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Education in Practice

Edited by Jon Green and Michael Grove

Teaching Academy

Education in Practice

Disclaimer

Contents

Editorial

Welcome to this second issue of Education in Practice which is published at a time of change and opportunity within the higher education sector. The recent publication of the Higher Education Green Paper, 'Fulfilling our Potential: Teaching Excellence, Social Mobility and Student Choice', proposes the biggest change in the national framework for higher education in England since the 1992 Further and Higher Education Act led to the establishment of a series of 'new' universities.

As we move into this new era of higher education, the University of Birmingham has published its new Strategic Framework and Education Strategy. The Education Strategy defines the skills and abilities that a Birmingham graduate will possess upon completion of their studies. Final year projects are an important way of developing and consolidating these skills: Lodge describes a new type of literature review project that incorporates elements of critical review of published papers as well as designing a research proposal. The University's Strategic Framework describes our vision as a research-focused university and this provides natural opportunities to develop links between teaching and research: McLinden et al. review the research-teaching nexus focusing upon student expectations of research-informed teaching and the results of a recent University-wide survey. D'Souza and Mandeville further highlight this in a review of a new Postgraduate Certificate in Advanced Research Methods and Skills – in this study, evaluation of student feedback is explored.

The Strategic Framework also sets the goal of providing our students with a distinctive, high quality experience through curriculum innovation and enhancement and investment in world-class facilities: Rowley and Green show how changes to the conventional lecture can also improve student engagement and learning – the flipped lecture approach benefits from use of the virtual learning environment, but also involves interactive sessions in class. To support innovative teaching, appropriate learning spaces are required and Rutherford describes a study that considers how the effective design and arrangement of learning spaces can encourage and enhance the student learning experience.

Finally, students must be at the heart of what we do, and working collaboratively with students offers real opportunities to enhance their learning experience: Collis et al. explore how marks can be allocated in group work activities using peer assessment and base their findings upon a survey of undergraduate students within the School of Mathematics. In the School of Physics, Ansell et al. describe work undertaken to improve student information about modules so that they may make a more informed choice of the structure of their degree programmes.

To promote and encourage excellence in teaching and learning, the University of Birmingham has recently established a Teaching Academy. Education in Practice forms an important part of the Teaching Academy's mission to not only disseminate evidence-based practices, but also encourage their wider uptake and stimulate innovation. While many of the papers in this current issue refer to work in particular subject areas, the principles, ideas and findings described are applicable to a range of subjects across the University.

Please send any comments or suggestions relating to the journal to either of us; we welcome contributions from anyone working at the University of Birmingham and particularly those staff who have received funding through the Education Enhancement Funds. We have aspirations to increase publishable outputs from educational research and to increase the publication of Education in Practice to several issues per year.

Jon Green and Michael Grove
November 2015

Paper

Creating Physical Learning Environments that Enable Effective Learning and Teaching

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Abstract
This paper is a summary of a Master's thesis completed in 2013 and considers the types of physical environments that are required to enable effective learning and teaching in respect of a student centred, active and collaborative pedagogy. The paper examines the conclusions of a small-scale empirical research study that investigated the impact of new spatial designs at two universities in England. The methodology was mixed and resulted in a set of data from interviews of academic staff and student focus groups that regularly occupied the learning spaces, together with classroom observations and photography. A thematic data analysis resulted in conclusions that were intriguing, persuasive and thought provoking. It is clear that student's preferences for their working environment are evolving. They require a more informal atmosphere, closer connection with their tutors, more space within which to sit comfortably and sufficient writing surfaces to access. There are key social and psychological considerations to understand in order for an effective design and arrangement of learning spaces that encourage and enhance the learning experience.

Background and Context

It is evident from a review of the literature that the higher education sector is considering emerging pedagogies and is taking significant steps towards the design of new learning spaces intended to cater for active and collaborative learning (Blackmore *et al.* 2011; Neary *et al.* 2009; Van Note Chism, 2006). The literature was drawn from the UK, Australia and the United States and demonstrated how students may be engaged in activities such as discursive seminars, facilitated group study, experiential, enquiry and problem-based learning.

The overall aim of the study was to understand the impact of new student-centred learning spaces aligned with the principles of constructivist learning (Biggs, 1993; Montgomery, 2008; Prosser and Trigwell, 1999; Ramsden, 1992). Psychologists and contemporary educationalists use the theory of constructivism to understand how humans learn.

Biggs believes that knowledge is not *'out there',* an entity waiting to be discovered nor reproduced from others, rather learners should actively construct knowledge from their own experiences and these could be constructed through problem solving (Biggs, 1993). It is argued that problem-based learning as a paradigm is a key feature of group-based work and the social construction of knowledge. Problem-based learning involves challenging students with an issue linked to their curriculum, rather than the traditional didactic transmission of information (Ahlfedt, Mehta & Sellnow, 2005). It is claimed that this improves student motivation and develops greater cognition, stimulating independence and ultimately interdependence. It is also seen as improving student's ability to work together, to analyse issues and in strengthening their communication skills (Beetham & Sharpe, 2007; Fry, Marshall & Ketteridge, 2008).

The Study

The intention was to visit two universities in the UK where their deliberate and considered efforts to design collaborative learning spaces would be examined with a view to understanding what the impact has been through the triangulated methodology of observation, photography and interviews. The focus of the investigation was on the consequences of new layouts and furniture arrangements that have been designed to enable group based and active learning. The aim being to establish how effective these spaces are and how academic staff and their students perceive them. This work is of value as few studies have been carried out to question and evaluate the physical aspects of the layout and furniture in this new generation of learning spaces.

The research methodology was mixed, adopting an interpretive approach and based on a phenomenological study (Dick, Stringer & Huxham, 2009) of learning spaces at two different higher education institutions, to be known here as University D and University L. Two days were spent at each campus gathering data from a number of observed seminar classes, together with hosting 10 academic staff interviews and 7 student focus groups. Each interview and focus group lasted between twenty and forty five minutes, held in collaborative teaching rooms and social learning spaces on campus.

In terms of the data analysis, codes were utilised to represent and highlight instances identified from the transcriptions of staff interviews and student focus group sessions. These were viewed along a theoretical range from the *'mundane to the remarkable'* (Silverman, 2007:16) and in phenomenological terms, according to their level of sophistication as determined relevant to the research question. Such an example would be when a student talked about the layout helping her overcome her shyness when presenting to the cohort. This instance was marked with the codes of 'Confidence', 'Presentation' and 'Layout'. Braun and Clarke (2006) note in their work on inductive thematic analysis, themes soon to appear in one's consciousness as the codifying process develops.

Over forty different codes were grouped so to arrive at an overarching topic and then the completion of the naming of themes. So in adopting this phenomenological approach, the data has been arranged into the themes shown within Table 1.

Theme 1	Behavioural
Theme 2	Environmental
Theme 3	Pedagogical
Theme 4	Practical
Theme 5	Social/psychological

Table 1: Themes emerging from thematic analysis.

Findings and Summary of Data Analysis

With the Behavioural theme (1) one element was codified as 'time-consuming' and is related to classroom management. If students are set group tasks within the space, there is an obvious point to make about setting temporal parameters to the cohort. At University D staff development programmes have been introduced to support those academics new to the collaborative approach that these rooms enable. Another coded aspect of the Behavioural theme was 'talking in class'; this is intriguing as it is something of a dichotomy. The shape and layout of tables are designed to allow for group collaboration, which naturally is mainly about discussion. Where one academic found talking in class to be a problem, others recognised it as part of the nature of the space and recognised that students were more likely to be commenting on the content of the lesson.

Academics at both universities have witnessed supportive peer learning amongst their students, stating that this is more prevalent in the collaborative learning spaces than observed in traditional teaching spaces. In the rooms that were observed, there was a noted tendency for students to stay on after class. The academics believe this is due to students feeling more comfortable with the space, suggesting a greater sense of ownership. Students talked about *'our'* rooms, which is arguably an essential requirement for student engagement and the possibility of an enhanced experience of learning.

The Environmental theme (2) drew on issues that are important in terms of basic human comfort. According to the students interviewed, issues were discussed that are perhaps so obvious that they are often ignored or compromised. Clearly all rooms need good ventilation, controllable lighting and heating, with access to daylight. This featured regularly in comments by students, as apart from the natural aspect of needing daylight, it clearly impacted on their concentration and energy levels (Graetz & Goliber, 2002). Daylight is their connection with the outside world and for some, the view outside can be important for reflection and a reference to their day.

Then there is the issue of acoustics, an environmental aspect frequently neglected or demoted in the priorities for creating learning spaces. Again it seems to be an obviously apparent requirement, but inadequate loudspeakers, poor room reverberation or noisy ventilation can have a negative impact on learning (Dockrell & Shield, 2006).

Another significant factor is that of colour, which not only provides an aesthetic statement, but there is also the psychological element to consider. Respondents recalled how colour gave the rooms a modern look and significantly, left a lasting impression on them. There was a general dislike of rooms that appear bland and clinical, a factor that was uncovered in a research study at the author's previous institution (Rutherford, 2010). This demonstrates the significance of the environmental factors working in harmony with the layout, furniture and technology of the room, which is a major element of a holistic approach to learning space design.

With the Pedagogical theme (3) it was discovered that the majority of academic participants were very positive in their responses when discussing the pedagogical impact of the learning spaces under investigation. Staff considered that their students engaged more actively in exploratory learning than in other rooms. As the dynamics have changed, they talk more and engage in responses to their tutor more as they have worked together in their groups. Staff found greater engagement amongst students; they experienced more spontaneous questions, whereas teaching the same module in a traditional room had nothing like same level of interaction.

Two academics at University D responded positively about their own emerging practice, stating that they would change their delivery to suit the room and adopt more group-based work. Respondents found it easier to support higher order intellectual skills in the new spaces, as it appears to suit emergent styles of teaching and learning. One academic discovered that since she has adopted the role of facilitator, she has witnessed more risk taking by her students. Another tutor was quite emphatic in describing his role as a conductor, not as a teacher. Most academic staff saw the need for a change in the dynamics, where the relationship is less didactic, so that students gain an important and different perspective of their learning experience.

At University L, two tutors from different courses concurred on the impact of the new spaces on their students' learning outcomes. The new rooms provided the opportunity to combine the application of practice with discussion groups then considering theory. One respondent felt that this embodiment of pedagogy leads to a more confident learner who is then capable of acquiring transferable skills. With the feedback from her students, another academic was aware that they preferred group work as it significantly helped in developing their analytical skills.

Students were in agreement about the open nature of the rooms that encouraged an informal teaching approach. *'Being relaxed helps with creative work',* and *'it is easier and quicker to learn',* were common responses, unlike the small spaces where they are *'crammed in'* and where they are *'just talked at'.* Students at both universities preferred to be active and working in groups where they feel that they are learning more through discussion and participation.

Within the Practical theme (4) the research findings demonstrated that space is a crucial factor in the success of a room for collaborative learning. Students discussed needing sufficient space to work and move comfortably within the room. In simple terms, students need adequate table space, to work on a mobile device, to write or draw or carry out practical tasks. The findings show that students require space to work comfortably within each group without overcrowding, including adequate legroom. The argument appears to simple and persuasive, discomfort leads to distraction, which results in disengagement.

Students do not like being *'crammed'* into lecture theatres, feeling *'penned in'* by the restrictions of folding writing tablets, nor sat in rows in small and uncomfortable chairs. There is a lesson here for those who timetable too many students into a room, which has been shown in this study to have a negative impact on the ability of staff to facilitate group working. Interestingly, the focus groups demonstrated that students need a balance; they want sufficient space in the room to avoid distractions from other groups who might otherwise *'invade'* their space. But they also prefer a space that allows for movement within the room, so that they can engage with other groups at their choosing, surely a factor that leads to wider group collaboration.

Quality of furniture is an important and challenging issue, as furniture can be under specified due to budget restraints or a lack of understanding of its significance. As one student at University D commented, 'weary' furniture can inadvertently send out the wrong psychological message, he implied that the university does not consider student comfort to be important. Students can be in class for a considerable time and as is known from research (McClelland, Dahlberg & Pilhal, 2002) discomfort can lead to distraction and therefore disengagement.

Figure 1: 'Plectrum table'.

The findings from this study were clear about the value of chairs on castors, a simple but practical feature that enables effective group-based learning. A number of respondents commented that square or rectangular tables are not so practical and far less effective for group work. Staff at University D commented on their preference for rounded triangular group tables that allow adequate space for the activities assigned to students (See Figure 1). These 'plectrum' shaped tables have equal sides and cater for six students, allowing space for students to easily move around the table on a wheeled chair to observe a presentation and returning to a position to work in a collaborative fashion. These tables have become widely adopted at a number of universities, recorded in visits to institutions both in the UK and in Australia (Rutherford, 2011). What was noticeable at University L was that the type of triangular tables did not give equal space to students due to their shape not being equilateral (Figure 2). This can cause problems for students and perhaps lead estates and timetabling staff to misjudge the real capacity of a room.

Another important factor to emerge from the study is that students need time to develop their confidence and expertise in working collaboratively in these types of spaces. Some students were observed as quite reticent and naïve in their use of shared spaces. For example, it was unclear if they were permitted to swivel or move their wheeled chairs. A number of students sat almost rigid in a chair with castors, rather than moving to face their tutor.

Through the introduction of adequate writing surfaces, rooms can afford opportunities for conceptual and creative work, liberating students to express themselves with greater confidence and to experiment on a larger scale, so complementing the layout with an additional dynamic and active element. Confidence is key issue here. At University D one student gave her appraisal of the impact of the new space on her whole learning experience. She described how her confidence in presenting to others had improved and that has impacted on her approach to other classes.

The Psychological theme (5) drew out significant outcomes, the consensus amongst academic respondents showed that these collaborative spaces do engender greater participation. Students reported that they are more willing to collaborate if they feel relaxed in the classroom and by their tutors' complementary style of teaching. The research data underlined the strength of opinion from students about the importance of working in an informal environment. So the imperative must surely be to create spaces that allow students to feel comfortable and less inhibited, a more relaxed environment that is conducive to a greater sense of egalitarianism, so that students are able to learn without an overbearing sense of pressure or undue formality.

Describing their classes in group study rooms, students talked about the positive change in their relationships with others;

'*People say to me that it's really nice you make friends with people on your course, where they just go to a lecture and then walk out afterwards without speaking to anyone, sitting on a group table you're bound to talk to other people.*'
Product Design student, University L

Another student talked about the effect of collaborative working on her whole learning experience:

'Y*ou need to engage more with people's opinions, whereas at school it was more intimidating to say something when you got a whole load of people in rows. It's weird how that works I'm not sure why.*'
English student, University L

Participants from both universities spoke emphatically about the collaborative spaces, recalling them as their favourite rooms on campus, using superlatives such as *'fantastic', 'fabulous', 'innovative'* and *'exciting'*. This is of course an emotive aspect of the research, but it was a key feature of the thematic data analysis. The data showed that the academics recollection of these rooms clearly impacted on their own levels of motivation.

Student's responses included a feeling of greater equality with their tutors, where the new rooms have created an opportunity for a more egalitarian and less formal type of relationship. They discussed their preference for rooms that allow their tutor to move freely.

The interpretation being that students do not like to feel isolated and want to have equal access to the academic, which is far more difficult in a traditional teaching room with serried rows of tables and fixed seating: *'Many undergraduates tend to be authority dependent, passive, irresponsible, overly competitive and suspicious of their peers'* (Bruffee, 1999:91). This situation is arguably fed by the lecture-based system. Bruffee suggests that collaborative learning can provide a *'re-acculturative process'* that assists students to become participants in learning communities and to learn the attributes of interdependence (Kelly, 2002). It is pertinent to this study as a number of academics at both the universities discussed the ease with which the new spaces allowed them to involve introverted students or those lacking in confidence.

Figure 2: Non-equilateral triangular table.

This was opposed to large lecture theatres where most students reported feeling too intimidated or physically restricted to actively engage in responses.

Finally there is the consideration of the implications for practice, policy and further research. In spatial terms, the ability to move freely also removes the traditional academic hierarchy. Collaborative spaces can facilitate greater equality in terms of dynamics and create mature relationships between staff and students. In pedagogical terms, the success of the studied rooms has encouraged staff to alter their teaching delivery. Some staff have begun to adopt techniques of blended-learning such as the *'Flipped'* classroom approach (Bergmann & Sams, 2012) and one has experimented with the *'Jigsaw'* technique of teaching with groups (Aronson, 1978; Perkins & Saris, 2001). This is surely a positive and important outcome from the new room designs and could be developed by creating new spaces within the universities. Certainly institutional approaches to learning and teaching may be addressed by wider and sustained research into learning space design alongside continuing professional development in the constructivist approach to pedagogy.

In practical terms, the success of a space is equally determined by something as simplistic as good housekeeping and intelligent timetabling. With a collaborative space, a more effective facilities regime is required, together with a considered and academically informed approach to timetabling. There is a real challenge here. If a room can be reconfigured with moveable furniture, then perhaps there should be a buffer zone between classes to allow for the room to returned to its designed state or rearranged according to the requirements of the next class. As the data has shown, this simplistic approach belies the importance of room configuration and cleanliness on the impact for effective collaborative learning and teaching.

Conclusions

The data uncovered material that is considered to be informative, invaluable and illuminating:

'*I think the results are slightly higher, slightly better than results I have in previous years, I think it's because their critical skills have developed a little bit more but I haven't changed a lot in the way… I teach the theory, but I think they are having discussions about work, on developing presentation and critical skills, I think that was facilitated by the type of room that we were using.*'
English academic, University L

There is compelling evidence in the study that should be a catalyst for further research. Clearly there is a requirement to determine the impact of collaborative learning spaces not only on students' learning outcomes, but also in respect of the constructivist principles of teaching and learning. So despite the small scale of this phenomenological study, it is argued that it has relevance for higher education and real value to those stakeholders who contribute to the design of new learning environments.

At the outset, students clearly demonstrated the significance of getting the environmental factors working in harmony with the spatial aspects of the room: heating, lighting, access to daylight, comfort and acoustic elements are fundamental, in fact this is considered to be representative of the desired holistic approach to learning space design.
Overall it seems that the engagement of students is easier to achieve within these new learning spaces. Along with a change in the dynamics, students appeared to be more relaxed, confident and focused on their learning. The spatial impact on group work was seen to be more effective, with students able to function more efficiently whilst producing more experimental, collaborative and creative work than in traditional, more formal classrooms. There are important practical measures to consider too. Providing an equality of space, comfortable seating, new furniture, and bright and modern décor, together with appropriate and easy to use technology for all. But there are of warnings too, as students were clear what they did not like. If there are too many students in too small classrooms, it is far more difficult to adopt a collaborative approach and staff would be battling with unhappy, uncomfortable and ultimately, disengaged students. However, it is not all down to the physical space. New forms of teaching delivery are possible and seem to be evolving, indeed it was welcomed by participants, along with a parallel motivation for staff to engage with academic development to give them the confidence to change and embrace the opportunities offered by these new spaces. The impact of group-based learning was quite pronounced from the research, students were in the majority of cases very positive and encouraging about the impact on their experience of university.

To conclude, one of the most significant outcomes from this research study came from students who talked about being more motivated to attend classes. One student at University D remarked that he genuinely felt a real sense of enthusiasm on a Monday morning for his class; clearly a significant impression had been made. If students perceive a room as being memorable and the association with that space is one of a positive experience of learning, it can be argued that this is due to a heightened sense of engagement and motivation to participate in class.

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Case Study

More Than a Literature Review: An Alternative Final Year Project for Bioscience Students

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Abstract
With increasing pressures on staff time and increased diversity in the student population it is important that universities explore different ways of providing final year projects. This case study describes a successful format developed in the School of Biosciences at the University of Birmingham. The project consists of a literature review followed by an in-depth critical analysis of five key papers and the subsequent development of a research proposal.

In addition to written reports and an oral presentation students are asked to write both a lay and a technical abstract for their research proposal. This challenges the student to explain the importance and also the scientific approach to different audiences. The analysis of five key papers has been found to be an excellent tool to encourage a deep understanding and critical analysis of research papers and that the skills demonstrated in this section are distinct from those demonstrated in a traditional literature review. The research proposal allows students to develop many of the skills usually associated with a practical project including identification of gaps in current knowledge and developing a hypothesis.

Overall this format allows students not choosing a lab or field based final year project to apply the skills and knowledge accumulated during their degree in a discipline related context and despite not having a practical element it remains true to its roots in experimental science.

Introduction

The importance of a culminating experience that is qualitatively different from the taught components of the programme of study is widely acknowledged across a wide range of disciplines and education systems. Sometimes referred to as a *'Capstone'* project or experience this should *'utilise to the full the research and communication skills learned in the previous years'* (Healey, Lannin, Stibbe, & Derounian, 2013). The Boyer Commission on Educating Undergraduates in the Research University in the USA emphasised that *'all the skills of research developed in earlier work should be marshalled in a project that demands the framing of a significant question or set of questions, the research or creative exploration to find answers, and the communication skills to convey the results to audiences both expert and uninitiated in the subject matter.'* In defining the Capstone Experience in their University of Melborne guide Holdsworth, Watty, and Davies (2009) the importance of projects in the transition between undergraduate and graduate student or employee is emphasised.

In the UK most students take a final year project which accounts for between 20 and 40% of their final year credits (Healey *et al.* 2013). The QAA benchmark statement for the Biosciences states that *'All honours degree students are expected to have some personal experience of the approach, practice and evaluation of scientific research (e.g. within a project or research-based assignment)'* (QAA, 2007). This has been reinforced more recently by the inclusion of the capstone experience which *'should include the analysis and critical evaluation of data within an independently produced piece of work'* amongst the criteria for accreditation by the Society of Biology (Society of Biology, 2015).

The Need for Alternative Project Formats

Provision of a high quality project for all final year students is a major challenge for a large Biosciences department. Prior to the sharp increase in undergraduate student numbers in the early years of the Blair government the norm for the vast majority of final year students in a research intensive university was that they would join one of the research groups in their school or department and would work on an aspect of the research in that group. As numbers of undergraduate students have increased this has placed a strain on research groups, particularly in popular areas. Moreover, it is clear that within the increasingly diverse undergraduate population there exist a group of students who, by the time they enter their final year, have already decided that their future lies outside of the laboratory or field. Indeed while the proportion of young people going to university has increased rapidly over the last decade in the UK and elsewhere only a small proportion of science students will go on to have academic or research careers. The importance of allowing such students to *'fulfil their potential through undertaking final year project or dissertation more closely aligned to their needs and aspirations'* has been identified (Healey *et al.* 2013).

For many years the School of Biosciences, and many other similar departments, offered a literature review as an alternative to a practical project. This is an excellent alternative asking students to read a wide range of literature, to make a unique synthesis of this material into something similar to a review article. However in reflecting on this alternative project we began to identify important aspects delivered by project work in Biosciences that the conventional literature review did not fully meet. These included in-depth interpretation of data and proposal for further work. As a result, over a period of years, a two-part Evidence Base Literature Review Project has been developed which allows students to develop and apply a range of important analytic and interpretive skills relevant to the Biosciences without doing an experimental project.

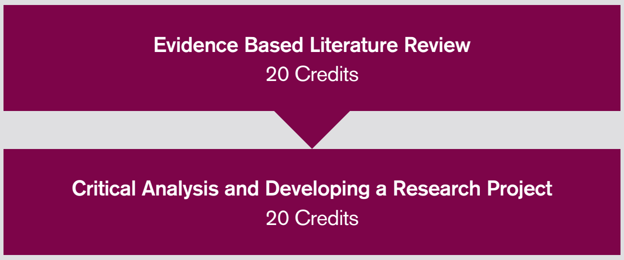

Figure 1: Overview of project.

Structure of the Project

The overall format of this project is outlined in Figure 1. It comprises two linked 20-credit modules: the first module is a literature review; the second is an in-depth critical analysis of five key papers and the subsequent development of a research proposal. There are a number of important advantages to dividing the project into two 20-credit units. This gives students and staff clear milestones ensuring that good progress is made during semester one. It was in fact at the instigation of the welfare team that this format was introduced as the early milestones allow us to identify any problems at a point when it is still possible to do something about them. Because students choose the topic from a list supplied by supervisors this ensures that the topics will allow the students to demonstrate the learning outcomes. The direction taken in the second module is chosen by the student, allowing them greater independence once they have demonstrated a firm understanding of the area of study.

Evidence Based Literature Review

In the first module students undertake an in depth literature review in order to address a specific question posed by their project supervisor; the students will also give an oral presentation, usually as part of our project symposium. Learning outcomes for this piece of work are similar to those for any literature review module. It has been found that posing a question rather than just giving a broad topic for the literature review is a successful way of enhancing the analytical aspects of the piece of work.

Critical Analysis and Developing a Research Project

The second 20-credit component involves an in-depth critical analysis of five key papers identified as a result of the original literature review and the subsequent development of a research proposal. In this module the student chooses the direction of the study in consultation with their supervisor.

The critical analysis involves a short introduction (500 words) summarising the subject area and justifying the direction taken in the second semester in the context of the literature review and identifying gaps in current knowledge. Each of the five key papers must be analysed in detail and summarised in approximately 500 words. This task requires very close reading of the original article and an in depth understanding in order to identify and summarise the key points in a very brief piece of writing. Students are encouraged to reproduce data from the chosen sources in the form of tables and figures but must clearly explain how the data supports the conclusions made. They are encouraged to think about the experimental design, controls and statistical analyses and to draw their own conclusions about the significance of the results presented. For some students this is the first time that they have independently looked closely at data presented in papers in order to draw their own conclusions. As they begin this task they will often ask ‘who am I to criticise a paper that has passed the peer review process?’ However once they grasp the concept that critical analysis can mean identifying what makes paper really good as well as indentifying problems with it they are able to tackle this component.

Finally the students work on a research proposal. Importantly this element has its own assessment criteria and counts for 50% of the mark for this module, elevating it, both in the mind of the student and of the supervisor, from an afterthought to a key component of the module. The research proposal includes some of the components of a grant proposal but focuses on scientific issues rather than practical management and cost aspects of a proposal. Students must identify an area for further investigation which shows that they have an understanding of the gaps in current knowledge and they are expected to give a clear statement of the hypothesis to be tested. They must outline a range of appropriate approaches and techniques and show understanding of appropriate controls and statistical analyses. They are also asked to include a flow diagram illustrating a clear and well-designed plan of work. Finally they must write both a lay abstract, aimed at an intelligent 14 year old, and a technical abstract summarising the proposal for a scientific audience.

Developing the research proposal is obviously a challenging aspect of the module and requires guidance from the supervisor; however the ideas must be the student’s own. Initial proposals are often over ambitious or impractical, for example using large numbers of experimental animals, however with guidance students develop excellent proposals. A good proposal will focus on a genuine gap in knowledge and often bring techniques into play that the student has read about applied in a different context. Students are not constrained by considerations such as what expertise is available in the current research group or the availability of local facilities so they are sometimes able to come up with truly innovative approaches. Inclusion of the flow diagram is an excellent way of assessing whether the student understands the development and organisation of the project. It also encourages them to think about the likely outcomes of early experiments and how these may influence the execution of later ones.

The abstracts ask students to focus on two different audiences. The technical abstract requires the identification of the key features of the proposal; the lay abstract however challenges the student to explain the importance and also the scientific approach in language that is accessible to a non-scientist. It helps to develop the key skill of communicating scientific ideas to a wider audience. This element would be easy to incorporate into any existing project model.

	Evidence Based Critical Review	Practical Project	Literature review	Source
An extended in-depth, independent piece of work relevant to the student's discipline	+++	+++	+++	Healey *et al.* 2013;
QAA, 2007;	73.2	88.2	87.1	96.8
SoB, 2015	98.4	92.6	97.8	95.6
Underpinned by a range of relevant resources, for example original literature	+++	+++	+++	Healey *et al.* 2013
Collect, organise and synthesise a large body of information	+++	+++	+++	UoB LO
Collect and record data	-	+++	-	UoB LO
Laboratory- or field-based technical skills	-	+++	-	UoB LO
Detailed critical review	+++	-	-	UoB LO
Clear and well-explained recognition of the significance of other work in the field	+++	+	+	Healey *et al.* 2013
Shows understanding of gaps in current knowledge	+++	+	+	UoB LO
Framing of a significant question or set of questions	+++	+++	+	Boyer, 1998
Design of experiments including the identification of controls	+++	+++	-	QAA, 2007
Understanding of appropriate statistical analyses	+++	+++	-	UoB LO
Analysis, evaluation and interpretation of data	+++	+++	-	QAA, 2007
Presentation aspects of the work in an oral presentation	+++	+++	+++	Boyer, 1998
Communication the results to both lay and expert audiences	+++	+	+	Boyer, 1998

Table 1: A comparison of features of the evidence based literature Review with a practical project and a traditional literature review.
+++ indicates that the project type clearly supports this feature.
+ indicates that the project type offers, or could offer some evidence for this feature and – indicates that the project type does not normally evidence this feature. University learning outcomes (UoB LO) indicates that this feature relates directly to learning outcomes for Projects in the School of Biosciences.

Table 1 summarises the key attributes of the Evidence Based Literature Review in comparison with other types of projects. A recent accreditation visit by the Society of Biology identified, as an example of innovation and good practice, the two-part literature based project, and in particular the in depth critical analysis of research papers, saying that it *'provides an excellent level of training'.* The projects are well received by students with over 90% of students finding the topic of the project 'interesting and stimulating'. Interestingly, in the 2012/13 cohort of students, 91% of students allocated the evidence based literature review were 'happy with the type of project' compared with 86% of those allocated lab or field projects. It is clear that the students value and enjoy this project format.

Discussion

Over the five-year period in which this alternative final year project has been running it has evolved into something much more than a traditional literature review. The analysis of five key papers is an excellent tool to encourage a deep understanding of research papers; students start to ask themselves and their supervisors questions that they would otherwise be able to avoid. There is a 3000 word limit for this section which means that students have to be very selective in what they present. The skills demonstrated in this section have been found to be distinct from those demonstrated in a traditional literature review (Table 1) and indeed represent real critical analytical abilities.

Development of the research proposal allows students to develop many of the skills usually associated with a practical project. Identification of gaps in current knowledge which provide sufficient scope to develop a detailed research proposal is an excellent opportunity to meet many of the QAA benchmarking criteria including *'interpretation of the information within the context of current knowledge; suggestions for further work; a hypothesis-driven piece of work'* (QAA, 2007).

The alternative final year project described here is an example of a project without a practical element but which none the less delivers a wide range of skills and learning opportunities which reach far beyond that of a traditional dissertation. In a science discipline where the lab or field based project is seen as the gold standard, this format offers a culminating academic and intellectual experience in which students can utilise to the full the research and communication skills learned in the previous years. It is in no way a second best and for many students it offers a more appropriate and meaningful way of completing their degree, applying their accumulated skills and knowledge in a discipline related context and preparing them for employment in the modern diverse skills economy. It does this while remaining true to its roots in experimental science involving as it does elements of research, synthesis, critical analysis and design of a research proposal as well as oral and written communication.

Acknowledgements

The Final Year project described in this article has evolved over a number of years and many colleagues past and present have contributed to its development.

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Review

Just-in-time Teaching and Peer Instruction in the Flipped Classroom to Enhance Student Learning

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Abstract
The 'flipped classroom', also known as 'lecture flipping' or the 'inverted lecture' is becoming more prevalent as an approach used to engage students in their own learning and as an alternative to the 'didactic' lecture. In the 'flipped classroom' students study material (for example online screencasts, a recorded lecture or directed reading) before an interactive session that replaces the traditional lecture. This latter session is based around problem solving and/or discussions and collaborative learning. This review focuses on and appraises the two methods that are commonly used in the 'flipped classroom' approach: (i) 'Just-in-Time Teaching' (JiTT) is used alongside the preparatory material which is tested in online quizzes and students can post questions online to clarify aspects that they did not understand; (ii) 'Peer Instruction' (PI) is used in the interactive session, and enables students to generate knowledge through discussion with their peers, to actively participate in the subject which they are studying and to clarify topics that they find difficult. When combined, these approaches provide the students with clear opportunities to learn individually and collaboratively, and to obtain rapid feedback. This review highlights the clear advantages of the 'flipped classroom' approach over the traditional lecture that lead to enhanced student learning, and also considers the challenges for staff and students in undertaking these approaches.

Introduction

The 'Flipped Classroom' (Bergman & Sams, 2012) is a blended-learning approach (that is it uses a combination of face-to-face teaching and learning with digital and online learning) that is becoming more widespread in higher education as a way to engage students in their own learning and as an alternative to the 'didactic' lecture (Bishop & Verleger, 2013; Butt, 2014; Sharples *et al.* 2014; Tune, Sturek & Basile, 2014; Millard, 2012; Hereld & Shiller, 2013; Enfield, 2013). The traditional lecture is predominantly a passive event for students; they may take notes but valuable face-to-face time is often not used effectively for student learning. Lectures can be made interactive if, for example, questions are asked or multiple choice questions linked to personal response systems ('clickers') are used (Lasry, Mazur & Watkins, 2008; Watkins & Mazur, 2010). In 'flipped teaching' or the 'flipped classroom', traditional lectures are replaced, sometimes entirely, by interactive sessions. Students study material prior to the session; this can take the form of short online screencasts (10–20 minutes), entire recorded lectures or directed reading (Sharples *et al.* 2014). The screencasts and recorded lectures can be produced by the lecturer, but there is also a large resource of material available on the web that can be used for this purpose.

To complete the preparation for the interactive session, the 'Just-in-Time Teaching' (JiTT) approach is often used, in which the preparatory material is tested in online quizzes, and students can also post questions online to clarify aspects that they did not understand. The JiTT exercises have a deadline a few hours before the class, which allows the teacher time to incorporate material based on the comments and questions raised by the students (see Figure 1). These activities taken as a whole encourage students to take ownership of their learning and they can work at their own pace, ensuring better understanding of the material (Simkins & Maier, 2010).

The interactive session that replaces the lecture is generally based around problem solving and/or discussions and collaborative learning. A key aspect of these sessions should be that students work together and learn from each other. These sessions typically involve a period of reflection on the pre-lecture material during which questions posted by the students online can be addressed directly by the lecturer in the interactive session. Problem solving and/or data interpretation linked to multiple choice questions and the use of personal response systems ('clickers') are also typically used. This can also be achieved using the students' own mobile devices and these approaches stimulate active engagement by students in their learning and allow the teacher to judge student understanding. Data and/or text can also be provided in the interactive session for students to interpret and/or critically analyse and they can also construct essay plans. All of these activities can start as exercises to be done by students thinking and working individually followed by students working collaboratively in small groups.

Once students have made an attempt at an answer to a question or challenge, a common next step is to use Peer Instruction (PI). Peer Instruction requires students to work collaboratively either in pairs or in larger groups. It encourages interactivity in classes to engage students and address topics which students find difficult. For example, the students are asked to respond to a question, based on the material they

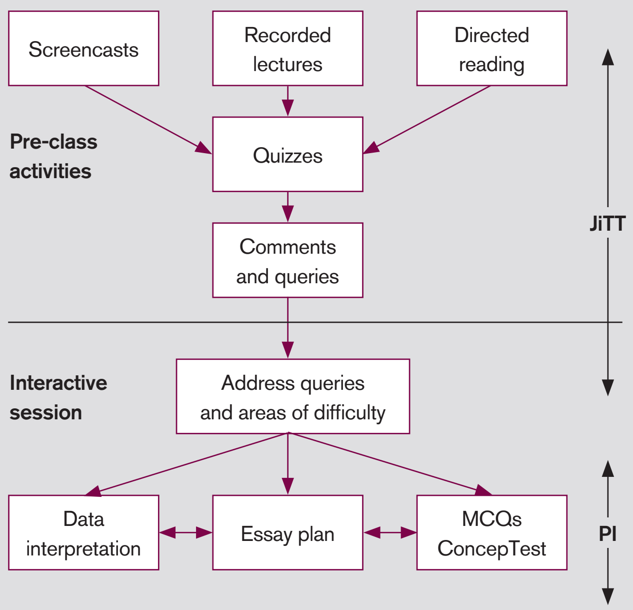

Figure 1: The 'flipped classroom' showing how JiTT and PI are used in the pre-class activities and interactive session.

have studied pre-lecture, using personal response devices. Students are then requested by the lecturer to discuss their answers with a neighbour or in small groups. After several minutes the students vote again after which the lecturer goes through the correct answer (Lasry, Mazur & Watkins, 2008; Watkins & Mazur, 2010). This approach therefore uses assessment for, or as, learning (i.e. uses formative work), provides rapid feedback and enriches the learning experience of students.

This brief review focuses on the two established methods of Just-in-Time Teaching and Peer Instruction that are frequently used in the 'flipped classroom' approach and describes the methodology and pedagogy for these techniques and evaluates the effectiveness of these methods for student learning and the acquisition of knowledge and skills.

Just-in-Time Teaching

The Just-in-Time Teaching approach (Novak, Patterson, Gavrin & Christian, 1999; Gavrin, 2006; Novak & Patterson, 2010; Novak, 2011; Simkins & Meier, 2010) was originally developed to help students to organise their work out-of-class and to gain more from valuable in-class student-teacher time. The approach is founded on some of the *'Seven Principles For Good Practice in Undergraduate Education'* (Chickering & Gamson, 1987). JiTT has evolved over a number of years and its users have enhanced the technique by drawing on a number of modern learning theories and educational techniques (Novak, 2011; Bransford, Brown & Cocking, 2000). Of particular importance are research into teaching for conceptual change (Scott, Asoko & Driver, 1991) and into assessing students' motivational beliefs (Beghetto, 2004).

The main concept behind the JiTT approach is to create a direct link between the pre- and in-class activities by making use of introductory web-based assignments, commonly referred to as *'JiTT exercises'* (Novak & Patterson, 2010). In these exercises students usually have to read, watch or carry out an activity and then answer questions related to the task. As much of the student learning takes place outside of class, those who use the JiTT approach regard their pedagogical methodology as a feedback loop between pre- and in-class experiences (see Figure 2).

JiTT exercises can be short quizzes (for example multiple choice questions) or more challenging questions that require a response in the form of text (Novak & Patterson, 2010). JiTT assignments have a deadline a few hours before class, thereby allowing the teacher sufficient time to adapt the forthcoming class, taking the students' responses into account. Often exemplar student responses are shown at the start of class thus prompting small group or full class discussions. Student misunderstandings or areas of difficulty are also identified in the pre-class responses and these are used to determine the appropriate choice of classroom activities.

JiTT classes are different from traditional lectures for two important reasons: firstly, students enter class having very recently completed the pre-class assignment and so are prepared for the in-class activities; secondly, the students have a sense of ownership towards the classes as the activities are tailored towards their specific understanding of the topics (Novak & Patterson, 2010). The exact format of classes varies depending, for example, on the number of students, the learning space, the personalities of both the students and their teacher. Examples of in-class activities include whole-class discussions, demonstrations, or group-based learning activities to facilitate cooperative learning. JiTT can be used in conjunction with other pedagogic techniques and innovations, it can be used to motivate student learning and is applicable at different levels and in a wide range of disciplines for example Biological Sciences, Geosciences, Physical Sciences, Economics, History and the Humanities (Simkins & Maier, 2010).

Figure 2: The JiTT feedback loop
(adapted from Novak & Patterson, 2010).

It has been demonstrated that successful use of JiTT can result in cognitive gains ranging from moderate to quite significant (Novak, 2011). As an example, in a first semester introductory Physics course, the Force Concept Inventory (FCI) is the assessment instrument typically employed (Hake, 1998). Through the FCI identical multiple choice questions are used on the first and last days of class and any improvement is measured in terms of *'average normalised gain'* ((post-test percentage score)-(pre-test percentage score))/(100 - pre-test percentage score). On traditional courses improvements are generally 10–20% but teachers using JiTT cite gains of between 40 and 70% (Hake, 1998). These gains can be even greater when JiTT is used in conjunction with other interactive engagement techniques such as Peer Instruction or collaborative learning (Crouch & Mazur, 2001). Similar gains have also been reported in an introductory Biology course (Marrs, 2010). The average normalised gain where both JiTT and in-class cooperative learning were used was 63.6% compared to JiTT only (56%) and cooperative learning only (45%). Using either JiTT or cooperative learning led to an average normalised gain of 52% but classes using neither JiTT nor cooperative learning had average normalised gains of 17–21%. In addition, the use of JiTT in Biology has been shown to lead to positive assessment results, decreased attrition rates, increases in student attitudes, interactivity and study habits (Marrs & Novak, 2004).

Peer Instruction

Peer Instruction (PI) is an interactive method of teaching delivery which encourages in-class interactivity to engage students and address topics which students find difficult (Mazur, 2014; Watkins & Mazur, 2010; Crouch, Watkins, Fagan & Mazur, 2007; Crouch & Mazur, 2001). PI facilitates peer learning by enabling students to discuss concepts in class. For the technique to work optimally, however, students need to have a basic understanding of the concepts when they come to class, so JiTT complements the technique well. JiTT organises students' pre-class preparation and enables teachers to receive feedback from their students in advance of class. Teachers can therefore select the PI questions used in-class to address the specific difficulties encountered by students.

PI uses short, multiple choice questions in class which probe students' conceptual understanding, known as *'ConcepTests'* (Watkins & Mazur, 2010), for example Physics (Mazur, 2014), Chemistry (Ellis *et al.* 2000, Landis *et al.* 2001), Astronomy (Green, 2002), Mathematics (Hughes-Hallett *et al.* 2006; Terrell, Connelly, Henderson, & Strichartz, 2005), Geoscience (Steer & McConnell, 2011) and Philosophy (Bigelow, Butchart & Handfield, Undated).

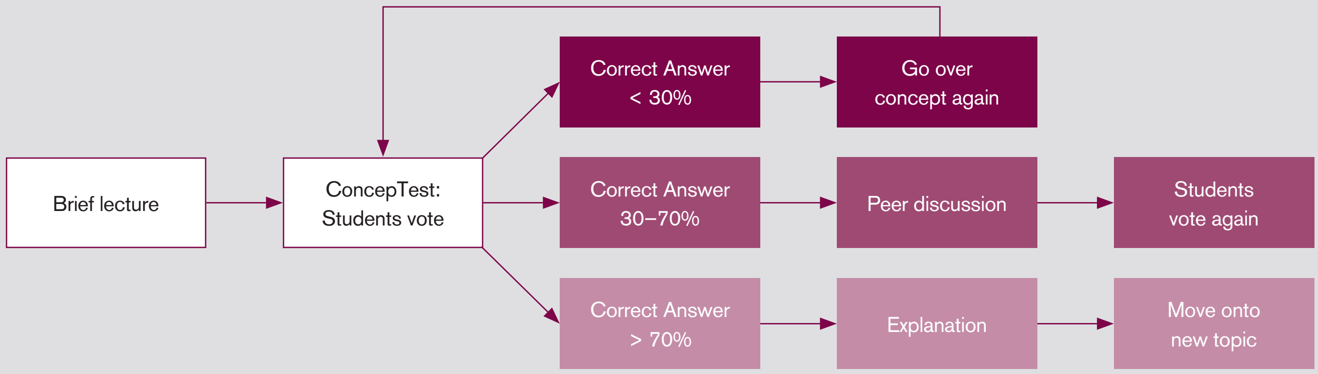

Fig 3: The ConcepTest-Peer Instruction Implementation Process (adapted from (Lasry, Mazur and Watkins, 2008)).

To implement ConcepTests and PI (Watkins & Mazur, 2010) the teacher briefly presents on a topic after which the students reflect on what they have learnt through a ConcepTest (see Figure 3). After thinking about the question for a couple of minutes students vote individually on an answer. If *ca.* 30–70% of students answer correctly the teacher asks them to turn to their neighbours and discuss their answers, in pairs or small groups, preferably with someone who voted differently. The teacher moves around the class promoting active discussions and to direct student thinking. After several minutes the students vote again after which the teacher goes through the correct answer. Depending on the student responses, the teacher may ask another ConcepTest on the same topic or move onto a different topic.

There are different types of question format which can be used in PI, for example, questions on general theories and definitions, application of concepts in varying contexts and questions which inter-relate different ideas (Watkins & Mazur, 2010). PI can not only be used with questions for which there is a 'correct' answer but also to stimulate discussion amongst students where there is no definitive answer. PI facilitates students improving their critical listening skills as well as the ability to create solid arguments. Whatever the discipline, PI supports students in the creation of knowledge through discussion with their peers and in active participation in the subject which they are studying.

At Harvard University, PI courses in introductory Physics have demonstrated greater average normalised gains than traditional courses (Crouch & Mazur, 2001). Other research has shown positive results with PI in a variety of disciplines, for example Biology, Engineering, Psychology, Medicine, Philosophy and Mathematics (Watkins & Mazur, 2010).

Conclusions

Lectures can encompass a range of approaches, from the traditional, didactic presentation of material, to sessions that incorporate interactive activities and the fully flipped classroom. The flipped classroom has two key elements: (i) pre-class activities, including the use of resources, attempts at quizzes and posting comments and queries online and (ii) interactive sessions that replace the traditional lecture, often including the use of personal response systems and mobile devices and that encourage peer and collaborative learning. JiTT links the pre-lecture study with the interactive session. Peer Instruction linked to ConcepTests and/or multiple choice questions engages students in their own learning and encourages them to work collaboratively; it also provides rapid feedback to students. PI can be used in the context of a lecture that incorporates interactive exercises but, as has been described above, works most effectively when combined with the JiTT methods that take advantage of online provision of learning resources. This blended approach releases more time for active learning and interaction with the instructor in the 'lecture' session.

This short review has cited evidence in support of both the JiTT and PI approaches. The 'success' of such approaches requires an appraisal of student engagement (for example do the students use the resources and try the online quizzes? Do students take an active part in the classroom activities?), the student experience (for example do they enjoy and value these approaches?), student performance (for example is there an improvement in tests and assignments?) and the acquisition of key skills (for example working collaboratively, interpretation of data and critical thinking). This review has shown that there is an increasing body of evidence that suggests that all these criteria are met to some extent. Probably the most challenging aspect of these approaches is to ensure that all of the students are engaged – in the experience of the authors, there is usually 10–20% of the class who do not take advantage of the pre-class resources and quizzes. The evidence presented here is also important in demonstrating explaining to some teachers the benefit of these approaches for student learning. Facilitating the interactive sessions can be an extremely rewarding experience for the teacher, but preparation of the resources and quizzes takes time and the unpredictability of the interactive sessions can cause problems for some staff, while being stimulating to others. The flipped classroom, JiTT and PI depend on digital technology – the internet, VLE, mobile devices and these need to function optimally for an effective experience. In the approaches described in this review, the virtual learning environment needs to be in place, but also the physical space can restrict the type of interaction that's possible. Large lecture theatres are not ideal for peer learning, and collaborative activities involving students working in groups of maybe 6–8 members work best when they can sit around a table. All of these factors, staff, students, the virtual and physical learning environment as well as the quality of the resources, quizzes and interactive exercises need to be taken into consideration when considering the flipped classroom. The payoff is a more challenging experience for both teachers and students that encourages active learning and the acquisition of skills not easily attained in a conventional lecture.

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Paper

Examining Peer Assessment Methods Amongst Undergraduates: A Student Review

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Abstract
This report examines the current methods of peer assessment used within the School of Mathematics at the University of Birmingham. Here the focus is upon the use of peer assessment when deciding how to allocate marks between different members of a group to reflect their individual contributions to group work rather than the peer marking of individual assignments and tasks. It uses both quantitative and qualitative responses from students who have experienced one or both of the methods currently used within the School. Further, it goes on to discuss and compare alternatives to the current methods used and proposes possible improvements to be used by the School.

Introduction

In the modern world, undergraduates are now expected to graduate not only with great technical knowledge and understanding of their subject, but also with skills that make them more employable. These skills include organisation, decision-making, presentation, and teamwork (McCorkle *et al.* 1999). Group work – an assessed task where a group of students work together over multiple timetabled sessions, that also requires work to be completed outside of the normal class meeting – has long been thought of as an effective method of developing such skills (Jacques, 1984).

Assessment of group work, however, raises an issue when it comes to distributing marks fairly to individual group members (Conway *et al.* 1993; Cheng & Warren, 1997). Possible choices for the module leader include: (i) simply marking the projects and awarding the same grade to each member of the group; (ii) assigning members of the group different tasks within the project and grading them individually on their own part of the whole; or (iii) allowing groups to explain the division of workload and somehow incorporating this into each individual's mark; this is sometimes called intra-peer assessment (Race, 2001). Cheng and Warren (1997) make the case that awarding the same grade to group members can seem unfair (Cheng & Warren, 1997). Similarly, Goldfinch and Raeside (1990) point out that having students work on individual portions of a project *'disrupts the spirit of group work'* leading to reduced development of personal and interpersonal skills, effectively making the collaborative aspect of the task pointless (Goldfinch & Raeside, 1990). As such, it would appear that the third option would be the one to pursue – handing part of the assessment process over to the students and finding some way to incorporate this with the module leader's assessment of the work – so called 'peer assessment'. A range of peer assessment options are available: students can assess themselves and each other on technical ability and the ability to work in a group, and groups can be assessed on productivity and collaboration (Webb, 1997).

Conway *et al.* (1993) describe in more detail the methods of peer assessment shown in Figure 1. *'Pool of marks to be divided by negotiation'* involves a project being awarded a mark and then the students deciding how much of that mark to give to each person (Conway *et al.* 1993). This is fair, as students are the ones that understand who has contributed most to the project. However, the project marks awarded to each person are not

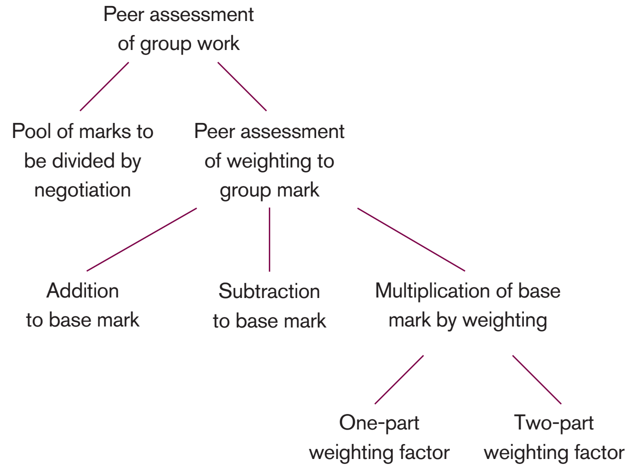

Figure 1: Methods for assessing individual contributions to group activities (Conway *et al.* 1993).

comparable, because some groups may have ranked different elements of the project work as more important compared to other groups. This can cause consistency issues with marks throughout the module. Therefore clear criteria are needed for the allocation of marks.

'Addition/Subtraction to base mark' is where each student is awarded the same mark for their project and they may gain or lose marks depending on their contribution to the group (Conway *et al.* 1993). The amount added/subtracted can be decided either by the module leader or the group themselves. This method means students' marks are comparable, as the marks awarded for the project are based on the same guidance. Often, this method doesn't create a significant difference in students' marks, which may cause issues with 'free-riders' not being penalised strongly enough.

'Weighting factors' allocates each student with a proportion of the mark awarded to the group project (Conway *et al.* 1993). This method differs from the *'Pool of marks to be divided by negotiation'* as the weighting factor is calculated by students critiquing each other against a rubric. As students are responsible for awarding the marks used to calculate the weighting factor, it makes them more accountable for their actions throughout the projects. This also means that students' marks are comparable across the whole module, as well as marks being varied enough that 'free-riders' will no longer be successful in the module.

Methods

This report samples first and second year single honours Mathematics students at the University of Birmingham. All students undertook modules which contained, in some part, tasks requiring them to work together to solve problems. At the end of the tasks, members of each group evaluated their own and each other's work within the group. These evaluations were then given to the module leader to be considered in the marking process, and students were all made aware that this would be the case at the beginning of the module. A sample of 55 students were questioned at the end of the academic year (2014/15) with specific references to their confidence in peer assessment before and after completing the module and the usefulness of peer assessment within the module.

More specifically, the first year students took a 10 credit Mathematical Modelling & Problem Solving module (MMPS) in their first semester. It required them to work in randomly assigned groups of 4 or 5 and complete 4 projects over an 8 week period. At the end of each project, the individual group members all filled in an online diary on the University's Virtual Learning Environment (VLE), in which they discussed the process and division of workload for that project, and evaluated their performance as an individual and as a group. There was also a small numerical component to the diaries where students provided outline allocations of the contributions made by both themselves and their peers to the task. Appendix 1 shows the prompts given by the module leader to students in order for them to complete their diaries. The module leader then allocated marks based on their performance, which, in total, were equivalent to 20% of the module mark, but independent of the project grades. This method is essentially *'Addition to base mark',* as shown in Figure 1. At the end of the academic year, a sample of 26 first-year students were questioned.

The second year students took a 10 credit MMPS module similar to the one in the first semester of their first year – the primary difference being the lack of a numerical component to the diaries. They also took a 10 credit Mathematics in Industry module in the second semester of their second year: 65% of the marks for this module came from two group projects, both of which included peer assessment to allocate the marks to each individual in the group. The larger project, accounting for 45% of the overall module mark, involved students being randomly assigned to groups of 4 or 5 students in which they completed a substantial industry-style research project; the smaller project (20%) allowed students to choose a group of 2 to 5 members in which they worked to produce a resource to communicate mathematics to a wider audience. At the end of each project, each group was required to fill in a form (see Appendix 2) allocating a numerical value to each team member for a list of criteria (similar to that described by Conway *et al.* 1993). This gave every member a percentage corresponding to the work they had put into the project. This was then used to give them the corresponding percentage of the marks for that project. Again, this can be seen in Figure 1 as a *'One-part weighting factor'.* At the end of the academic year, a sample of 29 second-year students were questioned.

Both sample groups were asked if they had experienced peer assessment before coming to university and how this experience (or lack of) affected their view of peer assessment before they started. They were asked to comment on the appropriateness of the types of peer assessment they experienced, and to what extent they understood how the peer assessment would be considered in their grading. The second year students who had experienced more than one method were also asked to compare the two. Finally, there was an opportunity on the form to give any suggestions for improvement of the peer assessment methods.

Review

From Table 1, it can be seen that many students had neutral and slightly negative opinions of their own ability to peer assess, whether they had prior experience or not. The high respondent percentage (33 out of 55 students) for this region comes primarily from two strata – first year students with prior experience (contributing roughly 20% of the weighting) and second years without prior experience (contributing roughly 50% of the weighting). Both groups may have been underestimating their ability, but there could be other reasons. Students without prior experience would naturally feel less confident. However, the reason behind the first year group's response is less obvious, especially as their less experienced counterparts felt more confident (with two of them marking themselves as very confident) – perhaps some of them had negative experiences with peer assessment at school. Harris and Brown (2013) note that no form of peer (or self) assessment at school is anonymous and this can create *'threats to psychological safety and inter-personal relationships'* as peer pressure is more prevalent in secondary schools. These issues may affect students' perceptions of peer assessment as they progress into higher education and, as a result, their confidence in their ability to peer assess may decrease.

Overall, the students were fairly evenly split when asked about how appropriate the peer assessment was for their course (the results can be seen in Table 2). First year students tended to lean towards a negative viewpoint, whereas second year students had a more favourable view. Focusing on the responses of the second year students, it is worth noting that students didn't necessarily vote 'yes' for one style of peer assessment and 'no' for the other (although the results in Table 2 do imply that). There were 10 students that voted 'yes' and 'yes' and 8 students that voted no and no. This suggests that there may not be one method of peer assessment flexible enough to be used universally for all assessments and that a combination of methods may be required to obtain the best results. For example, peer assessment comprised of a reflective section and a numerical section, similar to the method used by Goldfinch (1994), would provide the most flexibility.

When asked to explain the reasoning behind their answers, students gave varying responses. This is expected given how evenly split their opinions are. Many students felt the anonymity of the first year diaries allowed for fairer marks as students could openly discuss each member's contribution to the group. Second year students took issue with the group discussion required for the second year module and would have preferred an anonymous method, suggesting the use of the university's VLE:

'*...the scoring [for Mathematics in Industry] should be anonymous rather than in front of the group. Maybe this could be done on Canvas [the university's VLE].*'
Second year student

	First Years		Second Years		Total
	Prior experience	No prior experience	Prior experience	No prior experience	
Very confident	0	2	1	0	3
Slightly confident	3	2	2	4	11
Neutral	3	2	2	8	15
Slightly unconfident	6	3	1	8	18
Very unconfident	0	5	0	3	8

Table 1: Student perceptions of their ability to peer assess prior to taking the first year module.

	First Years	Second Years	
	Diary-Style	Diary-Style	Numerical-Style
Yes	12	16	15
No	14	13	14

Table 2: Responses to the question: 'Was the style of peer assessment appropriate for the module?'

The method used by Brutus and Donia (2010) of a centralised online peer assessment format is an example of submitting peer assessment *via* a VLE. It allows for staff to easily track students' progress in developing group-related skills and can be tailored so that students can provide their feedback anonymously (Brutus & Donia, 2010). In contrast, a number of students commented that they appreciated the opportunity to justify the numerical values they awarded in a face-to-face environment, but would like some more structure:

'I know other subjects allocate a time for the group to meet with their project leader who leads the group discussion...'
Second year student

The second year students were also asked which method of peer assessment they preferred (see Table 3). The majority favoured the numerical method used in the second year module; very few preferred the diary method, but many had no preference. This shows that there may not be one style of peer assessment that will fit all needs, as well as highlighting the importance of incorporating a written element, alongside a numerical element, into the peer assessment process.

Diary	4
Numerical	15
No preference	10

Table 3: Responses to the question 'Which method of peer assessment did you prefer?' (second years only).

However, some students mentioned that the written element of the process was time consuming:

'With a large project to do, it just seems a hassle to write a diary.'
Second year student

A method to combat the above issue, used by De Wever *et al.* (2011), would be to include a rubric for students to assess against. The rubric could provide detailed written statements that students then have to score their peers against. This avoids the issues of students having to write some text, but still allows for a more detailed review of their peers' contributions than a simple numerical method alone (De Wever *et al.* 2011). This method is similar to the one used in the module 'Mathematics in Industry', but the current model used lacks in detailed descriptions.

First year students raised concerns about the contribution level the peer assessment had in MMPS. Many felt the *'Addition to base mark'* method used needed higher weighting as it did not create enough distinction between group members when students didn't contribute evenly:

'I believe that peer assessment should be much more heavily weighted in the final marks.'
First year student

With hindsight, the second year students felt that the *'One-part weighting factor'* used in 'Mathematics in Industry', similar to the methods described by Conway *et al.* (1993), was more effective and showcased students' contribution to the group better (Conway *et al.* 1993).

The levels of confidence of all students tended towards the lower end of the scale, so time must be taken to develop how peer assessment is first presented to students. This should help them feel more confident in tackling the problem and will also increase confidence levels when transitioning year groups, as a more positive experience is had in their first involvement with peer assessment at university. For example, first years were particularly unhappy with the timing of the module, and felt that working in random groups and peer assessing early in their degrees was unnecessarily stressful:

'Don't do it in first year. Or at least, do it in the second term and let us choose our groups. It's hard to work with strangers, and getting into university life is hard enough without having to deal with peer assessment on the side.'
First year student

A reason for this could be that students do not always feel they have the skills to peer assess at this stage. However, Nulty (2011) explains that the benefits of using peer assessment early in students' university careers outweigh the detriments, as they need to gain experience through practice so that they develop these skills (Nulty, 2011).

Conclusion

Peer assessment, although a useful tool, will always be met with slight dissatisfaction from students. Past experiences can leave students feeling unconfident about undertaking peer assessment at university, and students with no experience may be apprehensive of the unknown. This, however, should not be used as a reason to remove it from modules. There is no clear divide on student opinion of peer assessment within this study, and, with research such as that by Nulty (2011) or Cheng and Warren (1997) suggesting there are more benefits to conducting peer assessment in the earlier years of degree study, it is apparent that the positive effects of peer assessment significantly outweigh the negatives perceived by students (Nulty, 2011; Cheng & Warren, 1997). This implies that peer assessment should still form a core part of the curriculum, and so consideration must be taken in how it should be implemented.

Clearly, there are benefits to both quantitative and qualitative peer assessment, therefore a combination of both will offer the most flexibility. It is relatively easy to translate a numerical assessment into a mark but this doesn't always leave students satisfied. A written component allows for more clarity as students can provide detailed reviews of their group members' contributions and staff can use these statements to quantify each individual's contribution. However, this is time consuming for staff and subjective to the marker. By combining the two methods these issues can be alleviated. The written component can be used as a method of justification for the numerical values awarded. This helps markers to understand where the values awarded come from, whilst still allowing for speedy marking where students have all worked equally well within their group.

Students wanted peer assessment to be more heavily weighted so that their individual contributions to group work was more fairly recognised. This is most easily implemented via a *'One-part weighting factor',* which gives greater precision, rather than an *'Addition to base mark'* method, the style currently used in MMPS (Conway *et al.* 1993). In the specific case of MMPS and Mathematics in Industry, a development of the peer assessment method used in Mathematics in Industry would more closely adhere to the improvements suggested by students.

Anonymity is an area where students have a split opinion. Many second year students recognised the skills they gained from discussing with peers, although some felt unable to be critical in this situation. As a whole, first year students appreciated that the diaries were anonymous, though this can create a lot more work for staff in having to interpret the responses. In general, students are so divided that the use of anonymous peer assessment should be taken on a module-by-module basis by the module leaders. They should consider a variety of factors, including the year of study, the nature of the group work and the subject area.

Although this work has looked at peer assessment within mathematics, its emphasis has been upon approaches for students allocating marks to recognise individual contributions to group based tasks. As this is something which is, in itself, independent of the material being considered, the ideas discussed here will be of interest and relevance to those from other disciplines.

Recommendations

Peer assessment is essential for group project modules. It should:

- Encourage student ownership of their marks.
- Contain both qualitative and quantitative elements.
- Allow staff and students to easily translate marks from the raw scores.
- Make an appropriate difference to an individual student's mark depending on their contribution.
- Use anonymity with consideration of the student cohort being assessed.

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Appendices

Appendix 1: Prompt sheet for peer assessment diaries in the first year module, Mathematical Modelling & Problem Solving.

Appendix 2: Numerical group contribution sheet used in the second year module, Mathematics in Industry.

Appendix 1

MMPS Diary Guidance

Fill in this online individual diary for project 3 which will be used (in conjunction with the diaries from the rest of your group and your Postgraduate Teaching Assistant (PGTA) feedback from the workshop sessions) to determine your contribution mark for each project. Individual comments made here will not be shared with the rest of your group, but trends across diaries and PGTA comments may be used in feedback to other group members. The deadline is the same as for your group project. You should include:

1. How your group spent their time together. Was this an effective method of working? What other approaches did you try than what ended up in report? Why were they not used? When did you meet outside of sessions?

2. How you spent your individual working time. Was this an effective method of working? What did you try? What did you take to the group and what didn't you? Why?

3. Who do you felt led on (give up to two names for each);
   a. Identifying the problem?
   b. Formulating the model (or each of the submodels)?
   c. Solving the model (or each of the submodels)?
   d. Critiquing/evaluating the model?
   e. Interpreting your solution?
   f. Writing the report?
   g. Anything else which proved necessary?

4. What went well with your project? What are you particularly proud of?

5. Which part of the project did you struggle with as a group? How did you overcome the problem? How could you improve things next time?

6. Is there some area of technical mathematics you now feel you understand better having done this project?

7. How confident did you feel tackling an unseen problem before the session started on a scale of 1–10 (1= very unconfident, 10 = very confident)?

8. How confident do you now feel in tackling an unseen problem on a scale of 1–10 (1= very unconfident, 10 = very confident)?

9. Any other comments you have.

Finally, allocate each member of your group (including yourself) a percentage which you feel reflects each person's contribution to the project. For example, if there are 5 people in your group and you think you all contributed equally then you would allocate each member 20%.

Appendix 2

Evaluating the Contribution From Each Group Member

Group Number:

Please complete the table below assigning a value for each criterion for each person using the guidance below. The figures you give will be used to calculate the Peer Assessment Factor as outlined in the assignment brief.

Student Names:					
1. Level of enthusiasm/participation					
2. Suggesting ideas					
3. Understanding what was required					
4. Helping the group to function well as a team					
5. Organising the group and ensuring things got done					
6. Performing tasks efficiently					

For each criterion marks are awarded as follows:

3 for *'better than most of the group in this respect'*
2 for *'about average for this group in this respect'*
1 for *'not as good as most of the group in this respect'*
0 for *'no help at all in this respect'*

Signatures

Name:		Signature:	
Name:		Signature:	
Name:		Signature:	
Name:		Signature:	
Name:		Signature:	

Paper

Strengthening the Links Between Research and Teaching: Cultivating Student Expectations of Research-informed Teaching Approaches

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Abstract

This article contributes to the pedagogical literature in drawing on findings from an institutional survey exploring perceptions of research-informed teaching, to examine how links between research and teaching can be suitably strengthened. Whilst the integration of research and teaching in higher education can provide valuable ways of enhancing the student learning experience, establishing such integrative links can be complex and problematic given different practices and levels of understanding. Definitions of 'research-informed' teaching indicate variations with respect to the active involvement of students in research that can be compounded by disciplinary traditions. The survey provided an indication of the extent to which research-informed teaching was practised at the University of Birmingham and thus an insight into understanding and practices. In particular, it offered insights into the ways in which research-informed teaching relationships were interpreted and embedded within disciplines, the barriers/difficulties to linking research and teaching and the perceived impact on the student learning experience. The findings suggest that understanding with respect to research-informed teaching was variable, with a lack of understanding among students of precisely *what* it constitutes identified as being a key issue. In this paper we discuss the type of approaches that could support more active student engagement in the curriculum and call for the sharing of more curriculum examples from within the disciplines.

Introduction

Teaching approaches that are considered to be 'research-informed' are considered to be central to undergraduate and postgraduate learning within Russell Group universities. As an example a recent publication by the Russell Group (Russell Group, 2014) reports that the experience of learning within an research-intensive environment through bringing together the activities of 'research' and 'teaching and learning' within an institution offers significant and tangible additional benefits to students which can help them *'take their thinking to a new level and develop skills they need for a wide range of careers'* (Russell Group, 2014:29). It is argued however that this 'experience' does not happen automatically and *'requires academics and universities to take proactive steps to bring them together'* (Russell Group, 2014:29). This paper considers proactive steps that can be taken to help ensure these activities are suitably embedded in the student learning experience at the University of Birmingham. It draws on an analysis of selected findings from an institutional survey undertaken in 2011/12 by the Centre for Learning and Academic Development (CLAD, 2012) to investigate:

- How research-informed teaching is understood and practised across different disciplines in the University.
- What the perceived enablers and barriers/difficulties to linking research and teaching are considered to be.
- What factors are perceived to limit the impact of research-informed teaching on the student learning experience

The survey built upon previous project work carried out by the university including a survey to determine what types of enquiry-based learning approaches were employed by staff to help identify potential barriers to its future development within the institution (McLinden & Edwards, 2011). The findings therefore have relevance to future institution-wide strategic developments in serving to highlight ways in which the links between teaching and research can be strengthened to ensure they are understood from both a staff and student perspective.

Research and Teaching Links in Higher Education

Research Teaching Nexus

The notion of a *'symbiotic relationship between research and teaching constituting the very core of higher education'* (Robertson 2007:542) has served as an important cornerstone for many higher education institutions, with these two core strands of activity commonly referred to as a 'research-teaching' nexus. The term is attributed to Neumann (1994) who makes reference to a 'nexus' in a study exploring the relevance to university students' learning experiences. As reported by Cleaver, Lintern and McLinden (2014), the concepts underpinning this relationship have been debated, developed and refined extensively since Neumann's original article (for example Brew 2003; 2006) and more recently examined in relation to particular disciplinary activities (for example Spronken-Smith & Walker, 2010) and ontological/epistemological perspectives (for example Robertson, 2007). Further, as Robertson (2007) reports, recent policies driven by economic imperatives and accountability demands have served to forge a potential divide between research and teaching.

Cleaver *et al.* (2014) note that of significance in helping to *facilitate* the relationship between teaching and research has been the report of the Boyer Commission in the USA (Boyer, 1998) that called for *'a new model of undergraduate education'* at research-intensive universities. A key conclusion of the Commission was that research should be the basis of all learning at university and that the *production* of knowledge should not be an exclusive activity, but rather one that all members of an institution can participate in. Further, the report recommended that undergraduates who enter research-intensive universities should engage in discovery based activities as 'active' participants, that include opportunities to learn through enquiry.

Since the publication of this influential report, there have been a number of attempts to illustrate the complex nature and multifaceted nature of the relationships between teaching and research. Cleaver *et al.* (2014) report that a frequently cited example is the typology developed by Griffiths (2004) to help understand what is meant by linking teaching and research. Jenkins and Healey (2005) note that this typology is structured around four different approaches to show a different relationship between teaching and research:

- Teaching can be *research-led.* In this relationship, the curriculum is structured around subject content with content selected to be directly based on the disciplinary interest of teaching staff. The emphasis tends to be on understanding research findings rather than research processes.
- Teaching can be *research oriented.* In this relationship, the curriculum is structured to place emphasis on understanding the processes by which knowledge is produced in a particular discipline. Attention is given to the teaching of enquiry skills and on developing a 'research ethos'.
- Teaching can be *research-based.* In this relationship, the curriculum is mainly designed around activities that are enquiry led in nature with the potential for interactions between research and teaching emphasised.
- Teaching can be *research-informed.* In this relationship teaching draws on systematic enquiry into the teaching and learning process itself.

As noted by Cleaver *et al.* (2014:11), Healey (2005) drew on these first three approaches and replaced the broader notion of *'research-informed teaching with that of research-tutored which emphasises learning that is focused on students writing and discussing essays and papers'.* The nexus that emanates from each of these relationships is captured along two axes, one of which shows a continuum with an emphasis on 'research content' at one end, to an emphasis on 'research processes and problems', and the other from approaches that are considered to be 'student focused' to those that are 'teacher-focused' (Figure 1). Jenkins and Healey (2005) report that learning and teaching activities will frequently involve a mixture of these four approaches, the particular blend very much dependent on the context in which an activity is structured.

The 'nexus' between research and teaching is complex, as illustrated through the dimensions presented in Figure 1, and indeed has been described as an *'unstable terrain'* by Robertson (2007:543). Departmental-level research and teaching activities are often organised separately, for example via separate committees for teaching and research. Hence there may be structural and perceptual barriers in integrating undergraduate students into the departmental research community and involving them in research and enquiry (for example Coate, Barnett, & Williams, 2001; Durning & Jenkins, 2005).

Consequently as noted by Jenkins (2004) there may not be a simple functional relationship at a department level between 'quality' in research and 'quality' in teaching. It has also been noted that it may be difficult to make strong connections between staff research and learning, as staff research may be too far ahead of the undergraduate curriculum, for example in some of the sciences (Jenkins, 2004).

Jenkins (2004) reports that students tend to vary in their attitudes to staff research depending on their academic orientation to their studies, noting that disciplinary variations tend to occur in teaching-research relations which are shaped by how disciplinary communities conceive the nature of knowledge, research and teaching, the forms of pedagogy and curricula in different disciplines, and for some disciplines, the impact of professional organisations and student interests on the content and practices of the disciplines. It was within this complex pedagogic landscape that the University undertook a survey to investigate the nature of the relationship between research and teaching within the institution through a survey of staff and students.

Description of Survey

An online survey was conducted amongst academic staff and undergraduate and postgraduate students at the University, between November 2010 and February 2011, to investigate how research-informed teaching is currently understood and practised across different disciplines in the University. The survey was undertaken within the remit of a broader institutional educational enhancement project (McLinden & Edwards, 2011) and was designed to address the following research questions:

1. How is research-informed teaching understood and practised across different disciplines in the University?
2. What are the perceived enablers and barriers/difficulties to linking research and teaching?
3. What is the impact of research-informed teaching on the student learning experience?
4. What factors are perceived to limit the impact of research-informed teaching on the student learning experience?

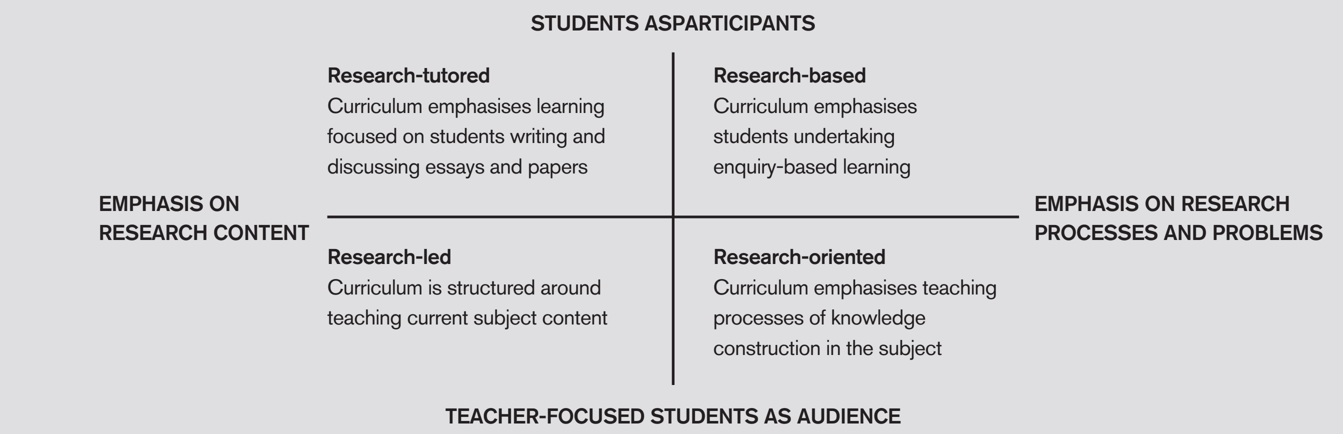

Figure 1: Curriculum design and the research-teaching nexus (Healey, 2005a:70).

1. Learning about the research of others
■ Students learn about research findings through a curriculum content which consists largely of staff or current disciplinary research interests.
■ It can provide examples and ways of illustrating ideas, concepts and theories.
■ Some or a lot of the teaching may rely on information transmission, for example through traditional lectures or set reading. There may be a focus on memorising the key facts that have emerged from research in the discipline.
■ Also known as research-led teaching.
2. Learning about research processes
■ The curriculum emphasises as much the processes by which knowledge is produced as knowledge that has been achieved, for example learning about, and critiquing, different research methods.
■ Students learn about how to undertake their own research within their discipline and staff try to engender a research ethos through their teaching, for example by encouraging students to begin to think like researchers, and not simply accept others' research findings as given.
■ Also known as research-oriented teaching.
3. Learning as researchers
■ The curriculum is largely designed around enquiry-based activities.
■ Enquiry-based learning can be described as learning that arises through a structured process of enquiry within a supportive environment, designed to promote collaborative and active engagement with problems and issues; examples include case studies, problem-solving activities, field trips and simulations.
■ The differentiation between teacher and student roles is minimised: both are participants in the enquiry process, with the teacher acting as the more experienced 'partner'.
■ Also known as research-based teaching or enquiry-based learning.
4. Critiquing others' research
■ Focuses on the critical appraisal of research and moving research forward.
■ Students typically participate in small group discussions with or without a teacher to consider research findings.
■ Examples of this include critical literature reviews and critical discussions about research papers.
■ Also known as research-tutored teaching.
5. Enquiring and reflecting on teaching and learning
■ Teachers engage in critical reflection on, and enquiry into, their own teaching, and approach their teaching as a scholarly activity informed by the research of others.
■ Learners reflect on their approaches to learning and actively work to develop their capacity to become more effective learners.
■ The processes of reflection and enquiry can apply to all types of teaching and learning.

Figure 2. Research categories of research-informed teaching used in survey.

The survey employed an amalgamation of the Griffiths (2004) and Healey (2005) research categories when asking respondents to select the type of research-informed teaching they had used at Birmingham (Figure 2). The survey was advertised on the University's web portal, via posters, leaflets and emails to College Educational Enhancement Fellows, Directors of Education and/or teaching project board members with a request to forward the information about the survey to academic staff and students. Students were given the opportunity to enter a prize draw for an Amazon voucher, as an incentive to complete the survey.

A full description of the research design, methodology and findings is presented in the final project report (CLAD, 2012). For the purpose of this article we are interested in a key finding highlighted in the project report, namely a perceived lack of understanding amongst both staff and students of *what* research-informed teaching is. In particular, the findings suggested that both staff and student respondents tended to equate research-*informed* teaching with research-*led* teaching, where the curriculum content is informed by current research, which may then be transmitted to students, often using a traditional, didactic approach. In fact the types of research-informed teaching that student and staff respondents were most unsure of were: 'learning in research mode' (research-based or enquiry-based learning) together with 'critiquing others' research' (research-tutored teaching). The project report recommended that it would be beneficial for staff and students to be made more aware of definitions of research-informed teaching approaches and be provided with examples of good practice within the institution. It was also recommended that students should be made aware of the different types of research-informed teaching and associated skills they will experience at Birmingham and be reminded of this throughout their programme of study. The report concluded that however well justified may be the claims to be offering 'research-informed' teaching, there is a risk of disappointing the expectations of the students if staff are unable to fully explain when and why they are being taught through a diverse range of 'research-informed' approaches, appropriate to their disciplines, highlighting that it cannot be assumed students will recognise research-informed teaching when they experience it without tutor clarification and/or explanation. Drawing on the recommendations outlined in the project report, we consider generic examples of the ways in which research informed teaching can be conceptualised in order to support both staff and student engagement with a particular focus on an undergraduate student experience.

Exploring Approaches to Research-informed Teaching

The findings outlined in the project report serve to highlight that establishing integrative links between undergraduate research and teaching can be complex given different practices and levels of understanding amongst students and staff. Drawing on the dimensions outlined in Figure 1, we map out an overview of the broad types of undergraduate research-informed teaching approaches that students may experience during their studies at a research intensive university

(Figure 3). This overview serves to highlight the nature of the relationship between the different approaches thereby underlining that *'research and teaching are linked in many different ways, so engagement with research can take place at any stage of a degree programme'* (Russell Group, 2014:31).

Generic examples of the ways in which research-informed teaching can be presented to students to help cultivate expectations of different types of research-informed teaching approaches that may be drawn upon during their studies are presented in Figure 4.

As highlighted in the Russell Group report, there can be significant benefits for students in developing approaches that *'focus on students becoming active participants in the production of knowledge, rather than passive recipients or consumers'* (Russell Group, 2014:29). Table 1 provides a summary of how such 'active participation' could be undertaken in relation to 'research-led' teaching (that is learning about the research of others) within a 3-year undergraduate degree to show how this approach need not rely entirely on lectures or seminars. Rather the curriculum is designed to provide students with a progressive and increasingly active role in finding out about the research of others in a given department, programme or other unit of activity at different points in their learning pathway.

Figure 3: Overview of the broad types of research-informed teaching approaches that students may experience during university studies (adapted from Healey 2005).

1. Learning about the research of others (research-led teaching)
■ Through this approach you learn about the research findings of others including your tutors. The content will consist largely of staff disseminating their current disciplinary research interests.
■ This approach can provide examples and ways of illustrating ideas, concepts and theories.
■ Some of the teaching may rely on information transmission, for example through lectures or set reading as well as seeking information yourselves about the research of staff in your College.
2. Learning about research processes (research-oriented teaching)
■ In this approach, your learning experiences emphasise the processes by which knowledge is produced. Examples include learning about, and critiquing, different research methods with reference to research papers, journals, academic text books.
■ You may be learning about how to undertake your own research within your own discipline in preparation for example for starting a project or dissertation.
■ Your tutors may try to engender a research ethos through their teaching, for example by encouraging you to begin to 'think as' researchers, and not simply accept the research findings of others as a given.
3. Learning as researchers (research-based teaching)
■ In this approach, your learning is largely designed around 'enquiry-based' activities.
■ Enquiry-based learning can be described as learning that arises through a structured process of enquiry within a supportive environment, designed to promote active engagement with problems and issues; examples include case studies, problem-solving activities, field trips and simulations.
■ You may find that in this approach the differentiation between tutor and your role as a student is minimised: both may be participants in the enquiry process, with the tutor acting as the more experienced 'partner'.
4. Critiquing others' research (research-tutored teaching)
■ In this approach, your learning focuses on the critical appraisal of research and moving research forward.
■ You will typically participate in small group discussions with or without a teacher to consider research findings.
■ Examples of this include critical literature reviews and critical discussions about research papers.
5. Enquiring and reflecting on teaching and learning
■ You may be involved in other types of 'research-informed' teaching approaches as part of your studies.
■ This may include supporting tutors in undertaking research into their teaching and could involve asking you to reflect on your own experiences of learning through a new teaching initiative such as a 'flipped lecture' or the use of 'clickers' to gather student feedback within a classroom.
■ Tutors may ask you to then provide information about your experiences through a questionnaire, or to participate in an interview, or a student focus group.

Figure 4. Generic examples of research-informed teaching approaches.

1. Research-led teaching	Description	Relationship to curriculum design and content	Student learning experience	Examples of activities in which students are provided with role in learning about the research of others
	Learning *about* the research of others.	**a.** Research interests and or outputs from activities of institutional staff are included in curriculum.	**a.** Students learn about the research of staff on their programme or in a particular department. They have opportunities to learn about this research through curriculum content which consists of staff or current disciplinary research interests.	**Year 1:** Students structure and undertake interviews with select staff in department to find out about their current research interests, plans for future research activities, current and planned publications, etc. **Year 2:** Students structure and undertake follow up interviews with staff in department to find out about *developments* in their research interests/activities over course of year (including outputs, publications, etc.). **Year 3:** Students structure and undertake final follow up interviews with select staff in department to find out about *developments* in their research interests/activities over course of year (including outputs, publications, etc.).
		b. Research interests and or outputs from activities of staff external to the institution are included in curriculum content.	**b.** Students learn about research findings through curriculum content which draws on the work of staff external to the institution.	**Year 1:** Keynote speaker/s from external institution invited to deliver a lecture on his/her research. Students are required to undertake a preparatory activity in advance of session (e.g. read a research paper by speaker and submit three questions for discussion in plenary). **Year 2:** The keynote speaker is invited back to the institution to report back on research activities. **Year 3:** Students identify and vote for an external to speak on her research.
		c. Research interests and or outputs from research activities of students are included into curriculum content.	**c.** Students learn about research findings through content which draws on the work of student research.	**Year 1:** Year 3 students showcase their research projects/dissertations to new students within induction activities. **Year 2:** Students given opportunity to view the outputs of previous student work as they plan their own research module. **Year 3:** Year 3 students showcase their research projects/dissertations to new Year 1 students within induction activities.

Table 1: Clarifying the nature of research-informed teaching approaches (examples given for students on a 3-year undergraduate degree programme).

Conclusion

The institutional survey referred to in this paper provides the most up to date information about the different types of research-informed teaching that students experience at the University of Birmingham. The findings suggest that whilst there was substantial activity by staff in relation to the linkage between research and teaching, this was not always widely recognised by students. Indeed, the overall conclusion drawn from the final project is that while particular groups of students or programmes of study may or may not benefit from a greater use of the full range of research-informed approaches to teaching, a key issue to address is a perceived lack of understanding among both staff and students of *what* research-informed teaching is (CLAD, 2012). As such, it is argued in the project report that however well justified may be the claims to be offering 'research-informed' teaching, there is a risk of disappointing the expectations of the students if staff are unable to fully explain when and why they are being taught through a diverse range of research-informed approaches, appropriate to their disciplines. Given these conclusions, a particular challenge in developing new strategic initiatives is to find effective ways to cultivate students' expectations so they can appreciate the importance of the 'nexus' between these two core activities in relation to their particular learning experiences at a research-intensive institution. It is hoped this paper and related discussion, will serve to stimulate debate and generate discipline specific examples that can be showcased within the institution to illustrate how students can effectively engage *'in the process of solving research problems, acting and thinking as active problem solvers – and not merely as passive recipients of established knowledge'* (Russell Group 2014).

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Paper

Longitudinal Evaluation of the Postgraduate Certificate in Advanced Research Methods and Skills Programme

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Abstract

The Postgraduate Certificate in Advanced Research Methods and Skills is a recently introduced postgraduate certificate programme providing enhanced advanced training in research methodologies and transferable skills for postgraduate researchers. A longitudinal evaluation has been undertaken by assessing skill levels and feedback from participants throughout the programme and, as feedback from the first cohort to complete the programme is now available, an assessment of the programme's value can be made. This paper outlines the evaluation methods used to demonstrate the impact of the programme as well as summarising the successes of the programme, plans for programme improvement and the future application of evaluation.

The Postgraduate Certificate in Advanced Research Methods and Skills

The Postgraduate Certificate (PGCert) in Advanced Research Methods and Skills (PGCARMS) was introduced in the 2011/12 academic year to provide mandatory enhanced advanced training in research methodologies and transferable skills to a small cohort of doctoral researchers in the University of Birmingham's Economic and Social Research Council (ESRC) Doctoral Training Centre. A PGCert qualification is awarded upon successful completion of the programme. The programme has been expanded and is now offered to researchers from the Biotechnology and Biosciences Research Council Midlands Integrative Biosciences Training Partnership (BBSRC MIBTP) and doctoral researchers from other Colleges.

The advanced research training takes a variety of forms including formally taught short courses from the MA in Social Research and other institutional programmes, placements on research projects and volunteering opportunities, as well as credit-bearing central provision in advanced transferable skill areas such as entrepreneurship, research consultancy, public engagement, and teaching.

The programme aims to:

- Combine research and transferable skills training to enable a more embedded and holistic approach to doctoral researcher development.
- Encourage a critically reflective, evidence-based approach to doctoral researcher development (in both subject specific and transferable skill areas).
- Provide an enabling environment in which to assist the professional development of individuals engaged in doctoral research.
- Promote peer learning and dialogue within and between the disciplines across Schools and Colleges in respect of 'good practice' in research methods and transferable skills development.
- Ensure programme participants have the necessary advanced research methods techniques they need to succeed and excel in their doctoral research.

The programme is managed by the University Graduate School (UGS), with teaching provided by colleagues from across the University including academic staff from the College of Social Sciences, the College of Life and Environmental Sciences and central partners such as the Enterprise and Innovation team.

Participant feedback is encouraged within the programme not only from individuals, but also through the Student-Staff Liaison Committee. In addition, the UGS has an evaluation strategy for all the training and development activities undertaken (see D'Souza, Hawkes and Mills, 2013). The programme provision is evaluated using the Impact Framework developed in 2008 by the Vitae Rugby Team to effectively evaluate researcher development activity following the provision of ring-fenced funding for researcher development (Bromley and Metcalf, 2012). The Impact Framework defines five impact levels quantifying the effect of the training or development activity provided and continues to be widely used across the sector to evaluate researcher development. These impact levels are shown in Figure 1 below and demonstrate how difficult it can be to evidence that training or development activities are delivering impacts up to Level 4. Longer-term outcomes, such as successful completion of a PhD or securing employment, are likely to result from a combination of inputs rather than any one training or development activity.

Development of infrastructure	Researchers participate in training and development activities			Results
Level 0 – Foundations	**Level 1 – Reaction**	**Level 2 – Learning**	**Level 3 – Behaviour**	**Level 4 – Outcomes**
Further developed programmes, increased capacity	Participant positive reaction to activity	Attitude change, eg. improved knowledge, increased skill level		External impact, eg. better research, improved qualification rates
Example proof: documentation for modules	Example proof: feedback forms completed after sessions	Example proof: feedback forms completed after training sessions	Example proof: supervisor feedback that reseacher is applying new skills/ knowledge	Example proof: researcher attributes contribution to success from participation in activity

Figure 1: Schematic representation of the levels of the Rugby Team Impact Framework (after Bromley and Metcalf, 2012).

The evaluation strategy for the PGCARMS programme sets out a methodology to assess the success of the programme at all levels of the Impact Framework, to learn from mistakes made and to implement improvements as the programme progresses. The use of baseline, interim and completion surveys has been designed to assess participants' perception of skills development and achievements over time and therefore has potential to collect evidence of impact at Level 3 and 4 as well as collecting participant feedback. Now that many of the first small cohort of participants have completed the programme, we have been able to collect survey responses from them at all stages and carry out a longitudinal analysis of how doctoral researchers' perceptions of the programme changed over time.

Completion Survey Results

To encourage honest responses, no personal data was captured by any of the questionnaires sent to the researchers on the programme. This means it is not possible to determine whether age, gender or research topic had any influence on the answers given, or to identify if the same people who completed the baseline or interim surveys were those who completed the final survey. Fourteen researchers started the programme in 2011/12 and, by July 2014, seven had completed the PGCARMS programme. Of these seven, six filled in the completion survey. It is recognised that this is too small a population to draw convincing conclusions from, but analysis of their data has been useful to test our evaluation strategy.

The first question asked in both the interim and final survey was: *'How satisfied are (were) you with the PGCARMS programme (so far)?'* From Table 1, it can be seen that the level of satisfaction increased over the period of participation although the responses are not necessarily from the same individuals, and so only the general trend itself can be commented on.

'How satisfied are you with the PGCARMS programme?'	**Total at interim survey**	**Total on completion survey**
Very satisfied	0	**1**
Satisfied	2	**4**
Dissatisfied	4	**0**
Very dissatisfied	1	1

Table 1: Question one on interim and final survey.

The next question, *'Of the PGCARMS modules you took, which was the most useful and why?'* was designed to identify what participants most appreciated about the programme. Four of the six respondents to the completion survey mentioned that the most useful module was 'Introduction to Teaching and Learning for Doctoral Researchers'. Quotes in support of this included: *'good chance to discuss with people from different departments about teaching experience'* and *'external accreditation and likely to help with future career plans'.* Two respondents mentioned the placement module because: *'it gave me the opportunity to work on a research project giving me an insight into life beyond the PhD' and 'it gave me some ideas for my own research'.*

The completion survey asked, *'Of the PGCARMS modules you took, which could have been better and why?'* This gave respondents an opportunity to comment on what hadn't worked so well. A variety of responses were received, with the only common theme around the fact that modules on statistical methods were not flexible enough to apply to doctoral research in varied topics.

When asked on the completion survey, *'What topic would you like to have seen included in the PGCARMS modules?',* responses included: *'there were no modules which were directly relevant to my discipline'* and *'it appeared that the modules were created with only students from the school of social research in mind'.* The fact that many modules were not relevant to each participant's area of research was a problem noted for the first cohort and further evidenced through corresponding feedback to the Student Staff Committee.

Participants were asked to reflect positively on the course with the question, *'What was the best thing about the PGCARMS programme and why?'* which elicited a range of responses: *'introduced me to new tools I could use in my research and provided me with very useful teaching advice'; 'self-reflective assignments…made me take a step back and really evaluate my work'; 'meeting other students from outside of my department'; 'great to get extra knowledge through courses which maybe wouldn't have done if not compulsory'; 'the opportunity to broaden my horizons in terms of taking modules that I wouldn't have had the opportunity to engage with otherwise'.*

A number of weak areas had been identified from results to the interim survey so the completion survey again asked, *'Do you have any comments on weak areas of the PGCARMS programme?'* Limited module choice was mentioned by three of the six respondents to the final survey. One of these felt they had been forced into taking a difficult module which was not relevant to their studies and therefore *'it felt very much like a box-ticking exercise'.*

The questionnaire then asked, *'What do you think the impact of PGCARMS was on your overall student experience?'* which uncovered mixed feelings among those who had completed the programme, with four of the six respondents giving negative comments highlighting how difficult it was to complete the course alongside the their own research commitments, for example *'quite stressful at times to balance the PGCARMS work with the PhD research'.* However, some positive aspects were also mentioned: *'nice to have an achievement prior to completing my thesis', 'I enjoy extending my knowledge' and 'helped to put my research into real life context'.*

As PGCARMS was intended to help doctoral researchers develop their research skills, the question *'Do you feel you have all the skills you need to successfully complete your research?'* was asked in all of the baseline, interim and completion surveys to allow progress to be tracked over time (although the respondents are not necessarily the same population in each case so direct comparison cannot be made). It is hard to identify a trend from the results presented in Table 2, and it should be borne in mind that a baseline can be misleading as the participant may be unaware exactly what is required of them prior to starting their research and, even on completion of PGCARMS, the researchers may have some research to do before completing their PhD.

'Do you feel you have all the skills you need to successfully complete your research?'	Total from baseline survey	Total from interim survey	Total from completion survey
None of the skills	0	**0**	**0**
Some of the skills	2	**3**	**2**
Most of the skills	4	**4**	**2**
All of the skills	1	0	2

Table 2: Question repeated on all three surveys.

When asked in the completion survey, *'Would you recommend PGCARMS to others and why?',* five out of the six respondents said *'yes',* but all applied reservations such as: *'if it includes modules useful to them'* and *'if they are looking to expand the range of methods/methodologies they might use during the PhD and in the future'.* A couple of other positive points were mentioned: *'the interviewer for a fixed-term teaching contract I've just been offered was very interested in it in the interview!'* and *'it's a good use of any extra time'.*

In response to the last question on the completion survey, *'Have you changed anything in your approach to your research as a result of PGCARMS?',* two respondents mentioned that learning about other research methods has been useful: *'I used NVIVO in my research which I wouldn't have done otherwise'* and *'the narrative analysis module was particularly helpful in choosing my research direction…I have definitely picked up some skills along the way that have influenced my approach.'* Another two respondents were less convinced they'd made specific changes but had gained more awareness in some areas: *'Maybe add the aspect of reflection and learn how to communicate my research with non-experts'* and *'maybe teaching'.* The remaining two respondents did not believe they'd changed anything in their approach to their research as a result of PGCARMS.

Discussion of Results

The results of this longitudinal analysis show that not only did satisfaction with the programme increase over time but for some participants both behavioural changes and positive outcomes are being attributed to PGCARMS. The survey results also delivered useful feedback on the programme content and structure which will be used to improve the programme for future cohorts.

It was useful to see that the modules participants most valued were those designed to develop transferable skills (teaching module and the placement) while the more academic modules such as those on statistical methodologies were criticised as they could not be made topical enough for the researcher's own requirements. This is difficult to address when providing a programme for such a varied group of researchers but the number of modules offered under PGCARMS will continue to be increased which should allay concerns about the limited choice and allow participants to tailor a programme which is of more relevance to them.

It is becoming more common that funded cohorts such as those who are part of Doctoral Training Centres are expected by Research Councils to participate in additional training such as PGCARMS and it is important to recognise the burden this places on researchers in addition to their own doctoral research. The fact that most of the participants surveyed could see the benefits of PGCARMS is a positive outcome, as is the fact that the 'best thing about the programme' reported in several cases were outcomes such as having met researchers from other disciplines and being introduced to new ideas. Without PGCARMS, these outcomes may not have been achieved.

When asked to judge whether they possess all the skills required to complete their research, responses fluctuated from participants perhaps displaying false confidence at the start of the programme, to a slight loss of confidence in their abilities by the time of the interim survey, followed by a mix of responses on the completion survey. This perhaps reflects a more mature approach to research with the recognition that there are many new skills to learn and apply. Therefore, the result is not interpreted as a failure of the PGCARMS programme aims.

Case Study of a PGCARMS Participant

One of the first cohort of PGCARMS completers volunteered to be interviewed for a case study about her experience with the programme. In this researcher's opinion, the best thing about PGCARMS was the opportunity to try out skills in settings other than her own research. Meeting researchers from other disciplines within an academic and focused environment rather than a social one also forced interactions which proved useful. The worst thing in her opinion was how the programme was initially presented. The module selection available to the first cohort was limited, so she had to try to find topics that she could potentially make useful. The selection in her second year was wider and the teaching module was particularly useful as it fed into her career development plans.

She had taken some stand-alone UGS courses in addition to PGCARMS, for example Time Management, and found these made her aware of different ways of doing things. The PGCARMS modules were more focused and structured with the feedback on one module assignment giving her ideas to apply to her own work. She found that after the UGS short courses there was no further need to engage with the topic in a more formal way. She believes both types of courses have value.

She was under some time pressure as a result of doing both PGCARMS and her PhD at the same time. When a deadline to do with the PhD came up she did have to juggle and prioritise that. However, she believes having the PGCARMS qualification shows she's done more than just a PhD and this will hopefully give her an advantage when looking for jobs as she will be able to present a wider skills base. She's pleased to have the academic recognition for this, especially for the work experience and teaching modules.

Conclusions

It is clear from the survey responses about the experience of this first cohort to complete the PGCARMS programme that their feelings changed over time to move from dissatisfaction with being forced to participate in a programme they didn't feel was relevant to them, to a more positive outlook on the experience when they had completed the programme and reflected on what they'd learnt. The longitudinal analysis as well as the case study interview undertaken with a participant, have delivered evidence that the PGCARMS programme has had some impact at both Level 3 (behaviour change) and Level 4 (outcomes) with participants reporting a range of positive outcomes. It is hoped a further follow-up survey will be undertaken with this cohort once they have completed their PhDs and moved into employment.

As this cohort were the first to participate in the PGCARMS programme it was to be expected that issues would be uncovered and lessons have been learnt to make improvements for future cohorts. The choice of modules has already been increased to support the wider range of subject backgrounds participants come from. The size of the participating cohorts has increased and the intent is to continue this longitudinal analysis to assess ongoing satisfaction with the programme.

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Case Study

Module Selection from a Student Perspective: A School of Physics and Astronomy Student Summer Internship

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Abstract
Within the School of Physics and Astronomy at the University of Birmingham there are many optional modules available to students throughout their degree programs. It is the students' responsibility to plan their choices through their course and to seek advice on suitable combinations. Funding was secured from the College of Engineering and Physical Sciences for a summer project to investigate if this advice could be made more readily and consistently accessible to students. The objective was to look at the module selection process from the student perspective. This article details how the undergraduate population and academic staff were surveyed to ascertain what information was most requested and its optimal format – and how it could be made available to students. The resulting changes made to current module information given within the department and the additional resources created to help students in making their choices are then discussed.

Introduction

Physics is a hierarchical subject. At the University of Birmingham the core subject material is concentrated into the first two years of the degree programme. The final one or two years, depending on whether a student is enrolled on the BSc (3year) or MSci (4 year) programme are then tailored by the student to their strengths and intended study or employment destinations post graduation. This 'tailoring' is achieved via the selection of combinations of options. It might for instance be that the student has a preferred pathway, for example specialising in medical physics or an emphasis on numerical modelling and data analysis. However, the hierarchical nature of physics education remains – and as a result there are prerequisites for all modules: they rely heavily on content taught in previous modules.

It is essential for students to plan their way through their degree to ensure they have chosen the correct options in order to take the modules they wish to study in later years. This can be particularly challenging for the circa 80 students who choose to complete a 4-year undergraduate masters course as they are planning two years worth of study. The project described in this article was carried out as a three-week summer internship in the School of Physics and Astronomy. Its objective was to provide an analysis of the currently available module choice information in terms of detail and ease of access and to then suggest, and implement where possible, improvements.

The Project Team

At the time of the project James Kendrick (JK) had completed his fourth year of a five-year degree MSci Physics with Particle Physics and Cosmology (with an intercalated year in Computer Science) and Helen Ansell (HA) had completed the second year of a four year MSci Theoretical Physics programme. Both students had been part of the active student representative system within the School and were well known to the other undergraduates – essential as student opinions would need to be collated over the summer vacation.

Nicola Wilkin (NKW) had put in place a system of advice for second year choices, via a 'module selection fair'. This could be placed in the first semester of second year, as the choices are timetabled for the second semester. At the fair all lecturers of optional modules had discussed the type of material they would cover, how they would deliver it, and how mathematical the material would be. Importantly, they also detailed which modules would require this knowledge in later years. In the third year there is a half-day of discussion about modules to inform module choices, but the number of options prevents the detail being discussed as for the second year.

Student Questionnaire

At the time of the internship two of the authors (HA and JK) had both recently chosen modules for the next academic year, and so had experience of the process of choosing modules as it was at the time. Having come from different degree programs and different year groups, HA and JK had a wealth of possible ideas for improving the portrayal of the module information.

In order to gather opinions from our fellow students a questionnaire was created for all students who had just completed Years 2,3, and 4. The survey was sent to students via email and also via Facebook groups for each year group and the University Physics Society. There were 72 responses in total, split evenly across the year groups.

Students were asked to rate how useful they found each of the following pieces of module information:

- Course content
- Mathematical content
- Assessment format
- Prerequisites
- Which modules it is a prerequisite for
- Course material availability
- Availability of support (e.g. examples classes).

Utilising the six-point scale in Figure 1.

Not useful	Slightly useful	Quite useful	Very useful	Important	Crucial

Figure 1: The six-point scale for capturing student views.

The responses indicated that students surveyed found the current information to be very useful. Indicating that the project objective should be to supplement and make more accessible the existing information.

Students were also asked, 'Is there anything else you consider when choosing a module?' as an open text question. Of the 45 responses to this question, 30 comments indicated that the lecturer was a consideration when choosing modules.

One student commented:
'For me the style of lecturing is quite important. I prefer handwritten notes which are then uploaded to canvas. However, I know other people prefer PowerPoint presentations given as hand-outs during the lecture.'
The majority of the remaining comments concerned timetabling and how particular modules might complement each other.

Open text questions asked students what they thought the best way to track module choices was, additional considerations when choosing modules, and improvements that could be made to the current information given. In response to the question 'Are there any other improvements that could be made to the way module information is communicated?' there were 44 responses. Of these, 60% commented that a flow diagram or visual aid would be useful in helping choose modules.

Working With Staff

In response to the student survey results, a discussion was held with the Heads of Years and then all teaching staff were surveyed via an emailed pro forma. They were asked about the mathematical emphasis of the modules they currently taught and to give examples of specific mathematical topics that are particularly important for the module. They were also asked to give details of their modes of teaching delivery and the resources they made available to students on the University's virtual learning environment, Canvas. Finally, the pro forma asked if students ever contacted academic staff with any particular questions about optional modules. The responses indicated that most lecturers were not usually contacted for information about modules during the selection process.

Programme coordinators were also consulted to discuss possible pathways through a degree. This gave a different perspective on what students on different programmes might need to consider when choosing their optional modules.

Module Information Templates

From the work that was completed, it became apparent that there were various areas in need of standardisation throughout the School, especially with respect to the format of the information given to students. There were different templates used providing the module information, making it difficult for students to easily compare modules.

A Canvas pages was therefore produced for all of the modules available in the physics department. Having looked into the options available, they felt that storing the information on Canvas was the most efficient mechanism available to keep it up to date and to make it easily accessible for students. They produced standardised templates for module information, with guidance for what information should be contained within each section, and an approximate word limit for the module descriptions.

What is a Prerequisite?

It was found that the term 'prerequisite' needed clarification because it was not being used with a standard meaning. Some teaching staff were prepared to allow students to take particular modules without having taken the 'prerequisite' modules, considering these modules as good background knowledge rather than having essential content for the particular course. These examples provided a clear contrast to where students were not allowed to take a module without having successfully taken the prerequisite module. Some teaching staff chose to list 'advised prerequisites' but again this was without any common definition. It was also noted that some modules gave a more thorough list of prerequisites than others – some listing the previous years' compulsory modules as prerequisites for their module. For improved clarity, separate sections on the module information templates were created for prerequisite and advised modules and gave the definition of each that should be used.

Mapping out the Physics Programme

A 'module map' for each physics degree programme was produced which had been suggested by many students in the survey. This module map was a diagram showing all of the available modules, arranged in columns according to the year group. Compulsory and optional modules were shown in different colours and the prerequisites for optional modules given by arrows. The number of credits to be chosen were given for each year group. Care was taken to ensure the colours chosen for the map could be distinguished by those with colour blindness.

The module map was then used as a basis for creating sample pathways through degree programmes. The aim was to help students think about where their interests lie by listing possible modules that could be taken in each year focusing on certain areas of physics. Concern was raised that students may simply choose a particular pathway without properly considering their options, or that some options would be seen as favourable to others if they appeared more frequently in the pathways. To ensure this would not be the case all optional modules were included in at least one of the possible pathways and a wide range of possible focuses was created.

Teaching Profiles

Profiles were created for each member of teaching staff, including contact information, their main teaching methods for each of the modules they teach and the resources they make available to students on Canvas. These are stored on Canvas and are available to students as links from the relevant module pages.

Mathematical content

The optional modules vary in the selection of mathematical techniques they rely upon. The survey indicated that 82% of respondents rated the mathematical content as 'very important' (4/6) or higher on the scale used. It was understood that some students would preferentially choose modules with a higher mathematical content, while others would choose the modules of a more qualitative nature. There was much discussion about how to display the information, to avoid the modules appearing to be ranked. It was decided to include information indicating the level and nature of mathematics required and the particular areas of mathematics relevant to the course within the module information template.

Summary

During this relatively short (3 weeks) internship the School of Physics and Astronomy acquired valuable insight into the structuring of its information delivery for the process of selecting modules. Suggestions for improvement were made based upon results of a student survey, working with members of staff and HA and JK's own suggestions. The way in which module information is now presented and created was clarified and supplementary resources produced to aid students in their selection of modules. The results of the project were disseminated via an information poster (see Figure 2) for students which is on display in the Physics department and provides a summary of the main work completed, including an example of a module map, which is also available on Canvas.

Feedback on the new resources available was obtained through the student representative committee. A general discussion of the changes that had been made and the additional resources available concluded that the students have found them to be very useful.

One student said:

'The module map helped me shape the remainder of my degree, and made the decision making process a lot easier.'
Undergraduate student, School of Physics and Astronom

Another student added:

'Being able to see prerequisites for all modules in one place was really useful. Having an overview of the key information for all modules on a single page made choosing modules much easier.'
Undergraduate student, School of Physics and Astronomy

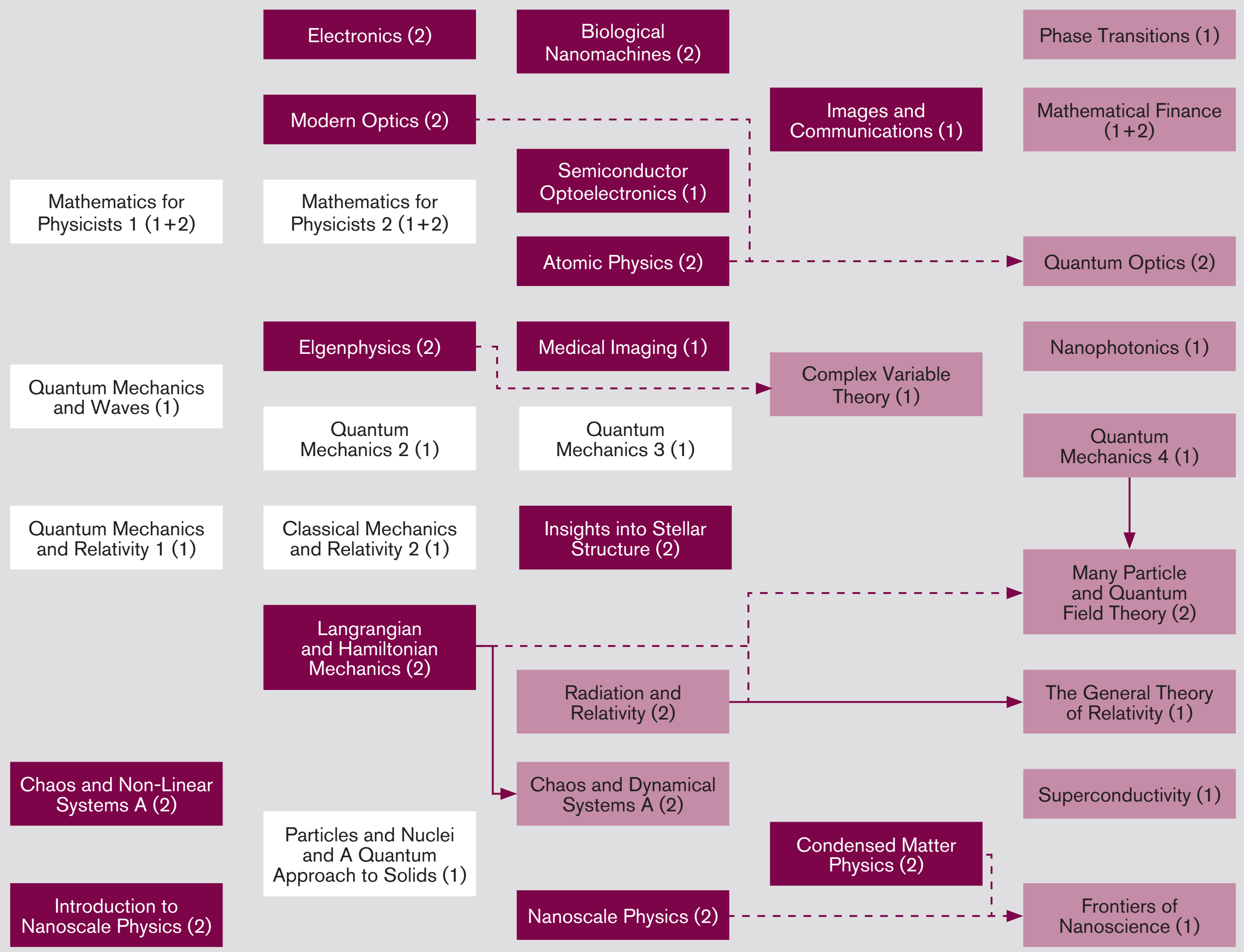

Figure 2: Example of a module map.

Contributions

Education in Practice seeks a range of contributions from staff and students from within the University in relation to any aspect of learning, teaching, assessment and support. Details of the kinds of contribution sought are described below, but to discuss your ideas, please contact either the Editors or a member of the Editorial Board.

Original Articles and Papers

Original articles may include: reports of educational research; evaluations of learning and teaching activity and innovation; summaries of outcomes from learning and teaching projects; or discussion papers. They should contain an appropriate level of data and evidence to support any arguments made or conclusions reached; such evidence may be obtained from either individual work or an analysis of existing educational literature to support the ideas. They should offer a high degree of academic integrity by being evidence informed, reflective and scholarly in nature. Each original paper should typically be around 2,000–3,000 words although exceptions will be made for papers that contain a substantial elements of original qualitative data.

Case Studies

Case studies, typically up to 2,000 words in length, are sought that describe examples of current individual and departmental activity and practice and outcomes from learning and teaching projects. They might relate to ongoing activities and projects, or initiatives that have proved particularly successful or insightful. Where case studies describe successful or insightful interventions they should contain a level of data or evidence in support of any claims that are made.

Reviews

Reviews, which may be literature reviews of particular thematic areas, analyses of topical areas of interest, or, 'think pieces' exploring applications of theory to inform practice, should typically be no more than 3,000 words. Their focus should be upon critically analysing the current literature to identify the implications of current or emerging findings to University of Birmingham practices and approaches towards student learning. On occasions, the Editors will commission reviews on topical areas of learning and teaching activity.

Have you seen this?

Such contributions may take a variety of forms, but should typically showcase reports, book reviews, resources, papers and any item that may be of interest to others. They may be up to 250 words and briefly summarise the item of interest including any relevant links or references so that others can find out more.

Getting started in…

Practical contributions outlining a particular approach, for example utilising Canvas for the automated submission of student work, are welcomed. They should be written in an appropriate but practical style (numbered stages are welcome) containing sufficient information and guidance to allow those unfamiliar with the particular idea to implement it successfully for themselves. Contributions should not typically exceed 500 words.

Letters

Letters to the Editors are welcome on any relevant topic, and submissions articulating how ideas contained in previous issues have been applied to practice are particularly sought. They may be up to 250 words in length.

Detailed guidance for preparing submissions is available and should be consulted prior to submission:
www.birmingham.ac.uk/eip

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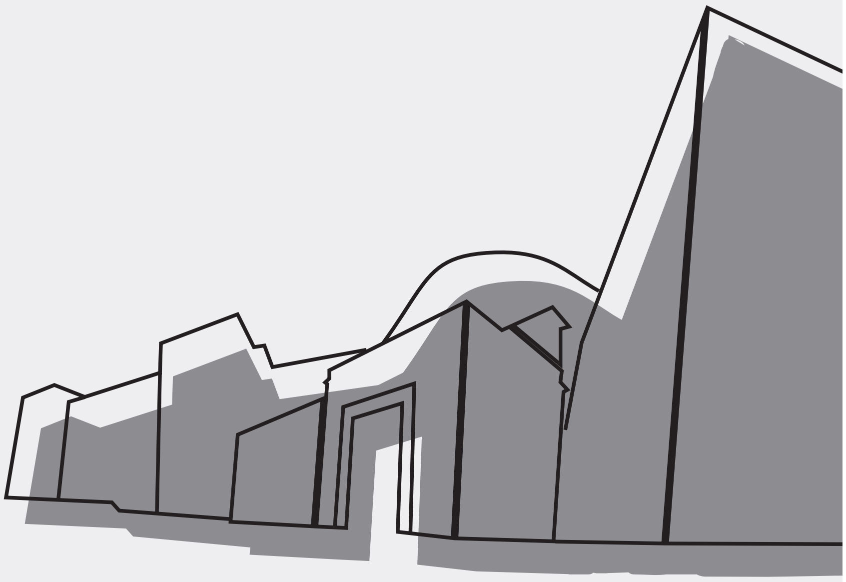

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