employment of those with the title of Teaching Fellow or with other teaching dominant lecturer positions.

We have so far held two workshop sessions within conferences in addition to the inaugural meeting. During the first workshop, held at the HEA STEM Annual Learning and Teaching Conference in Edinburgh last Spring, we had an invited talk by Antje Kohnle on undertaking pedagogic research as a TF and we reported on our national survey of the status of TFs. We also had a discussion on how the network could be taken forward, especially in the light of some of the survey responses which showed that many TFs feel isolated and under-valued. The full report can be found on the Forum website:

www.physics.le.ac.uk/TeachingFellowForum/phpBB3/

At the second workshop held during the VCIE-PHEC meeting in Durham in August there were invited talks by Dylan Williams (University of Leicester) and by Charles Bailey (University of St Andrews) together with six shorter contributions. These workshops are intended to give newly-appointed teaching staff a chance to talk about their projects and to network with more experienced Teaching Fellows. There was also a short update on the progress of the survey report, in particular the work being done by the Society of Biology and the interest from the Royal Society for Chemistry (RSC). The full programme can be found on the Forum website.

It is interesting that an Institute of Physics report (McWhinnie, 2013) identifies, through direct requests to human resource departments, 355 teaching-only staff in Physics and 425 in Chemistry, whereas the websites of the academic departments identify far fewer. With only 66 registered users of the Forum, we are clearly failing to attract the great majority of academic teaching-focused staff to the Network. This may be because (a) there are too many options (RSC run a network and there are internal networks in some institutions); (b) there is too little time (the obverse of (a)): TFs find themselves too overloaded with teaching; (c) the title “Teaching Fellow” is misconstrued to exclude ‘proper’ academics. (It was intended to be a high-status appellation - compare ‘Research Fellow’ awarded only to the best researchers - but, for example, at Leicester “Teaching Fellow” is now not even treated as an ‘academic’ role.); (d) the Network is just not visible yet.

One way of raising visibility, which was suggested at the Edinburgh meeting, is the possibility of a STEM TF Network Newsletter. This is an excellent idea, but it cannot be seen as just a Leicester initiative: we need some volunteers to help put it together (and to distribute the workload). Let us know if you are interested, or know anyone who might be.

Derek Raine
(University of Leicester)


McWhinnie, S, (2013), ’Academic physics staff in UK higher education institutions’, a report prepared for the Institute of Physics by Oxford Research & Policy.

How to join the Higher Education Group

You can become a member of the Higher Education Group via the IOP website by logging into MyIOP and selecting ‘Change my Groups’ from the menu on the left of the page. If you have forgotten your MyIOP membership details, you should email member.services@iop.org for help.

Forthcoming Events

19th November 2014
The White Rose Industrial Physics Academy Inaugural Event, University of York

10th December 2014
Innovative Approaches to Assessment. HEG meeting, IOP HQ, London

3rd - 6th January 2015
American Association of Physics Teachers Winter Meeting, San Diego, California

25th February 2015
Student Engagement, HEG meeting, University of Leicester

2nd June 2015
Developments in Teaching Physics Students Computer Programming Skills, HEG meeting, University of Sheffield

6th - 10th July 2015
Key Competences in Physics Teaching and Learning. GIRED-EPEC (European Physics Education Conference), Warsaw, Poland

25th - 29th July 2015
American Association of Physics Teachers Summer Meeting, University of Maryland, College Park, Maryland

26th - 31st July 2015
ICPE (International Commission on Physics Education) Conference, Beijing, China

9th - 11th September, 2015
MPTL (Multimedia in Physics Teaching and Learning) Conference, Munich, Germany

July 2016
WCPE (World Conference on Physics Education), São Paulo, Brazil (precise dates not confirmed yet)