Case Studies on the Teaching Researcher

Overview

The aim of the work was to identify practices that help academic staff manage and integrate their research and teaching roles. Data was collected from across the UK using semi-structured interviews and an online survey. The interviews involved academics from the STEM disciplines, and represent a small UK sample of accomplished researchers who are also exceptional proponents of university education.

12 case study summaries, from a subset of 34 academic staff interviews, are presented in this report. These have been designed to stimulate discussion on the teaching and research roles. A succinct style is used to enable the quick assimilation of teaching philosophies and practical advice. Each case study is concluded with a summary of key messages (denoted by ) as well as suggested questions for reflection (denoted by ). Several of the summaries are accompanied by a short commentary from an education expert.

The interviews were based on 12 questions:

1. At a personal level, what do you perceive as strengths and weaknesses of teaching in research-intensive universities?
2. How do you manage your roles as both a researcher and a teacher?
3. What does integration of teaching and research mean to you?
4. What are the main motivational drivers for your academic career?
5. What helps you to manage your different academic roles effectively?
6. How would you describe your own teaching approach / philosophy?
7. How do you integrate your research into your undergraduate teaching?
8. Are there similarities in how you support the development of your research and undergraduate students?
9. Is there anything within your institution that helps to support the effective integration of research with undergraduate teaching?
10. What helped you most in your development as a teacher?
11. What kind of teaching induction / training did you receive?
12. Given your experiences, how best can universities support new academics in the management of their teaching and research roles?

Together these questions covered the main case-study themes of: teaching practices and work approaches (especially for teaching-research integration and student development), motivational drivers, coping mechanisms and support systems / resources.

Report Structure
Further information on the project background, its implementation and key outcomes is given in Appendix A.

The 12 case study summaries are presented in Appendix B. A list of academic staff contributing to these summaries is given in Table 1.

Table 1 – Case study summaries: sub-set of interviewed academic staff.

name	institution	discipline	page
Sarah Bell	University College London	Engineering (Civil)	10
Grant Campbell	University of Manchester	Engineering (Chemical)	13
Claire Davis	University of Birmingham	Engineering (Materials)	16
Paul Ewart	University of Oxford	Science (Physics)	19
Lee Fawcett	University of Newcastle	Mathematics	22
Andrea Jackson	University of Leeds	Science (Environmental Science)	25
Julian Park	University of Reading	Science (Environmental Science)	29
John Parkin	London Southbank University	Engineering (Civil)	32
Eann Patterson	University of Liverpool	Engineering (Materials)	35
Bernard Porter	University of Coventry	Engineering (Mechanical)	38
Stephen Richardson	Imperial College London	Engineering (Chemical)	42
Jon Steed	University of Durham	Science (Chemistry)	46

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Esat Alpay* and Rianne Verschoor
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Faculty of Engineering
Imperial College London
South Kensington Campus
London, UK. SW7 2AZ.

* Corresponding author:
e.alpay@imperial.ac.uk;
+44 (0)20 7594 1567

Appendix A
Project Background, Implementation and Outcomes

see also: Alpay and Verschoor (2013) re the online survey data

Background and Rationale

Tensions between research and teaching in university are well recognised. Currently, the problems are confounded by the increasing competitiveness amongst research-intensive universities for both research funding and student satisfaction ratings. In September 2010, Imperial College London held the first Educating Engineering Leaders (E2L) conference, bringing together an international group of experienced educators and industrialists. The two-day event focused on the teaching concerns and aspirations of research-intensive institutions. Specifically, discussions were held on the relationship between university teaching and scientific research, how engineering degrees respond to the needs of industry and society, and the student transition into, and experience of, engineering education. A survey on the views of the delegates reinforced concerns of the growing dichotomy between the teaching and research responsibilities of academic staff (see Alpay and Jones, 2012). Whilst institutional and personal prestige may rely on research output, such research-focused institutions must also address the increasing need for student professional skills and aptitude development for work and leadership in global work contexts. Students themselves are stressing a desire for such development and often, in research-focused institutions, for greater involvement in exciting research developments. Thus, a strong need exists for improved synergy in the teaching and research realms of such institutions.

The aim of the project was to identify and disseminate practices that effectively integrate the research and teaching needs of institutions. Surveys and interviews were used to address the fundamental questions:

- What are the typical practices, work approaches and support resources of those individuals who are able to maintain both outstanding teaching and research profiles?
- How are / were obstacles overcome?

The project outputs could then inform the induction and training of new lecturers on matters of teaching and research role integration, and elaborate teaching pedagogy through examples of good practice. Ultimately, practices for improving teaching and research practice are expected to benefit both teacher motivation and student engagement.

Implementation

The project involved a combination of an online survey and semi-structured interviews. Several scientists and engineers (see Table A1) were initially consulted to explore their views on the teaching-research nexus and to enable formulating relevant questions for more in-depth case studies (see below). For the case studies, STEM academics from a broad range of UK institutions were selected based on their achievements in both teaching and research. An online survey was also designed to obtain complementing data from a wider pool of academics. Where appropriate the case study data was further supported by information on institutional policies.

Table A1 - Scientists and engineers involved in preliminary interviews.

Position / role (number of people)	**Affiliation**
Senior academic staff across STEM universities (13)	Universities of Aston, Loughborough, Liverpool, Northumbria and Imperial College London
Education consultants (3)	Engineering Education
Academic & curriculum advisors (2)	Higher Education Academy
Principal Concept Engineer (1)	Industry (Shell)
Educational Development staff (4)	Imperial College, King's College, Newcastle University

Although the target audience of this study is academic staff in research-intensive universities, data collection was from a broad range of institutions to reflect individual examples of teaching and research excellence across the Higher Education sector. Specifically, a wide network of Higher Education Institutions was established through existing contacts and with the help of three university groups, namely the Russell Group, Million Plus and 1994 groups. On our behalf, representatives from these groups sent a letter to all their members (about 75 universities in total) requesting assistance in identifying individual and teachers with both outstanding credentials. In order to obtain a representative sample of academics, selection-guidelines were devised accordingly. For example, indicators for teaching excellence included: teaching awards / prizes or other similar recognition; leadership in major teaching innovations; and significant publications in teaching and learning. Other selection criteria, such as gender, career stage and discipline, provided some balance on participant demographics. In total 34 semi-structured interviews were undertaken with a variety of STEM-academics from several universities including: Birmingham, Coventry, Durham, Imperial College, Kings' College, Leeds, Liverpool, Loughborough, London Southbank, Manchester, Newcastle, Nottingham, Oxford, Reading, Sheffield and UCL.

A semi-structured interview was designed and included 12 questions covering the following themes: motivation, coping mechanisms and support work approaches, teaching practices, and student development. Namely:

1. At a personal level, what do you perceive as strengths and weaknesses of teaching in research intensive universities?
2. How do you manage your roles as both a researcher and a teacher?
3. What does integration of teaching and research mean to you?
4. What are the main motivational drivers for your academic career?
5. What helps you to manage your different academic roles effectively?
6. How would you describe your own teaching approach / philosophy?
7. How do you integrate your research into your undergraduate teaching?
8. Are there similarities in how you support the development of your research and undergraduate students?
9. Is there anything within your institution that helps to support the effective integration of research with undergraduate teaching?
10. What helped you most in your development as a teacher?
11. What kind of teaching induction / training did you receive?
12. Given your experiences, how best can universities support new academics in the management of their teaching and research roles?

Where possible questions were linked to theoretical understanding and/or existing research, e.g.:

- Motivational drivers: Responses were framed by some current understanding of individual and social psychology relevant to work motivation, such as content and process theories (Mullins, 2010).
- Teaching approaches for research integration: Jenkins and Healey (2005) developed a framework on curriculum design and the research-teaching relationship. This framework was used to prompt interviewees and where possible responses were categorised accordingly.
- Supporting teaching development: Where appropriate the educational understanding needed as a teacher was discussed and related to an "informal guide for the engineering education scholar (Case, 2009). Specifically reference was made to concepts of *learning as acquisition* and *learning as participation*.

In total, 34 academic staff were interviewed; a subset of 12 interviews was then selected to illustrate a range of key messages, anecdotes and practices (see Table A2). Before interviewing the selected academics; two pilot interviews were carried out. The first was used to test the interview design and the second to retest the questions

and trial the audio and video recording. Interviewees were sent a project outline, themes for discussion and a summary of the questions. This allowed preparation for the interview (at least) a week in advance. The interview data (for all 34 interviews) was transcribed and analysed further using a cross-case display (Miles and Huberman, 1994). This method allowed overall conclusions to be drawn by systematically noting patterns and themes; key messages from the interviews were also extracted into a separate table. Interview reports were then built up, using a pre-defined template including these categories from the cross-case display. In addition, each is accompanied by a short commentary (by an external teaching expert) on the educational premise of the practices being described. Draft reports were sent back to interviewees for approval, clarification or further input where necessary.

Table A2 – Sub-set of interviewed academic staff.

Name	**Institution**	**Discipline**
Sarah Bell	University College London	Engineering (Civil)
Grant Campbell	University of Manchester	Engineering (Chemical)
Claire Davis	University of Birmingham	Engineering (Materials)
Paul Ewart	University of Oxford	Science (Physics)
Lee Fawcett	University of Newcastle	Mathematics
Andrea Jackson	University of Leeds	Science (Environmental Science)
Julian Park	University of Reading	Science (Environmental Science)
John Parkin	London Southbank University	Engineering (Civil)
Eann Patterson	University of Liverpool	Engineering (Materials)
Bernard Porter	University of Coventry	Engineering (Mechanical)
Stephen Richardson	Imperial College London	Engineering (Chemical)
Jon Steed	University of Durham	Science (Chemistry)

To complement the qualitative data expected from the interview, an online (SurveyMonkey) questionnaire was designed to collect quantitative data from the wider academic network described above. The questionnaire consists of 18 items (the full questionnaire can be attained upon request; see also Alpay and Verschoor (2013)):

- Items 1-7 focus on background information, such as discipline, gender, academic rank and teaching experience and load.
- Item 8 is an adaptation of questions from Ramsden and Moses (1992) to gauge attitudes about the value of teaching for research and vice versa.
- Items 9 and 10 include questions adapted from Healey and Jenkins (2005) on the use of approaches to teaching that integrate research into teaching.
- Items 11-15 relate to work life aspirations, motivation, balance between teaching and research, and the value of specified achievements.
- Items 16-18 relate to academic role management and support

A response rate of 411 was achieved from across the UK. The STEM subject representation was 40.6% from Science, 6.3% Technology, 41.8% Engineering and 11.2% Mathematics. 28.5% of the respondents were female. The distribution of academic rank was: lecturer – 25.5%; senior lecturer / reader – 41.6%; professor – 23.6 %; other – 9.2%.

Discussion, Learning and Impact (Success):

Interview Reports

The 12 interview reports and the full cross-case matrix are included as supplementary files to this report; audio recordings can be attained upon request. The interview reports themselves have a succinct design, whereby there is a focus on key messages, rather than detailed descriptions of practice. Workshop feedback was supportive of such a design, in that much information on practice could be conveyed without excessive reading or time on the part of the lecturer. However, follow-up links and references are used to support the information. As mentioned above, in all cases, questions for reflection are included to encourage deeper engagement with the

content. This was a feature that was particularly desired from by participants of the evaluation workshops.

Key Findings from the Interviews

The work has generated a range of different practices and approaches in teaching and research, from which overarching themes can be identified or current examples. The cross-case display approach of the 34 interviews was particularly helpful in grouping practice and advice; see Table A3 for an abstract of such a display. Likewise, the study led to some current practical elaboration on previous concepts of teaching-research integration. For example, the case study findings provide several current (and occasionally innovative) examples under the 4 typical categories for approaches that integrate research into teaching (Jenkins and Healey, 2005), e.g.:

- Learning activities involving both postgraduate and undergraduate project-students to discuss issues such as "how to write a paper" (i.e. research-oriented)
- The publication of student research work in national undergraduate research journal (i.e. research-based)
- The regular creation of new courses (or inclusion of new material) to reflect the specific interests of the researcher (i.e. research-led teaching)
- The use of real data from the teachers actual research work / papers for, e.g., statistical analysis, critique and evaluation (research-tutored).

Table A3 – Abstract of the cross-case display. (The full cross-case display is available as an Excel spreadsheet upon request.)

	University	**Discipline**	**Work Approaches**	**Teaching Practice**	**Student Development**	**Motivational Drivers**	**Coping Mechanisms**
Case A	Reading	Bioscience	Whole ethos as "Student as Producer" - Research is increasingly led by students.	Website: ''Engage in Research' guidance in research process.	Developing new skills: research, employability, professional.	Immediate response from students "when the penny drops".	Reviewing as many papers as expecting to publish.
Case B	Newcastle	Mathematics	Using consultancy and collaborations with other disciplines to inform teaching.	Enhancing visual learning environment to engage students.	Able to relate statistics to own background and real-life context.	Not driven by promotion more by enjoyment and student learning.	Focus on clear goals and deadlines as discussed in appraisals.
Case C	Liverpool	Mechanics	Link teaching and research activities, e.g. joint discussions with UGs and PGs.	Connecting teaching to real-life every day examples.	Developing research and critical thinking skills by reviewing publications.	Peer-respect. Contribution to the society.	Effective use of colleagues and resources.
Case D	Birmingham	Materials	Provide an interactive environment where students can and want to ask questions.	Formulate assessments in relation to own research questions.	Support confidence development to become an independent learner.	Learning something new, intellectual stimulation of both research and teaching.	Awareness and recognition of the academic cycle. Align T&R interests.
Case E	Manchester	Chemical Eng.	Aim to do things write the first time. Adopt a policy of incremental improvement.	Managing the struggle of learning.	Encouraging a desire to know and learn. Critical reading and thinking.	Being part of a community and doing something noble. Share joy of learning.	Organise time / dairy to include teaching tasks. Create synergies between T&R.

In a similar way, much practical advice on motivation for and management of the teaching role emerged, e.g.:

- The creation of a "research momentum" by partitioning teaching and research time; e.g. where possible teaching activities are carried out in one semester
- A personal policy of "systematic incremental improvement", i.e. the on-going development of teaching resources and pedagogy in a similar method to maintaining knowledge of a (technical) research field
- Relating exam questions to research interests so that the assessment (reading) of these become particularly interesting and relevant.

Attitudinal perspectives also featured strongly for work motivation, namely through the recognition of the privileges and advantages of teaching in a research-intensive institution. For example, interviewees commented on the learning that can be gained by interacting with motivated and high-calibre students that such institutions attract, and indeed the immediate impact that can be achieved through such interactions.

With regards to teaching induction and support, several of the interviewees commented on the importance of a grounding in educational theory to facilitate innovative teaching approaches, and the strong influence of peers on academic development. However, in most cases direct and informal support was seen as more helpful than workshops.

National Survey

A summary of the online survey data is given as a supplementary file. As indicated above, the sample size was satisfactory (411), especially given the broad representation from the different STEM disciplines, academic ranks (i.e. lecturer, senior lecturer /reader, professor) and work experience and teaching load (see also the supplementary file). Some key points emerging from the data are summarised below:

- The sharing of research work / ideas with undergraduate students is common. Unlike some of the interview data however, there is a lower consensus on the value of teaching to research, suggesting that highly accomplished *teaching researchers* may have a different perspective on the research benefits of teaching.
- The research-led and research-oriented practices feature relatively strongly when compared to the research-tutored and research-based practices. This shows that there is a tendency for teaching-focused activities rather than student-focused, and so only partial engagement of students in the research culture of the institution.
- Although the respondents clearly see the importance of collaboration in research, this is not true for collaboration in teaching, suggesting that the scholarly rigour in research development and dissemination is not applied to teaching. This was not the general case for the selected interviewees, where a strong teaching development ethos existed.
- In terms of role enjoyment, assessment proved to be single most disliked aspect of teaching. Interestingly, several of the interviewees overcome this issue by integrating a research premise into the assessment activity.
- The data indicates that many of the respondents are unsatisfied by the teaching-research work balance, with a general desire to reduce the teaching role. However, as mentioned above, in many cases this may be attributed to assessment issues.
- Interestingly, whilst the data indicates reasonable aspirations for teaching recognition at institutional and national levels, and indeed a reputation as an outstanding / innovative teacher, generally little motivation exists for scholarly activity in teaching such as publication or project funding.
- The data is consistent with the interview findings that peer support (discussions, feedback and observations) is the most useful resource in managing academic and teaching roles. Workshops and other equivalent training were generally viewed as neutral to not useful.

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Appendix B
Case Study Summaries

Sarah Bell – University College London

Sarah is a Senior Lecturer in the Department of Civil and Environmental Engineering [1].

"Solving sustainability problems and contributing to society"

By adopting a constructive alignment approach to teaching, students develop professional skills through appropriate activities.

Integration of Teaching & Research

Universities are all about teaching and research according to Sarah, and as an academic she regards the mix of roles as a natural way of working:

"The best academics I know are also very good teachers. So the best researchers are people who are passionate about their subject and that flows over in their teaching as well."

The purpose of university is to create and share knowledge. The main way of sharing knowledge is through teaching.

Sarah's examples of integration:
Research projects to illustrate how practical outcomes link to theory.

Student essays that are current and relevant to the field, and allow students to provide their perspectives on a topic.

Motivational Drivers

Before starting her PhD, Sarah worked as an engineer. Although the work was enjoyable, she felt something was missing:

"One of the things that I found difficult was the inability to really be able to ask serious questions, because in the end you just have to get the job done and move on without questioning too much."

The privilege of being able to teach in a way that questions and challenges knowledge is something that Sarah finds motivating. A broader motivational driver for Sarah is being able to contribute to education in sustainability:

"I am really disturbed by the state of the environment and the world...engineering has a really important contribution to try and solve some of those problems...it's really important to provide new engineers with the awareness and knowledge of these issues...and the broader context in which they are operating."

Coping Mechanism

Sarah comments on the value of finding the right personal balance between teaching and research:

"*I have got just the right amount of teaching [so] that I really enjoy it, without feeling it's overwhelming me or stopping me from being able to do research."*

Sarah's tips on balancing the roles:
Control the work focus, e.g. by loading most of your teaching into one term you can focus on research the rest of the year.

Be vocal and pro-active about what you want to teach, rather than waiting around for someone to allot this:

"[It's] a combination of luck and my own management I guess...I was quite pro-active in proposing teaching activities...and I got a very positive response to that [and the opportunity to develop a new MSc]."

Teaching Practices & Approaches

In 2007, Sarah received the Exxon Mobil Excellence in Teaching award from the Royal Academy of Engineering for "taking the risks of moving beyond the traditional boundaries of engineering" [2], e.g.:

"Bringing social science into engineering teaching...which is risky considering more conservative definitions of engineering as a purely technical profession."

"The curriculum can be characterised as a hybrid of problem-based, project-based and traditional approaches to learning. Four times a year students work in teams for one week on a scenario which aims to integrate learning from lecture and laboratory classes and to develop generic skills including team working and communication" [3].

"One of my aims is...to expose [students] to different ideas and develop skills in writing and critical thinking that they otherwise may not develop elsewhere in the programme as strongly."

Sarah's examples of good practice:
Constructive alignment is an example of outcome-based education [4]. Sarah always starts with clear learning outcomes and links these with the appropriate teaching methods and assessments.

In induction week students are taken on a walking tour around central London and work through a set of field notes that include tasks and questions like:

" 'Draw the London Eye' and 'How do you think the London Eye stands up? Which element of the London Eye is in tension, which is in compression?'...Or 'Think about the quality of water of Thames and how that might have changed over time and what might climate change mean for water quality of the Thames'?"

The tour is complemented by a library induction and is been assessed through individual reports that require at least two peer-reviewed publications. Students learn to search information, critically evaluate their sources and avoid plagiarism. If there are any problems in English proficiency, then they are discovered early and will be supported by the university's language centre.

The 2nd year Engineering History module gets the students to think about the origin of the profession and question some of the stories. It puts engineering projects in a broader social and political context.

When Sarah developed a new MSc course there was some funding for administrative support to build and maintain an industrial network. She now works in collaboration with partners including Thames Water, Waterwise, AECOM and Arup [1]. For example, one of the modules includes:

"A collaborative environment systems project which is entirely problem-based...Problems are defined by academic staff in collaboration with an external partner and the students engage with the external partner to get data and to help to refine the problem and clarify expectations...I run a series of skills based workshops for that...like: team working, writing and presenting."

According to Sarah supporting the development of undergraduate and postgraduate students is very different:

"Partly it's just a level of maturity of students and also the way they are comfortable interacting with me...A first year student looks for more guidance...and there's a fine line between pushing them out of that comfort zone like 'you're an adult now you have to take responsibility for your own action and stop calling me miss' to leading them or letting them flounder."

It has taken Sarah a while to find the right balance and approach in supporting undergraduate students' development. She feels more direction and less instruction is the best approach:

"Over time I am becoming more confident in just giving students direction. And if they are hitting the wrong direction, I guess [I'm] now stronger in pointing them back...Students need to spend some time dazed and confused, because that's part of the learning process, but if they spend an entire term dazed and confused I haven't done my job properly."

Support

Sarah feels she followed a gradual pathway into teaching from running small groups as a PhD student to developing a new MSc as a lecturer. In particular, her experience as a distance teacher was useful:

"I taught Sustainable Agriculture and Land Management from a rural campus in Australia to students all over the world. Distance learning involved students mostly working through the materials on their own, with teleconferences, phone calls, online forums and email support from staff and other students."

"As a teacher I am just a mediator between a body of knowledge and students, so I'm kind of a gatekeeper...That's why having good learning outcomes...worthwhile assessment tasks and...providing access to good materials...is important. It's not actually me as some sort of fount of all knowledge for students...[It has been] helpful for me to clarify my role as a teacher."

Sarah comments that the Postgraduate Certificate in Higher Education is a good opportunity to discuss your teaching with other people who just started and to get some ideas of "best practice". It helped her to have the language and theory to talk and think about her teaching approach in a constructive and reflective manner.

From her own experience Sarah feels that allowing PhD students to get more involved in teaching could create a win-win situation. This would enable academics to share their teaching tasks and experiences with PhD students effectively. However, she is aware of the potential pitfalls of such an arrangement, e.g. undergraduate students often like to have exposure to accomplished researchers, and research students need to give focus to their PhDs. Sarah comments that changes in the funding of research students may help create space / incentives for their greater involvement in teaching.

References

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[4] Constructive alignment, http://www.johnbiggs.com.au/constructive_alignment.html.

Sarah Bell

See the bigger picture of the value of teaching, e.g. education for sustainability.

Constructive alignment as a means of teaching and assessing that supports your intended learning outcomes.

Build industrial networks.

Find a win-win situation through the use of graduate teaching assistants.

The time / experience effect: what is a realistic timeframe to build-up teaching commitments that balance or integrate with your research?

Grant Campbell – University of Manchester

Grant contributes to research in the Satake Centre for Grain Process Engineering and teaches undergraduates and MSc students in the School of Chemical Engineering and Analytical Science [1].

"It's [about] the Students, Stupid!"

The title of an intended speech by the former Manchester President and PVC the late Prof. Gilbert that informs Grant's attitude towards the integration and management of his roles.

Integration of Teaching & Research

Grant feels that being involved in research influences your credibility as a teacher and indeed the ability to teach certain topics at a practical level. For example, he comments on the value of having access to and knowledge of basic research tools and facilities when teaching.

Grant's perceptions of integration:

You are a role model; you write papers and undertake research and so you should expect students to write and think like a researcher as well.

Teaching is more important than research, but research enables better teaching.

Research can take place elsewhere, but higher learning can only take place in universities.

Motivational Drivers

Grant is more motivated by role satisfaction and enjoyment than by achievement:

"I don't do this because I need to prove myself to be the best...but for the enjoyment of discovering new insights...the satisfaction when you see students do something they couldn't do before...and the buzz of interacting with a class. It is important for the students 'learning that I enjoy the class. To quote Salwak: 'Your purpose for being there in the first place is to share the joy of learning'."

Coping Mechanism

It's tempting to say: *"One day when I got time I'm really going to give that course a make-over, but it's never going to happen, you are kidding yourself."* Grant comments that you need to have the discipline to create new exercises and put in new examples every year. *"This means that your stock builds up over time, doesn't become stale and it keeps the whole thing fresh...and up-to-date."*

Grant's tips on balancing the workload:

Aim to do things right the first time: it saves you time in the long-run. For example:

"When writing exam papers type out the model answers completely. Once you have them electronically, then they are available the next year for when the students want model answers or when you decide to use them to create coursework."

Be organised and prepared. Grant puts his students' deadlines on coursework and assessments in his diary so that he can plan his teaching responsibilities accordingly.

"I couldn't manage without my electronic diary...I prefer to be organised and prepared rather than to work hard."

Adopt a policy of incremental improvement.

Teaching Practices & Approaches

One of Grant's teaching philosophies is: *"Effective teaching is inclining people to learn willingly what they would otherwise be disinclined to learn."*

"My aim here isn't just to impart information and occasionally get [students] to respond...to a question, but actually make them value this."

To emphasise how you can make students want to learn, Grant refers to Bloom's Taxonomy [2] to motivate educators to focus not only on the cognitive domain (thinking and knowledge), but also on an affective domain (feelings, emotions and associated attitudes).

Grant's examples of good practice:
Critical reading: final year students choose and read a technical book and are assessed on their understanding of this [3].

Teach what you research: there was little overlap between Grant's research and his teaching, but he argued the importance of renewable resources for Chemical Engineers (of which cereals are an important example) and was then allowed to create an undergraduate course based on his research.

Another teaching philosophy of Grant's is "Managing the struggle":

"Learning is an intellectual struggle. The struggle is a necessary part of the [student] learning process and so I manage the struggle such that it remains a struggle, but one that they successfully overcome."

"For example: my students ask me to provide model answers to past exam papers. If I were to do so, they would follow my clearly laid out answers and kid themselves that they understood the material and could tackle these questions themselves. And they would think I was kind. But in my kindness I would in fact be depriving them of learning. Instead, part of my management is to provide numerical answers, so that they know if they have got the right answer, but only to provide full model answers a few days before the exam, so that they've had the opportunity to struggle themselves before referring to my model answers as a final resort."

Managing the Struggle – an analogy from Grant:
"A group of school children in a science class are watching a butterfly emerge from its chrysalis. It's struggling to get out and they feel sorry for the butterfly, so they break the chrysalis. With their help, the butterfly manages to get out, but it doesn't spread its wings and fly off. It just sits in the soggy mess and after a while it dies." [Moral] "The struggle to push itself out of the chrysalis pumps blood into the butterfly's wings. By removing the struggle, the children had denied it the chance to get blood into its wings, such that it was unable to fly off and be a butterfly".

Support

The Times Higher Education [4] Magazine stimulates Grant to think about educational issues, ideas and solving problems. He also comments that *Teaching Life* [5] has been an inspiring book for him: it reflects on more than three decades of teaching literature and how these have touched the lives of students. But most of all, Grant enjoys picking up tips from a wide variety of sources, i.e. books, articles, conference presentations, courses, students and colleagues. For example, when someone at a conference pointed out that images are much more memorable than words, Grant comments:

"[It] Transformed both my research presentations and teaching; I use images a lot more."

For Grant teacher training should be about responsible academic freedom, i.e. institutions provide opportunities and encouragement for development as opposed to making it mandatory:

"It's a personal policy to update myself, but there's no obligation."

In his view senior academics should be obliged to support teacher training and in that way help to raise the profile of teaching. For example, Grant runs a session on Assessment as part of the New Academics Programme [6].

Similar to maintaining a research profile, academics need to feel responsible for their teaching development. However, Grant stresses the importance of new lecturers having a good mentor to provide guidance, advice and feedback:

"[New lecturers] Should teach their first courses alongside someone experienced (co-teaching) rather than be given a course and be told to get on with it."

Grant also comments on the need for humility as an academic, i.e. to know and appreciate the hierarchy and complexity of the academic world and to recognise when you need to ask for help.

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Grant Campbell

Like student learning, intrinsic rather than achievement motivation may be better for a healthy and long-term career focus.

Organise your time / diary to include teaching tasks other than lectures and tutorials. Like research slides (and literature references), build up your teaching resources in a systematic way.

What's your teaching philosophy? How is this applied in practice?

"Grant makes some illuminating points: learn from your research habits and keep well-organised records of exam answers and case studies, building a teaching portfolio just like your research CV. He is also keen to admit that learning is not necessarily easy – something most of us discover quite early on in our careers! His butterfly analogy is full of insight and accessible to all students. I shall add it to my own repertoire."
Peter Goodhew, University of Liverpool

Claire Davis – University of Birmingham

Claire is Professor of Ferrous Metallurgy in the School of Metallurgy and Materials [1].

"Enquiry approach to teaching and learning"

Teaching is about providing students with the means to acquire knowledge and think about problems in an enquiry-driven (research) environment.

Integration of Teaching & Research

For Claire integration of teaching and research is a fundamental approach to learning:

"It's not just about prescribed knowledge, it's giving [students] the means to acquire knowledge...and to keep it new...interesting [and] make it stimulating (for both academics and students)."

In this way students are encouraged to adopt a research approach in their learning. Claire comments that academics are enquiry-driven, so they should expect their students to be as well.

Claire's examples of integration:

Claire creates an interactive, enquiry-driven environment where students can ask questions and learn how to answer them.

Students are expected and encouraged to solve problems themselves, e.g.: homework questions are set that are open-ended and need problem formulation and not just solution.

Motivational Drivers

Claire has always been motivated by work she likes doing and gives her personal satisfaction. Learning is a motivational driver for both her research work as well as her development as a teacher:

"Learning something new, I am enquiry driven, I like to learn things. So even now I feel I am learning things and that is very satisfying...[And] the satisfaction of interacting with somebody (undergraduate, postgraduate or research fellow) who wants to learn and who's capable or learning."

Coping Mechanism

Claire's attitude for coping is to appreciate the value that both teaching and research offer to career development, rather than neglecting the former and seeing it as a chore:

"If you only do one, you are trapped into one...Being able to do both allows you to balance your career and allows you to ensure that both aspects are nurtured."

Claire's tips on balancing the roles:

Appreciate how teaching and students' immediate questions can keep you grounded and sometimes make you think about things in a different way.

Recognise the importance of both teaching and research. This allows you to prioritise your tasks accordingly, e.g. teaching activities may take priority during term-time.

Awareness and acceptance of the annual academic cycle and the active planning of work accordingly, e.g. write exam questions according to your time frame rather than responding to last minute reminders:

"I balance the two by being organised; to do things I can do in advance, in advance."

Teaching Practices & Approaches

For Claire it is important to change the teaching content and keep it stimulating for both the students and herself. The subject changes because of her research input:

"The stories I tell...will vary depending on what my experiences are through my research or in the field."

The majority of Claire's research projects are linked with industry. They involve applications and a need to find answers to problems. Some of her undergraduate research projects are set around these industrial problems. Furthermore, she expects a level of independence from both undergraduate and postgraduate students:

"You have to develop a student's confidence to be an independent learner."

Claire's examples of good practice:
Claire enjoys the challenge to explain a topic in such a way that students understand. She contextualises the learning process with a variety of examples, e.g. from her own research, the news or students' own experiences [2].

When teaching large groups of students from different backgrounds, Claire recognises and targets their interests by using several different examples and case studies from her research or industrial work. In practice this means that they may be 5 different examples per topic in a lecture and students can pick the one that is of interest to them and work through it [3,4].

Claire's exam questions try to reflect her current research work and interests, even for early-year undergraduates. Sometimes, she'll set an open-ended exam question on a research or current issue to get students' perspectives. In this way the questions are always new and relevant, and she is interested in writing them as well.

Support

At the start of her career, Claire had the opportunity as a new lecturer to work alongside a more senior academic at the University of Cambridge developing laboratory content:

"Teaching an undergraduate course, developing labs and working alongside a more senior academic...taught me quite a lot (indirectly and directly) about teaching approaches."

Personally Claire feels she benefited from all the (training) opportunities available to her and the interaction with other colleagues:

"I am not one of those who believe that if I ask a question then people think I cannot do it, so I have asked and I found colleagues that are supportive...and I still do ask."

Claire is grateful that the department has allowed her to focus on and do what she is good at without over-loading her:

"I haven't been made to do lots of it [teaching]...that could kill the enjoyment and be detrimental to my research. [The department] has allowed a good balance to develop. That means I am allowed to be good at both."

According to Claire academics should generally be appointed to do research and teaching and be supported to excel in both. However, at the moment she feels that there are times when it is unclear what is understood by teaching excellence. Claire comments that universities should provide better guidance, support and recognition to achieving excellence in both teaching and research activities.

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Claire Davis

Enquiry-based learning for students.

Ongoing satisfaction from learning how to teach better.

Develop your thinking as a researcher through teaching.

Bring in research into case studies and exam questions.

Simply ask for help, and go on asking.

What would you need to do to achieve teaching excellence? Is this clear from your institution?

Paul Ewart – Oxford University

Paul is Head of Atomic and Laser Physics at the Clarendon Laboratory.

"Teaching is as fulfilling as research"
Doing research and teaching to the best of your ability to gain the respect of both your colleagues and students.

Integration of Teaching & Research

Paul finds working amongst different research experts stimulating for both his teaching and research. His colleagues are able to offer much advice on teaching that often has a research basis. In his experience, students also value (and indeed expect) opportunities for interaction with such research-active teachers:

"Students are reading about things and expect to be brought up to speed with leading edge [developments]."

As a result of his research Paul feels able to deliver "joined-up" teaching, i.e. of suitable depth and yet related to a wide set of subjects within the discipline:

"Drawing from a whole range of Physics enlightens your teaching...not learning a bit here and a bit there, in a kind of modular form...Teaching at undergraduate level is to get [students] to think as physicists in a rounded way and not compartmentalising their knowledge, but learning how to relate issues in one sub-topic to another."

Paul's examples of integration:
Use research topics to enliven teaching and enthuse students towards the material, e.g. up-to-date examples from current research to illustrate principles or practices.

Provide students with the basic needs to cover the curriculum, but also include some challenging elements to stretch the students and make them think about the subject in the wider context and its applications.

Relate even basic-level material to interesting applications or current research; e.g. in Paul's 1st year Mechanics of Collisions, he uses the example of colliding particles in accelerators, such as the Large Hadron Collider, to demonstrate why it is better to collide two moving particles head on rather than have one hit a stationary target.

Motivational Drivers

Whether it is teaching or research, Paul's personal motivation is:

"To do it to the best of my ability, because that's what gives me fulfilment and satisfaction."

He also finds it fulfilling to be involved in scientific discourse that is socially or culturally useful, i.e. positively affecting society and benefiting the lives of others. Paul feels that an advantage of being an academic is the freedom to interact with both students and colleagues, thus contributing to change across different education levels.

Coping Mechanism

Over time Paul realised his motivational drivers for teaching and research are similar, and this has helped him to resolve the tension between the two roles:

"In research my motivation was doing a good job; earning the respect of my colleagues...And then I began to see that teaching students was a service...that they find helpful and I was...helping them to grow and develop as young scientists (and getting their feedback to do a good job). I began to find that just as fulfilling as getting the feedback from my colleagues in the research field."

Paul's tips on balancing the roles:
Set reasonable limits on time for teaching activities (e.g. preparation, marking).

Where possible schedule teaching within blocks to leave continuous periods of the week for research.

Temporarily delegate responsibility to senior Postdocs to maintain continuity in the research lab while you are elsewhere (teaching).

Request the assistance of colleagues in providing (structured) course materials and/or supporting examples to save time when you start teaching a new / less familiar (non-research) subject.

Teaching Practices & Approaches

Paul adopts two different teaching approaches depending on the class size. When he is lecturing to a large group he makes very few assumptions about the students' knowledge and tries to keep it simple. In a smaller group it is easier to check students' level of understanding and develop interaction; Paul then tends to ask a series of (probing) questions or set challenging problems to discuss and work through:

"So you are going from the situation of conveying information of giving explanations in a lecture to, in a smaller group, focussing on understanding. I always tell my students that 'I cannot give them an understanding; I can give them an explanation, but an understanding they have to find for themselves'."

Paul's examples of good practice:
Regular lectures from leading researchers in the field who are also gifted communicators on topics of current and general interest:

"That helps to maintain the interest and enthusiasm of the students [because] they feel that they are being taught and interacting with people at the leading edge of the field. That keeps undergraduates in touch with research."

Practical laboratory courses with the help of demonstrators introduce students to equipment and techniques used at a research level.

A curriculum that focuses more on understanding than facts:

"If you want to teach people how to think as a physicist then the important thing is that they learn how to make things work, how to take a principle into practice. They need to develop ways of thinking to solve problems and not just how to look up the answer. Learning how to make an experiment work is just that kind of experience."

The use of Einstein's maxim "Things should be made as simple as possible, but no simpler", and likewise the KISS principle: "Keep It Simple, Stupid".

Paul comments that his industrial (research) partners are keen to have students working with them. He encourages summer projects and industrial / commercial placements:

"Having exposure and experience in the workplace would be a very valuable part of their learning experience."

In supporting student development, Paul's approach depends on the individual's ability and stage of career. Initially his focus is on study skills and examination preparation. Gradually, students are encouraged to use concepts from different subtopics in Physics to solve a problem. Ideally, if possible, he wants them to develop as "independent thinkers" who also come up with their own ideas:

"[It's the] Transition from learning facts and solving academic problems and exams to tackling a real life research topic, which involves side-ways thinking, pulling in ideas and concepts from different parts of Physics to solve the problem."

Support

The best practical help Paul had was the feedback from his students. Although he comments it is impossible to please or satisfy everyone all the time:

"Nonetheless you have to look at all the...feedback you get and try, in as dispassionate way as possible, not to feel personally hurt...but think...'What was it that I was doing that gave that perception? Is it only a perception or is there some reality to it? Should I do something differently? How can I restructure my teaching to take into account those criticisms?' "

Paul also benefited from the advice and examples of some outstanding colleagues who were both at the top of their "research game" and exemplary teachers. This encouraged him to reflect on his own teaching and also develop empathy for his students and their learning difficulties.

He never received any formal teacher training, but teaching "Presentation and Communication Skills" to students forced him to think about his own style. Generally, he believes that new teachers could gain from advice on certain communications skills, e.g. how to be at ease in front of students (public speaking). There are some simple rules that can be taught and learnt.

"For example, engaging the students in a lecture is aided by making 'eye contact'. If one finds this disconcerting the same effect can be achieved by looking at the top of someone's head, or even at the space between two students in the back row. A structured presentation is also important and this can mean simply (a) tell them what you're going to tell them, (b) tell them, (c) tell them what you've told them. Practical aspects of presentation are also important such as planning what the black board will look like when the lecture is finished; i.e. [so] plan the layout beforehand and keep it orderly."

Apart from formal training, Paul thinks that there are several ways in which universities could better support the development of new academics, e.g.: more gradual introduction to the full teaching load to allow staff to learn good practice and establish their research at the same time; personal mentoring on both the teaching and research sides of the role.

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Paul Ewart

Meet student expectations through reference to leading edge research.

Schedule teaching into blocks where possible.

Support student skills development from study skills to independent and creative thinking.

Learn from colleagues and the feedback from students.

Develop empathy for students and their difficulties.

In what ways can your teaching approach / practice be refined to improve effectiveness?

"Reading Paul's case, you get a clear picture of his dedication to both his teaching and research. Paul's job satisfaction arises from success in both fields, especially with regard to good feedback. To provide excellent teaching Paul believes that students need to understand the big picture, being able to put specific learning topics into context. Paul goes on to give many examples as to how he achieves this, including drawing on both past and current practice to enliven lectures; involving external speakers at the leading edge of their field; and drawing on industrial research partners to provide placement opportunities for students. This case provides many pointers as to how Paul links his teaching with research."
Fiona Lamb, Loughborough University

Lee Fawcett – Newcastle University

Lee is a lecturer in Statistics in the School of Mathematics and Statistics [1].

"Communicating to non-maths specialists"

The freedom and possibility to collaborate with other disciplines helps to inform teaching and develops useful communication skills for subsequent interdisciplinary research.

Integration of Teaching & Research

Lee taught in Further Education colleges (e.g. post 16 courses) before joining Newcastle University. He comments:

"I think it is an element of prestige being able to teach in a research-intensive university... It makes me more passionate about my teaching...[My] material got a bit stale [when I was only teaching]."

Lee's examples of integration:

The use of real and relevant examples from Lee's consultancy and research work in teaching statistics.

Teaching non-maths specialists (e.g. business students) has helped Lee to develop the appropriate communication skills for subsequent interdisciplinary work.

The annual revision of advanced courses to reflect the current research interests of academic staff.

Motivational Drivers

Lee always wanted to teach and likes the combination of teaching and research. He enjoys teaching more when it is linked with his own research. He hopes that his love for statistics encourages student motivation for the subject:

"Teaching is my main motivational driver, but I find it easier to teach if I am doing research as well...It is easier to be enthusiastic about [the] teaching...I feel good when students are enjoying the class...when I know they are taking it in."

Coping Mechanism

When Lee started as a lecturer he was thrown in the deep-end by teaching statistics to a large class of business students:

"I was standing in front of 480 students and it was petrifying initially, but I think that helped [me]. It might not be right for everyone, but it really helped me...There's nothing...that can replace just standing in front of a class and teaching; thinking about (and reflecting on) how you have taught and then changing things as you go along."

Lee's positive attitude towards ongoing feedback and development helps him to cope with the pressure and responsibilities of teaching in such large classes. But even after 7 years of lecturing, he admits that the constant pressure to publish, and the tensions associated with managing consultancy, research, teaching and administration work never go away. Lee recently has tried to "partition" his teaching and research work across the academic year, which he feels is working well:

"I'm not teaching at all at the minute, so this semester 1 has been...very research productive...I build up enough momentum during to be able to continue this in my teaching semester...[and] I still have time to 'tie up loose ends' from stuff I've done in semester 1."

Lee's tips on balancing the roles:
Create a (research) momentum: partition teaching and research time; where possible have the majority of teaching activities set in one semester; set specific office-hours for student contact.

Set clear goals for both teaching and research. Where possible use the appraisal process or peer input to carefully reflect on goals and consider the teaching-research balance.

Teaching Practices & Approaches

In 2009, Lee received an Excellence in Teaching Reward for his introduction of formative computer-based assessments, the use of real-life data sets as examples, and videos to demonstrate complex calculations [1]. He likes to engage his students in creative ways, for example by using an electronic voting system (clickers) to encourage interaction:

"It makes me feel better [when I know] that the students have understood what I have been talking about...So I will talk for 10-15 minutes and then I will ask the students some questions [but]...maths students are so quiet...I [constantly] need to think of new ways to engage [them]."

Lee's examples of good practice:
Critical thinking: Lee will provide copies of his most recent publication to final year students and ask them to review it.

Visual learning environment: e.g. Lee introduced (and developed), revision DVDs / videos [2] and computer based assessments [3].

The use of Recap, i.e. "a lecture and event-recording service that allows audio and visual material, including the lecturer's voice, presentations slides and visualised documents, to be recorded and published online in an automated, easy-to-use process." [1]

External Engagement

As a statistician Lee provides a lot of consultancy to other non-maths research groups at Newcastle University. There is no funding involved, or a publication driver, so he is careful to select work that can have some value / relevance to either his research or teaching.

Student Development

Lee very much endorses a problem-based approach to learning and student skills development:

"I...teach...from the bottom up, so [I let] the problem drives the theory...students apply the theory to something that is quite convolute as set of data."

For example, when teaching statistics to large groups of business students, Lee uses examples of his consultancy work to relate to the students' discipline.

Lee's approach to problems and theory:
Mathematical and statistical models as illustration: e.g. Lee uses his research to illustrate how models can help to predict the next earthquake or hurricane. He does not discuss the modelling approach, but he uses examples from his research (as well as topical news items) to motivate students.

Practical application of research data: e.g. by comparing complex data sets, students build an understanding of a need for a *t*-test, and more generally, the importance and relation of statistics to their discipline.

Support

Lee got involved in teaching activities when he was a PhD student at Newcastle University. He would give small tutorials, the occasional lecture and mark exams. This early experience helped him to later digest the information from the formal teacher training he received as a new lecturer (i.e. Certificate in Advanced Studies in Academic Practice [1]. Lee feels that teaching workshops have less value without some experience (negative or positive):

"We had...practical courses about voice projection and public speaking, which did help. Because no matter how much I have been teaching...I still get quite nervous before teaching...Practical issues on how to use a microphone...now I always use a microphone (when I'm teaching a big class) and don't shout anymore."

Lee benefited much from having a mentor during his first three years as a lecturer. His mentor would observe lectures and check that Lee was “doing alright”. They have developed a close bond and Lee still asks him for occasional advice. He believes that it would have helped him to manage his career more effectively if he had more goal-focussed appraisals from the start. Lee also comments that he would find it a lot more difficult without the support of friends and family.

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Lee Fawcett

Annual review of advanced courses to reflect current research issues and trends.

An attitude of ongoing development in teaching.

Regular goal-setting to help manage and organise teaching and research activities.

Consider use of dedicated blocks of time for research or teaching.

The use of real problems and data to drive the theory in a lesson.

The use of practical workshops on voice projection and public speaking to improve large-class teaching.

Distributed workshops to enable reflection of teaching experiences.

Being an academic is a tough job – use the social support around you.

What control do you have in the scheduling of your teaching duties?
Could teaching-research partitioning help in the management of the roles?

Andrea Jackson – University of Leeds

Andrea is Deputy Head of the School of Earth and Environment [1a].

"Teaching is like mini-research"

Research publications and seminars can inform and stimulate student learning and development.

Integration of Teaching & Research

Andrea believes that universities have an important role in driving research that has an impact on society; the sharing of this knowledge through teaching is a key responsibility of the academic. She feels that a research-intensive university can be a particularly stimulating learning environment for students: teachers can "enlighten" students about research and encourage them to "question things and think how to research things themselves". The research environment, in combination with high calibre students, leads to much teaching experimentation (e.g. "mini-debates in lectures") and independent learning activities:

"This year we had a higher A-level grades student intake and you can really tell the difference in how much they want to read around the subject...And how much more prepared they are. I was really impressed by them."

Andrea's examples of Integration:

Encourage students to read around the subject and attend research seminars, e.g. Andrea provides links to research publications and information about research events in the School that could be of interest to undergraduate students.

Frontiers in Environmental Research is a new module that is entirely research-informed:
"Lecturers from right across the school give mini-research seminars to final year students"
Ensure the content of teaching material is relevant and up-to-date:

"You don't want to hear about something that happened 5 years ago. It's more interesting to hear about something that happened last week. And you can do that in this department, you can always look at the news stories on the web and see whether somebody just got something published...there's always enough going on that you can pass on to them."

Motivational Drivers

Andrea likes teaching and is especially interested in "the challenges presented by the transition of students from school to university" [1a]:

"I like to see them progress through university and really grow up...[into] mini-researchers...It's nice to see them come in from school...when they think they know what research is...and then they suddenly realise they don't. It's about opening them up to such a big research culture."

Coping Mechanism

The School of Earth and Environment has over 90 academic staff in several disciplines and they use "team teaching" in a variety of ways. This allows Andrea to teach topics that are better aligned with her research expertise and interests:

"We have...Earth Sciences, Atmospheric Sciences and through to sustainability...and the physical and social sciences here...If there's something you are not sure of you can always...ask someone for their advice or input."

Andrea's tips on balancing the roles:
Recognise the annual academic cycle and plan your teaching activities accordingly.

For new courses, prepare an overall course outline well in advance and add / revise detailed content on a weekly basis.

Allow flexibility in your lecture to introduce new and topical examples or information.

Allow enough time for both the mental and practical preparation of lectures:

*"*I still get nervous before giving lectures, so I always try to spend an hour beforehand to prepare myself so that I really know what I'm going to say in that session."

Teaching Practices & Approaches

The degree programmes are set up to prepare students for their final year research project. Andrea uses her skills and knowledge as a researcher to support student development accordingly:

"I get them to go out and investigate and research for themselves. And really question what is good and what is bad out there, because they tend not...[to think things] through, don't question anything what is presented to them, they accept anything. It's really for them to think about what constitutes a research project and how they can go through the different stages of that."

Andrea's examples of good practice:
A first-year module that includes research skills practice to support undergraduate students in their project work including problem solving, team-working, making physical measurements, analysing, interpreting and co-ordinating information.

First-year fieldwork weekends:

"They work in groups...on the geochemistry of the old mining area and we give them a research question and they have to answer that in groups...they come back and analyse samples in the laboratory...compile a mini-research report."

Some students undertake research internships e.g. they spend some time (usually out of term) in laboratories working with researchers. Nuffield Foundation funding can support these kind of extra-curricular activities [2]. Student research findings are sometimes presented at conferences and students have the opportunity to go abroad.

Final-year research projects that are in-line with the interests of academic staff. Discussions also take place on research methodology, such as formulating questions, laboratory techniques and data analysis.

Andrea describes several examples of industrial involvement in teaching. At the undergraduate level students can undertake summer work placements as part of their degree. Where the placement is not credit-bearing, it will nevertheless receive acknowledgement through a City and Guilds qualification [3]. At the MSc level: "Specialist courses are delivered by both academic staff and practicing consultants and other practitioners, providing students with exposure to real-life, international case studies and a good understanding of contemporary management techniques and solutions" [1b].

Support

Andrea keeps up-to-date with the activities of the Higher Education of Academy [5]; this provides helpful direction with regard to teaching and educational developments. She also likes to stay informed through national teaching conferences. The University itself runs an annual Student Education Conference:

"Talking to colleagues, finding out what practices everybody else are following...Sometimes the emphasis is on integrating teaching and research, there are different themes each year."

Sharing and disseminating good practice and building communities are an essential part of Andrea's personal development:

"I like talking to colleagues across the University about how to share best practice. I have been involved in various university's initiatives. We have one called Leeds for life [6]*...and as part of that we put together a publication of best practices across the University of research into teaching. That was really helpful and brought together a nice network of people."*

Andrea has been involved in the early stage of building an "educational research network" within the University. She also currently holds a University Fellowship:

"Fellowships are awarded annually to staff in recognition of their contribution to learning and teaching. An important part of the Fellowship is about sharing practice and the projects that staff are working on are presented on Casebook, an on-line resource." [7]

When Andrea started as a new lecturer she had to complete the Postgraduate Certificate in Higher Education, which she thought was helpful:

"As part of the programme you were required to submit assessments which involved researching the literature and ensuring your teaching was informed by the best possible practice...It's good in terms of making sure that we have some standardisation of staff in terms of what they know and how to teach. Rather than just being thrown [into teaching]."

Andrea thinks that a combination of formal teacher training and a mentoring scheme is initially the best way to support new academics:

"They have that as well as a probation advisor...somebody who ensures that they formally meeting objectives...whereas a mentor is somebody they can talk more informally with."

She has continued her development as a teacher through peer reviews, observations and discussions. Furthermore, her experiences as a programme leader and external examiner have built her confidence and provided her with the ability to view things from a different perspective:

"Quite early...I was a programme leader and...involved with its direction and ensuring it achieved the learning outcomes…[This] helped me in terms of what were the objectives of the programme as a whole, and then you can see how your teaching element fits into that sort of bigger picture...Being involved in learning and teaching policy really helped inform my practice. I think people sometimes miss that, they don't see the bigger picture."

"I am an external examiner for courses and I think being able to look at what other institutions do gives you confidence that you are doing the right sort of thing...but also learning from what they are doing as well."

The University of Leeds in general and the School of Earth and Environment in particular is a supportive environment. Andrea comments that one of the major strategy themes of the university is "research-led (or informed) teaching". Several mechanisms are in place that help academics integrate their research and teaching (e.g. funding streams for pedagogical research), and balance and manage their career, such as the Workload Model [1c]:

"If somebody is very heavily research intensive and...they cannot contribute to the teaching to the same level as somebody else, then we have to acknowledge that and 20% is expected of them in terms of their teaching. It is also that the students...hear from those who are heavily involved in research."

Across the University "research-led teaching" is included in the promotion expectation: you have *"to be able to demonstrate how your research is integrated with your teaching".*

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Andrea Jackson

Team teaching to bring together a range of research interests and expertise into a course.

Sharing and disseminating good practice and building communities as an essential part of your personal development.

Encouraging undergraduate student attendance at research events.

Involvement in wider teaching management / strategy / quality assurance activities to inform your own practice.

What scope is there for the beneficial involvement of undergraduate students in your research events / activities?

"This case study works on multiple levels: the description is focused on student transition from school to university research environment, with the students transforming into 'mini researchers', which is an interesting variation on the more general 'university student'. The transformation draws on master-apprentice models but also acknowledges the role of intellectual curiosity: with able students who are willing to read around the subject, the lecturer is seen as having both the delight and responsibility of feeding that intellect. But the case study is also a study of how the postgraduate researcher transforms into a university teacher, with mention of the systems available for an apprentice lecturer to join the community of teachers and enlarge it. The case study also touches on the way the institution's attitude can facilitate research-teaching crossover: special education events, and the opportunity to identify the fellow enthusiasts to create a 'nice network', reveal a culture within which the transformative work with students takes place."
Alison Ahearn, Imperial College London

Julian Park - University of Reading

Julian is Professor of Agricultural Systems and the Director of Teaching and Learning for the Faculty of Life Sciences [1].

"Ethos of Students as Producers"

Integration is about finding the synergies in teaching and research; seeing students as potential contributors to research.

Integration of Teaching & Research

According to Julian research integration should be part of the curriculum design, with increasing opportunities for independent student research as they progress through University:

"In the beginning the lecturer is doing quite a bit of the leading in terms of suggesting skills and techniques (e.g. defining problems, hypothesis setting and testing)...But students become increasingly independent learners as they go through their university careers... Their research is [then] increasingly led by them."

Julian's examples of integration:
Undergraduate Research Opportunities Program (UROP): students undertake short research project (including field- and lab work) during vacations.

Student involvement in *educational* research projects: e.g. a project undertaken by a 2nd year student during the summer months to investigate the effectiveness of fieldwork across the Science faculties.

Motivational Drivers

The reason why Julian "gets out of bed every morning" is because he is firmly committed to the student learning experience:

"I think working with young people...is exciting and is quite a privileged position...I do a lot of research, some into teaching and learning and also disciplinary...You often get a more immediate response in terms of what difference you made to...individual students when...That is something that gives me great satisfaction. Publishing the next paper, getting the next research grant is exciting sometimes, but [often not as immediate]."

Coping Mechanism

Julian is fairly strategic and thoughtful on how he spends his time:

"You have to try to feed one [research / teaching] into the other. You got to do things that you think will count and will have impact in relation to the student experience and also to [your] research...It adds credibility, so colleagues respect you both as a teacher and a researcher."

Julian's tips on balancing the roles:
Try to each subjects that parallel your research interests. This provides an opportunity for students to experience your research world, and is a way for you to think about your research differently.

Be careful with the number of papers you review: some people spend an enormous amount of time on reviews. Consider reviewing about as many papers as you expect to publish in a given year.

In a similar way, try to align the number of external PhD examinations with your own expected PhD student completions. "You have got to say *no* on some occasions...be selective."

Teaching Practices & Approaches

For Julian teaching is about motivating, enthusing and engaging students. Where possible he brings in examples from his own or colleagues' research to demonstrate practice or relevance. Specifically, his teaching often involves various small-group activities where students think about a research idea or problem.

Julian's website Engage-in-Research [2]:
The website has been designed to take students through the entire research process.
For example, it guides them in formulating a research question, developing a hypothesis, designing an experiment and even writing up the work.

Learning & Teaching Enhancement Priority: offers students opportunities for work-based (real-world) learning experiences [1].

Some departments at the University of Reading have industrial liaison boards that support departments in their curriculum design. In some cases, such as on the Nutrition and Food Science course, lecture contributions from industry are common and all students have an opportunity for work experience.

Julian's Knowledge-Transfer-Partnership [3]:
This is a well-established national programme to encourage business-university collaborations to improve the competitiveness and productivity of businesses through
the se of the knowledge, technology and skills that reside within a university.
Julian expects that such partnership will lead to teaching-related opportunities, such as industrial lectures, student visits and internships.

Julian has similar expectations from both his undergraduate and postgraduate students: to develop skills for employability and professional practice. He considers research skills to be important for both. Even though the learning and development needs of undergraduates are different, he strongly feels that their potential research contributions should not be underestimated:

"We do get some very great ideas coming through students' projects, which sometimes then develop into bigger things."

Julian's involvement in the undergraduate journal Bioscience-Horizons [4]:
Julian has been part of team developing a journal for undergraduates that publishes high quality student research work, particularly from final year projects.

Support

Julian stresses the importance of a good peer support network both in and outside the university:

"It's really important to get out of the zoo...get out of your own institution and see what people are doing elsewhere."

Additionally, he feels it is crucial to keep up-to-date in your subject in both research and teaching developments.

His experiences in Further Education colleges prepared Julian well for teaching at university. As an example, teaching in FE has made him realise how important it is to keep students motivated and to gain their respect. In relation to personal development Julian believes you have to be pro-active: *"Things don't happen by accident"*. Most institutions provide some form of teacher training, but it comes down to the individual academic to engage with these and to get the most out of this.

Julian's views are that: when you are setting off on your academic career, you have to set priorities and be supported in doing this sensibly; guidance on finding the balance between research and teaching is useful (i.e. clear expectations and guidelines); and a formal mentor who can help you to find your balance and point you in the right direction is important.

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Julian Park

Develop students' research skills from year 1.

Students as researchers on teaching and learning.

Value the immediate satisfaction of teaching impact as a motivational driver.

Time on indirect research-related activities (e.g. paper reviews, PhD examinations) should be in proportion to your level of research.

Don't underestimate the research capabilities of undergraduates.

Keep yourself up-to-date in both research *and* teaching developments.

How would you describe your ideal teaching mentor? Could (s)he be from outside a research-intensive university?

"Students as 'producers' thematically unites all aspects of this lecturer's mission as a researcher and teacher. 'Producers' evokes experiential learning pedagogy. As students produce their deliverables, they should move from 'doing as told / trained' to 'working out what best to do next' and then 'doing it, reflecting and improving it', with the teacher providing the scaffold to prop up students until they can function autonomously. High productivity is central to the lecturer's approach to his own work: rules of thumb are provided to ensure that enough, but not too much, effort is put in (e.g. on reviewing papers / PhD examining). It is a principle held dear within engineering management as 'value-engineering'; a phrase that lends itself to twin-meanings of ethos (values) and efficiency (value) being carefully balanced. This case study presents a pedagogy that we could label aspirational-pragmatism, likely to resonate well everywhere, but particularly within engineering education."
Alison Ahearn, Imperial College London

John Parkin – London South Bank University

John is the Director for Research and Knowledge Transfer and Professor of Transport Engineering in the Department of Urban Engineering, Faculty of Engineering Science and the Built Environment.

"Adopt a Socratic style of questioning and challenging"

In order to learn from your own and others' experiences, you have to be critical.

Integration of Teaching & Research

For John, effective teaching is about bringing in all kinds of experiences from your own research and consultancy. When he tells personal stories, he can sense the impact in the classroom:

"I'm teaching about how people choose which different modes of transport to use and...give them all the theory and then say 'when I worked on that job for Liverpool airport' and you can physically [feel]...a shimmer go around the room and they are all with you, because you are telling them something about yourself and your [work]."

John's perceptions and examples of integration:
Links between teaching and research can be both personal and functional. For example, getting students to help you undertake a piece of research, especially if it involves something about their learning (i.e. educational research).

He rationalises teaching and research activities as different "sorts of time":
Kairos: opportune, perfect, qualitative or seasonable time - it cannot be measured;
Kronos: sequential, linear, tick-tock time - it is measured and chronicled by clocks [1].

"' 'Kairos'...[teaching] that's a sort of pastoral time, like an open ended time. Student comes through the door...'How long is a piece of string? How much time do you offer them?' And as soon as the door closes, you are back into what I call 'kronos' time, which is like time-sheet time...every second is being counted towards a project."

Motivational Drivers

John is passionate about his subject and has been lucky to be involved in research work when he was in consultancy. He also taught in a Further Education College and the mix of research, teaching and engagement in student development attracted him to academia:

"I had also always enjoyed the pastoral aspects of...managing people...understanding where they were at...[and their] personal development."

Coping Mechanism

John is a "list person", but although being well-planned and having a clear view of all his deadlines for months ahead, he comments that you also have to be flexible:

"It's being human as well...to some extent do what you feel like doing that morning, because you are more effective doing what your mind is naturally thinking about than forcing yourself to do something else. Having said that, then there are moments when you have got to do what needs to be done."

John's tips on managing the workload:
Use standard time management techniques, e.g. break down a big task into smaller and more manageable tasks that you know you can handle.

Play psychological games with yourself, e.g.: *"What mood am I in? What can I tackle? What will be most effective? And constantly in a kind of meta-analytical way coming up and above what you have got to do. And sort of saying, ok how am I going to tackle this in the best way possible?"*

Teaching Practices & Approaches

By adopting a Socratic [2] style of critique, John constantly challenges both himself and the students:

"I...try to be even better at asking questions and think they are the most fundamental tool in teaching."

John's examples of good practice:
Bringing in real data from research. John uses research publication to talk about issues in surveying and design. He also uses real data-sets teaching descriptive statistical analysis.

Reflective practice is not a "sheet of paper to fill" in or a "box ticking exercise".
John will regularly go through the process of asking for student feedback, reviewing teaching materials and assessing whether the course (and curriculum) is still relevant and accurate as a whole.

According to John, academics should not be isolated in an ivory tower, but be a part of wider society by contributing to and engaging with on-going issues. All of John's work is applied research and he considers research and consultancy work as similar. However, he feels that there are many presumptions about academics that can make collaboration difficult:

"The typical perception that industry has of an academic...is: cannot keep deadlines, totally disorganised etc. That's not me, I'm not like that, but the [educational] system drives you to a point that you cannot meet the deadlines in a way to suit [industry]."

John regularly invites people from industry to give lectures, particularly on the MSc programme. Such activities help build relationships and break-down barriers. Recently his department has also appointed a visiting professor from industry.

His relationship with postgraduate students is more intense than with undergraduate students, but in both cases he tries to get involved in their professional and personal development:

"You're the parent, you're the mentor, you're the advisor or the supervisor, you're the friend...you have to understand what role you need to play with them at times to the extent that you need to be forthright with them [first] and share a cup of tea the following week."

John's view on student-teacher relationships:
John comments that: *"Far too often teachers are in the Parent-Child role and should be in the Adult-Adult role...a proper relationship will develop when you have an Adult-Adult relationship."* He feels that this type of relationship helps to support student development.

An elaboration of *adult relationships* that John refers to is given by Berne (1970) [3]:

"When people interact they do so in one of three different ego states. An ego state is a specific way of thinking feeling and behaving and each ego state has its origin in specific regions of the brain. People can behave from their Parent ego state, or from their Child ego state or from their Adult ego state. At any one time our actions come from one of these three ego states."

Support

John arrived in academia as a manager, and he received formal teacher training in parallel with his first years of managing and teaching. He learnt a lot by observing others who he felt were managing their roles effectively:

"The single most important thing I understood from the teacher training was the very first statement ever made to me in the very first class:...that teaching is a 'planned activity'."

In order to support academics in the balancing and integration of their roles, John feels more administrative support is needed. He comments that as departments and classes get bigger, management becomes more complex.

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John Parkin

Time management that considers *both its forms.*

Adopt a Socratic style to teaching.

Have a pro-active and structured approach to reflective practice in teaching.

Develop an adult-to-adult relationship with your students.

Make full use of administrative support.

How planned is your teaching activity and how often is this plan reviewed?

Eann Patterson – University of Liverpool

Eann is the A.A. Griffith Chair of Structural Materials and Mechanics in the School of Engineering [1] and a Royal Society Wolfson Research Merit Award Holder.

"Blowing up Balloons in the Classroom"

Connecting teaching to real-life examples and bringing in research at the right time and level.

Integration of Teaching & Research

According to Eann the main advantage of teaching in a research-intensive university is simply to be able to do both research and teaching, with the opportunity to teach excellent and motivated students at both undergraduate and postgraduate levels:

"Doing the two side by side and having students involved in both at the same time."

Eann uses different approaches at introductory and advanced levels of teaching in line with the Mere-Exposure Effect, sometimes also called the Familiarity Principle [2]:

"There has to be certain familiarity with the material before you can introduce some of the higher level [research] ideas."

Eann's examples of integration: At undergraduate level it is about connecting theory to real-life examples. For example, Eann will put candles on cakes and talk about combustion processes or let students release balloons around the room to illustrate entropy and chaos.

At a more advanced level, once the students "get the basics" Eann will allude to a piece of research to inspire them.

Motivational Drivers

Eann's motivation has changed over his career. However, he has always enjoyed discovering and communicating new knowledge, including that related to teaching practice:

"Peer-respect [is important]...and as I am getting older contributing to society is becoming more important...I have four young kids and they are expensive...so at the moment [I'm] also driven by reward [laughs]."

Coping Mechanism

Eann argues that managing your roles needs ability to multi-task and prioritise work. Without some strategy, he comments that it can be difficult to fit a day's commitments into one day.

Eann's tips on balancing the roles:
A good team around you is crucial; you can use them for both teaching and research.
Postgraduates are valuable teaching resources as well as being essential to research.

Teaching Practices & Approaches

Eann has been involved in various teaching-related research projects, most recently: "*the effect of context on student engagement in engineering*" [3]. He views such work as a two-way process: the research is founded on his own teaching experience, but the outcomes often inform his future teaching practice and approaches.

Once the students grasp the basics of a subject, Eann will invite industrial guest speakers:

"I would always teach design by bringing in people from industry who are doing it for real, who have real design problems that you can set as part of the course."

About once a month Eann brings his postgraduate and undergraduate project-students together to do various activities and to discuss work and progress:

"Opportunity to talk about things like "how to write a paper"...We will spend some time looking at good and bad [examples of] written and published papers."

Eann's examples of good practice:
The Engage Engineering project: "the overarching goal is to increase the capacity of engineering schools to retain undergraduate students by facilitating the implementation of three research-based strategies to improve student day-to-day classroom and educational experience. Strategies include: integrating into coursework, everyday examples in engineering; improving student spatial visualization skills; and improving and increasing faculty-student interaction" [4].

Providing real-life examples in the teaching of solid mechanics, dynamics, thermodynamics and fluid mechanics [5].

Support

When Eann was appointed as a lecturer there was little opportunity for formal instruction on teaching. His PhD supervisor became his colleague and mentor, and was "the biggest influence" in getting started as a teacher:

"I guess like most people I thought about how I was taught, which professors were the effective ones for me, and tried to emulate what they had done; what worked for...[me] and [how]...to make it work for [my] students."

Nowadays Eann is actively involved in the field of Engineering Education and sometimes facilitates webinars [6] for organisations such as the American Society of Engineering Education [7] and the American Society of Mechanical Engineers [8].

Most institutions hold annual teaching conferences, which Eann regards as a good opportunity for presenting ideas, getting updated on colleagues' work and exchanging good practices. Additionally Eann thinks it is important to get together regularly as a Department to talk about teaching-related issues. These are useful to both new and established lecturers:

"What are we teaching? How are we teaching [it]? How is the world changing and therefore how do we need to change?"

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Eann Patterson

Teaching is about connecting theory to real-life; at some point, the appropriate real-life examples are current research studies.

Enjoy the dissemination aspects of both teaching and research.

Multi-tasking and work prioritising as skills to be learnt.
Use the support resources around you.

The interactions of postgraduates and undergraduates on research projects.

The value of both having a mentor and being a mentor as means for one's own development.

How often do you annotate theory with real-life examples and / or classroom demonstrations?

Eann presents the classic example of a rounded academic who relishes both teaching and research. He makes a number of excellent points about the demanding nature of these dual roles and the synergy between them. For example it helps to be well-organised and a multi-tasker, and there is undoubted benefit in having a team of bright people around you; not only can they help in practical ways but they are also a source of ideas. Eann clearly uses active learning methods as a natural part of his teaching repertoire and his comment about the Mere-Exposure effect echoes Vygotsky's early ideas, which I can paraphrase as "find out what the students know and take them a bit further".

Peter Goodhew, University of Liverpool

Bernard Porter – Coventry University

Bernard is Head of the Department Mechanical and Automotive Engineering.

"Understanding the impact of the political agenda"

The direction, content and future of both research and (engineering) education is dependent on politics and economics.

Integration of Teaching & Research

The University of Coventry is one of the post-1992 universities [1]. Bernard comments that in comparison to more research-intensive universities its research culture is in development and needs to be better "incentivised":

"Structuring research projects, [i.e.] putting together the work plans and resources to allow student involvement at all levels, not just the traditional PhD students, is worthwhile in many ways, but it is not yet an established practice. Perhaps recognising this as good teaching practice would help."

As an engineering apprentice, Bernard learnt the profession through a combination of work experience and formal instruction. He comments that involving students in applied research is similar to an apprenticeship, and is an effective and natural way to learn how to be an engineer:

"I had opportunities that I think are more difficult for people to get now. I don't feel it [that vocational training] is a handicap in any way. For engineers it's the best way...[and to] get anywhere near that is to integrate teaching and research. This gives students the nearest thing...[to experiencing the benefits] of being an apprentice."

Bernard's examples of integration:

The expectation of academic teaching staff to have a commercial or industrial perspective, e.g. through research work. The subsequent use of industrial / research examples in the classroom.

Focus on applied research and expose students to pragmatic industrial research-work, especially in local industry. This has the added value of bridging (or indeed developing new) academic and industrial research and other links through student projects:

"Research clients see the value in having good access to undergraduate and postgraduate students to be able to influence their studies...choices of projects, material. And they probably feel that this will help orientate the students towards their particular industry, maybe even them as a company."

Motivational Drivers

Bernard comes from industry and was attracted to teaching because of the opportunity to contribute to the development of people:

"I enjoy developing other people...like to develop teams, business units...whatever my perspective on an organisation is, I like to be in a developmental role."

A platform and freedom to express an opinion is essential for Bernard, and he sees it as an academic's privilege. This is especially so in his role as Head of Department dealing with various political and economical aspects of engineering education:

"It's going to determine the pace of change; certainly the development priorities will be politically driven...The only bit that interests me more than working with industry is working with the political agenda and try to understand how that really works."

Coping Mechanism

As Head of Department, Bernard's role is more about business development than teaching, but he appreciates the research-teaching role conflicts of many of his colleagues. He believes that time management is a key issue, and also finding the right balance between work and personal commitments that are acceptable to your values:

"If you want to do well in both [teaching and research] you have to give up some private time. But incidentally I don't necessarily see that as problem, that is a personal choice. It's a holiday entitlement, not an obligation; you have to choose the balance for yourself and your family. And there will be point in your career where you are happy to make those sacrifices."

Bernard's tips on balancing the roles:
Reconcile your personal values with teaching and research commitments, e.g. Bernard thinks it is important to make a contribution to the economy, so he is motivated to solve pertinent engineering problems where he can.

Appraise your roles and position through discussions with colleagues from across the university. For example, business developers look at the bigger picture and they are not constrained by the same (departmental) problems as academics. This may help give a fresh perspective on your contributions and work role balance.

Teaching Practices & Approaches

Bernard's focus is on the application of knowledge but with a teaching philosophy that:

"Engineering is an imprecise science and it's more about practising an art than having very detailed knowledge."

Where possible he always tries to bring in anecdotes and connect new ideas to concepts that students are already familiar with, e.g.:

"When you are trying to explain some of the principles of heat transfer you can do that [using anecdotes]. People can understand much more when they realise...equations are...the mathematical explanation of something that they already know intuitively. "

Bernard's examples of good practice:
Use anecdotes and be "self-depicting" by pointing out the mistakes you made in your own work or career.

Orientate all undergraduate projects towards current research activity.

Look for good material from student projects to publish or to present to an industrial client.

Most of Bernard's research is applied and involves (local) industry and employers. Although the benefits to him and his students are clear he mentions a potential problem to be aware of:
"I think it can have a very narrowing effect actually on research...there's a balance to be struck between doing research which is interesting and motivating for us (has value either towards you personally or to society) and research that can be paid for."

In addition to industrial experience and industry-relevant projects, Bernard feels that students could benefit from engagement with a broader range of topics through, say, the humanities and social sciences. Ideally, by adopting more of a "devil's advocate view" he would like to challenge students to be more critical and engaged in intellectual debates.

The majority of the research in the department is "highly relevant and closely matched" to graduate employment and so the impact on students' learning and motivation is generally positive.

Support

There were times Bernard felt that "being at work or being at home wasn't that different": both utilised the same sort of skills. For example, raising his children and his experience as a swimming instructor contributed to his development as a teacher. In other words, teach in a way that is in-line with your personal skills and background:

"Teaching a sporty skill gave me different inside in how to teach, because you cannot teach with the same methods. It becomes a totally different way of looking at it...[For] teaching swimming development...you need patience...reassurance. It's much more about the soft skill side and I found that really helpful."

The Postgraduate Certificate in Higher Education (PGCHE) "broke the ice" and opened a new world for Bernard:

"[It] was the first introduction to anything of that nature at all...And then when I started teaching I was interested in reading books on psychology...I wanted it to understand it better."

As a result, Bernard's thinking is shaped by classical reading and understanding of educational and behavioural theories, such as Piaget's "Cognitive development' [2] and McClelland's "Human motivation" [3]:

"Perhaps the main aspect is motivational theory and understanding the perceived benefits from achieving a particular goal, and the likelihood of successfully achieving it. This particularly applies to concepts of excellence, or in practical terms, of optimising a solution to a problem rather than settling for the first solution."

Another important experience on the PGCHE course was the video recording of his lecture that made him aware of his own teaching approach and the need to make learning more interesting. The main benefit for Bernard was to observe other people teaching in different subject areas. He is a big fan of compulsory teaching and wished he had more practical training:

"How to use PowerPoint effectively, because I don't know whether what I do is effective or not. I follow some very simple principles...I would have benefited from 'refreshers' and 'reminders' on 'how to make classes more interesting?'...[And] detailed lesson planning that school teachers do I think could be more useful to us then we would like to admit."

In Bernard's view a *silo mentality* in an institution can inhibit both teaching and research development and needs to be broken down:

"Coventry works with a leading Engineering Russell Group university...certain departments prefer to work with us rather than with their corresponding department...Sometimes those politics work to somebody else's favour, but it's frustrating when you see it in your own organisation that these silos around research activities stop us from bigger projects, stop us from going to bigger, more complex things."

Coventry University has a Business Development Team that helps academics set up research projects, develop proposals and apply for funding. Bernard thinks it would be helpful if there was similar support for complex teaching projects as well. More broadly, he feels that all universities should adopt a more consistent approach to teaching and research:

"The landscape across the UK HE sector varies enormously and thus academic mobility is being limited by effectively having different definitions of the job."

Then it would be easier for individual academics to compare their roles and relate it to the wider academic community.

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Bernard Porter

The special role of applied research for student motivation and industry engagement.

Engagement in the wider political agenda that dictate engineering priorities and education.

Understand the wider perspective of your contributions to the university rather than becoming entrenched in a departmental culture.

Break down institutional silos to address common teaching issues and share new knowledge.

Reflection on the relevance of other non-academic teaching / coaching / support to university teaching.

How do your personal (non-academic) interests and values influence your teaching?

This piece highlights a very practical approach to integrating teaching and research. This is perhaps, not that surprising, given the engineering background of Bernard. It is, nevertheless, very useful and may be instructive to practitioners who do not come from such an applied discipline, or seek to develop a more integrated outlook. I am struck by the way Bernard seeks to bring developing an understanding of the political and economic agenda into his teaching, too. This is a really interesting approach and Bernard's students must undoubtedly benefit from this angle of attack in a discipline which is heavily focussed on solutions design and problem solving. Bernard's insights into how and why he developed his own teaching expertise, given previous experience are probably quite common amongst STEM disciplines. But bringing the political and economic aspects into his teaching too, is an added bonus. Perhaps this reflects Bernard's role as an HoD, too. The key flavour of Bernard wanting to develop things shines through, as does a commitment to working collaboratively with others. Once again, this partnership approach, especially with other Universities, is characteristic of integrating teaching and research in STEM disciplines, where access to specialised equipment, expertise or practice environments, is so important.

Kevan Gartland, Glasgow Caledonian University

Stephen Richardson – Imperial College London

Stephen is Deputy Rector, Professor of Chemical Engineering and former Principal of the Faculty of Engineering and Head of Department (Chemical Engineering) [1].

"Avoiding micro-management and building confidence"

When the bigger picture is managed well, both academic staff and students are able to develop their skills and confidence accordingly.

Integration of Teaching & Research

Stephen stresses that if an institute wants to stay at the top, it has to produce both the best research and graduates:

"How do you do the best teaching if you are not linking the two bits together there? How do you...remain world beating? Some undergraduates come here because they know they are going to a place where they will be taught by world leading researchers. So it feeds off itself there...as soon as you break the loop we become a second rate university."

He comments that Imperial is "famous for its excellent undergraduates, as well as postgraduates", yielding an implicit driver for staff to be committed to both research and teaching. When the "balance tilts", firm action is needed. For example, as Chair of the Academic Promotions Panel Stephen has turned down several cases where the teaching element was unsatisfactory, sending a strong message to all about the importance of this role:

"I am very proud of having done that...to be a professor at Imperial College you have to do some good research, but you also have to do some significant teaching which has to be good."

Stephen's example of integration:
Stephen cannot imagine giving a meaningful course without having had relevant work-experience through research or consultancy. For example, as a researcher on the safety of off-shore oil platforms, he uses personal anecdotes and photographs of major incidents to raise the impact of the subject. His research work then informs and supports his teaching.

Motivational Drivers

Stephen enjoyed being Head of Department because he likes to "make things work":

"A system that works, like a department...appraisal systems, teaching assistants, lab systems."

Similarly, on a teaching level: *"To see someone's eyes light up when they understood it."*

Although some lecturers may take greater comfort in structured teaching, Stephen enjoys open-ended problems in his classes:

"Design work is the thing I enjoy most, because...I don't know where it's going...I like problems where nobody knows the answer, because I think education is about confidence...To see me not knowing the answer and to see me making a mistake and...how I am correcting it, is actually quite a useful thing to do."

Coping Mechanism

Even as Deputy Rector, Stephen is still involved in teaching and research. He has always had a large teaching load and balancing his roles was "tricky at times". He thinks it is important for academics to be aware of their strengths and limitations and plan accordingly. Stephen recognised that his particular strength was managing the bigger picture, e.g. as Head of Department, and this influenced the direction of his career.

Stephen's tips on balancing the roles:
Don't let anxieties in teaching and/or student interactions put you off: "Harold Macmillan, prime minister *in the 1960s used to be physically sick before he gave a speech in the House of Commons and he said only on occasions when he didn't feel sick he gave a really bad speech."* Stephen still gets nervous when teaching and comments that you have to be a bit on edge to anticipate and interact with the students accordingly. You have to care about whether they have understood you and be able to try a different approach when needed.

Avoid micro management and manage the bigger picture if that works better for you.
This can help in running departments as well as your own research.

Use sabbaticals to refresh your ideas, but with the attitude that this will be beneficial to both your teaching and research.

Teaching Practices & Approaches

Stephen thinks that Engineering courses should teach and exam less and focus more on building confidence in the students to become independent learners. As an example, he will sometimes only use a few slides in a lecture to illustrate ideas and then work through problems with the students. He also feels that learning is perhaps less effective now because of a lower inclination towards "self-teaching": *"The journey is harder now...I had a better education, because I had to work it out for myself."*

Stephen's examples of good practice:
Just because you once were a student yourself, does not mean you can relate to students' experiences now. It is important to be aware of this gap and how you can bridge it: *" 'What experiences actually have they got?' I cannot tell them about accidents that happened before they were born, but I would like to tell them about what things they remember seeing on the news."*

The 1st year problem-based design course was an innovative approach when Stephen set it up in 1990. The course involves group work, creative thinking, role plays and, more generally, students being pushed out of the comfort zone of, say, a typical lecture. It is demanding for both staff ("they have to think on their feet") and for students ("everything is public"). In a multicultural environment the course can be especially challenging, but great for learning:

"Certain cultures...don't like to say something when they don't know the answer. So the first week was about: 'How can you say something, so that no-one laughs at you?...[and] allow you to make mistakes?' How can you allow students to make mistakes in public without ridiculing them?"

By providing no clear-cut answers to problems, Stephen reinforces the message that sometimes in real and complex situations there is no exact solution. Rather, it is about an engineer's judgement of the situation as a whole.

All of Stephen's lecture notes are available to the students. However, the notes are "reminders" and incomplete, and of no use without additional explanation and the students' own interpretations.

Stephen comments that there is no reason for getting bored in a lecture, either as a student or indeed as the lecturer. He always tries to make his classes entertaining by telling lots of jokes. He also avoids going into "auto pilot" by keeping the teaching interesting through demonstrations, e.g.:

"Making a cup of tea to illustrate what's actually going on there [thermodynamics]."

Industrial involvement makes it much easier for Stephen to teach. He designed many of the safety systems for off-shore oil and gas platforms and as a consequence has a lot of stories to share with students:

"Whenever there's is an explosion I always check whether it is one of mine...So far none of them has (touch wood)...I do some very dry theoretical stuff with the students, but I try to show them that in the end it makes a difference and that makes life easier for them and me."

Students are responsible for their own learning, and Stephen thinks it is not up to him (or indeed anyone) to teach everything. Rather, he believes that student development happens through challenging experiences:

"My view is: throw them in the swimming pool, don't let them drown, but let them swallow a bit of water."

By making his teaching interesting, challenging and funny, Stephen is encouraging students to want to learn more and be able to tackle new unsolved problems. He also builds up their confidence "by appealing to their vanity":

"You are top students...I am going to take you from where you are now to one or two problems that are actually at the front-end of what anybody knows...By the end of the fourth year I will hardly teach you anything, I will just nudge in the right direction...That's the sign of a graduate that's ready for the world."

Support

When Stephen first started as a lecturer, a "self-help group" with other new academics was formed, and supported by a mentor. Such peer support helped to create a culture for reflective teaching and occasionally a teaching experiment:

"We would bet that we wouldn't do something which was a bit risky...I don't think I would have dared to do some of the things with teaching [e.g. 1st year design project and role play] if I would have been by myself."

Stephen states that education is not only about building confidence in students, but also in staff:

"So when I hear staff say: 'I cannot teach like that', my answer is always: 'Why not? What is stopping you? If it works for you and if it works for the students, why not do it?' "

He also stresses the value of *freedom* in developing teaching skills:

"I had that road to Damascus experience that actually I could break the rules in year 1. Most people don't discover that until year 5 or 6 and that's really irritating. So actually the fact that my colleagues...bet me 'I would never do it' was one of the best things that ever happened to me."

As Head of Department it was Stephen's mission to create a balanced work load. For example, he "engineered" the difference between the minimum and maximum teaching load from "10:1 to a fairer 2:1".

He strongly feels that an effective mechanism to support probation, promotion, teaching and even private life is the annual appraisal system, i.e. an opportunity for staff to review their work with a mentor and/or line-manager. As a mentor, he likes to discuss issues such as how to enjoy teaching, make it fun and a bit more like research:

"It is normally a matter of discussing with the mentee aspects of their teaching that they find makes it less enjoyable and then thinking what might make a difference. This might be a matter of better preparation or different presentation, or just a matter of scheduling for those who feel that teaching gets in the way of research."

Due to the small size of the campus, teaching and research resources overlap. Stephen believes that this actually can be a positive thing:

"Research labs are also used for undergraduate experiments, you are just doing it at the same time, you bump into the postgraduates you cannot help it. So our greatest curse, our lack of space, is our greatest blessing."

References

[1] Imperial College London www.imperial.ac.uk/people/s.m.richardson

Stephen Richardson

Bring in research and other work experiences into the lecture, e.g. stories and photographs.

The use of sabbaticals for both research and teaching recharge.

Design classes as an opportunity to model problem solving and build student confidence.

Regard nervous energy for teaching as something positive and constructive.

Make teaching interesting for the students, even if it means taking risks.

Lecture notes as only a framework for lectures.

Try to actively relate to students' current experiences.

Form support with a few colleagues.

Use the research resources around you to support teaching.

What has helped to build your confidence in teaching?

Stephen's belief that it is crucial to link teaching to research and practice is obvious throughout this case. His reasoning is simple – students are attracted to an institution based on its reputation; where that reputation is based on both excellent research and teaching, then they are inter-linked and cannot be separated. Stephen puts this into action, for example, by turning down cases for promotion that do not show evidence of strong teaching as well as research. There is also a second important message in this case, regarding the clear divide Stephen sees between his and his students' responsibilities. Students must take responsibility for their own learning and he equips them to do this. The examples reinforce this message, often mentioning building student confidence. The subtext of these examples is a linked requirement for the academic to have confidence in the potential of their students.

Fiona Lamb, Loughborough University

Jonathan Steed – Durham University

Jon is Head of the Supramolecular Chemistry Research Group in the Department of Chemistry [1].

"It's all about the chemistry and creating a wow-effect"

Historical stories can integrate modern research, theory and rationale.

Integration of Teaching & Research

For Jon being an academic is all about communicating the importance of science to others, i.e. students, colleagues and industry:

"Researchers are enthusiastic about their science...it is a kind of luxury to have an interested audience, at whatever level, that you can enthuse about your science."

The entry grades at Durham University are high and students are generally well motivated. Jon values the interactions with the students, and the exciting research environment helps to spread enthusiasm for science:

"We are lucky in this department that we have bright students...[and] that we are being asked intelligent questions all the time...But that is a luxury we need to value and recognise."

Jon's examples of integration:

Teaching that takes place in the laboratory to demonstrate a research (problem solving) approach.

Continuous and collaborative learning through undergraduate research projects.

Research Services provisions (personnel and equipment) that are accessible by both final year students and staff. This allows the exposure to experimental techniques and encourages "adventurous" research.

Exemplifying the research journey of Nobel Prize laureates to create a "wow-effect":

"Making them aware of the sorts of things that people have been able to achieve by studying in the same way they are...I like to ask undergraduates whether they know who won the Nobel Prize this year? What was it on, what does it mean to us? Show...how much of dedication and study they had to put into their particular area."

Motivational Drivers

Jon likes Chemistry and wants to communicate and share his passion for the subject with others. At an international conference in his field conference he feels part of the scientific equivalent of an "Olympic team":

"The people at the meeting are not necessarily winning the equivalent of the 100 meters every time, but they are among the world's elite who are metaphorically racing it...Having a job where you are stimulated by the things people say to you and by the work going on around you. There's a positive feedback loop and that's probably the most we get out of the job. And that then feeds back in wanting to share those new ideas and concepts...with the people that are studying at a lower level."

Coping Mechanism

"I always have an open door policy for my research group and undergraduates...Whatever is going on gets in the diary in what slot is left. It tends to be a really enjoyable mixture, a bit of a mad mixture of undergraduate teaching, industrial sponsors, research grant writing, paper writing, talking to the research group...A lot of what we do is very interactive, so that's pretty easy to do on the fly."

However, ultimately personal priorities dictate the scheduling of Jon's work: taking his children to school, picking them up and spending some quality time before they go to bed.

Jon's tips on balancing the roles:
Create a block of undisturbed time for substantial tasks, e.g. Jon sometimes works at home. Use the support from technicians, graduate students and administrators to organise the preparation, demonstration and logistics of laboratory courses. This allows you to focus on the design and content of the programme.

Time management should also consider important personal priorities.

Teaching Practices & Approaches

Jon's teaching style could be described as "story telling". He considers science a logical sequence of questions and resolutions and likes to emphasise the narrative in research through stories. For example, his teaching helps to relate traditional / historic metal chemistry to modern research and practice (re an introduction to a 2nd year Inorganic Chemistry course):

"Instead of going through that good background preparatory stuff I put a slide in on Damascus' steel, which is this very sharp steel which the crusaders had to deal with when they encountered the forces of Saladin in the 12th century. There was a paper published in Science in 2005 where they had taken one of these Damascus's sabres and actually dissolved the metal...and looked at the residue using TEM microscopy to find that the steel was supported by carbon nanotubes, an exciting current area of research."

Jon's examples of good practice:
Jon carefully assesses students' questions and answers appropriately. His view is that *"there's no such thing as a stupid question, just stupid answers".*

Students receive immediate individual feedback on experiments in laboratory courses. This has several advantages: timely discussions on the "scientific rationale" of the experiment (why are you doing this?), detection of *free-riders* and the efficient use of staff time whilst in the laboratory.

Jon links undergraduate topics to real-world application to demonstrate their importance, e.g. for a 2nd year course about metals:

"Metals are important because they can work as catalysts. Metals can make reactions go faster and produce bulk scale of industrial products in a more green way...An example of a catalyst that makes a difference in the environment is 'hydro-desulphurization. This name won't mean anything to a 2nd year undergraduate student...but it's used in industry to get the sulphur out of petrol and if you don't do that you get acid rain, which everybody heard off."

A final year course is based on Jon's own research and textbook on Supramolecular Chemistry. His lectures include personal anecdotes about researchers in the field:

"One guy was annoyed because he didn't leave his reaction long enough, and so the other guy who was more patient published first."

His teaching often involves a consideration of both *tools* and *problems*:

"Solving the problems and giving them the tools to do that. A huge amount of experimental science is about instrumental techniques...The problem we have in Chemistry is that in order to equip students with the (conceptual) tools it is sometimes not obvious to them at the time for what problems they are going to use these tools. The key is keeping that sense of where the learning is going."

According to Jon the purpose of practical classes is to teach students techniques and how to handle materials and tools. In the beginning the experiments are well-defined, but they become more student and problem-led over time:

"That paradigm shift in their attitudes is from 'there's a right answer, I must get to it, because I must get my degree' to 'it doesn't matter whether it works or not, what matters is whether I prove whether or not it works and notice along the way what's interesting about it'."

Jon's interactions with postgraduate and undergraduate students are similar. In the beginning he may provide more guidance, but then it is about working together to solve problems.

Jon's view on student development and relationships:
He creates mentor relationships between senior research and undergraduate students to ensure dialogue, feedback and support.

As part of his regular research group meetings, presentations are given by each individual every fortnight. The group includes two final year students and the meetings provide them with valuable experiences and learning opportunities:

"They are already practising talking about their work, defending it, being responsive to suggestions of others and not feeling defensive about it. By the time they have to give a talk in front of an audience, they are comfortable with not knowing all the answers, but talking about what they understand and being open about where the edge of their knowledge is."

Over the last 5-10 years Jon's research has become more applied. Subsequent industrial interest in his research work has led to their involvement in teaching activities as well. Academic liaison officers from industry have been very helpful in supporting teaching. For example, a BP officer facilitates a business exercise as part of the Contemporary Chemistry final year course. Also, an Ashland Speciality Ingredients sponsors PhD students and the industrial supervisor is heavily involved in student learning:

"He visits regularly, is hugely enthusiastic about science and whatever result you have to tell him about he has got an angle on. He can see how it can make a commercial product, he can see how you can take it forward in academic sense, he wants papers to be published. Partly because it helps his company to show how they got a proper scientific basis for the products they are making. But he is full of suggestions for the students to take away and try new things, so he's fully another supervisor for them."

Support

"Fear" has made Jon a better teacher because he tries to anticipate students' questions:

"I remember doing my first undergraduate lecture...I thought they were going to ask all the hard questions and felt I needed to be able to cover everything they might ask...In a sense I try and gear everything I do in rewarding their effort: 'you make me work, and I make you work and we'll both be better of as a result'."

He later came to realise the value of questioning and question-anticipation for good teaching.
Jon feels he has learnt much from his direct interactions with students and the creation of an effective "feedback loop":

"Being perfectly honest, going ahead and doing it, interacting with students and being driven by their needs. As long as you are that kind of person that listens to what those kind of needs are and tries to respond to them...So there's a huge case of 'on the job training'."

However, he points out that you cannot use undergraduate teaching as "a forum to train people who are complete novices" (especially with the change in university fee structures). Generic teaching skills training should encourage academics to be self-critical and learn more from "the stimulus they get every day", e.g. from students, peer observations and discussions with colleagues. He also feels that teacher training should be organised departmentally and be supported by mentors. He particularly values peer-reviewed teaching whereby academic staff have to attend the lectures of several of their colleagues. Jon thinks this is a good learning experience, but without the University's requirement it would be unlikely to happen.

Finally, Jon comments that currently career progression "seems mainly to be a result of low-success-rate activities", particularly funding success. However, he states that universities should recognise and reward the assumed "easy" tasks that contribute to supporting student learning and development.

References

[1] Durham University, http://www.dur.ac.uk/jon.steed.

Jon Steed

Illustrate the research approach of great scientists and engineers.

The laboratory class to demonstrate and practise research skills.

Connect today's science to historical contexts.

Use senior research students as mentors for undergraduate students.

Review of others' teaching as part of your own ongoing teaching development.

How are important personal priorities integrated into your time management?

What comes across very clearly here is the enthusiasm Jon has both for his discipline (Chemistry) and for developing the skills and attributes of his students and researchers. The emphasis on learning by doing and on asking questions, without fear, is a very important facet of this approach. One gains a sense of the fun that working with Jon's group must involve and of the non-hierarchical way in which students are brought into activities. This is refreshing and most encouraging for students who want to ask questions, but might feel a little shy. Overcoming this effectively, can be an important part of integrating teaching and research. Including current hot topics, or interesting historical examples of applied chemistry and bringing them up-to-date, is an interesting approach that must increase students interest and fascination with the topics covered. Students can only benefit from approaches such as this that not only help to make learning and skills development more relevant, but also exciting. The approaches adapted to time management must be very familiar to all staff trying to integrate teaching and research, as are those about taking risks, story telling and the importance of developing a relationship with students, as learners. One difficulty with this approach, of course, comes from increasing class sizes and the lack of personal contact with key researchers, which can mitigate against such approaches. Overcoming this effectively is a conundrum for all interested in integrating teaching and research, especially at a time of increased turbulence in the sector re fees and putting the student at the centre whilst generating surpluses etc…

Kevan Gartland, Glasgow Caledonian University