



# Teaching *for* Learning NETWORK

Summer 2008

## Research Briefing

### Plant Sciences Pedagogy Project

Improving teaching and learning at the University of Cambridge

The Plant Sciences Pedagogy Project funded by the Cambridge-MIT Institute (CMI) conducted educational research and development at the Department of Plant Sciences, University of Cambridge, between 2005 and 2008. A mixed methods approach was used, involving collaboration with teaching staff and students in the department, and educational researchers in the Teaching for Learning Network (TfLN). A number of high-leverage strategies for improvement of teaching were identified. New resources and workshops were developed for staff and students, including online resources to support and enhance teaching and learning. Over the lifetime of the project, these activities led to improved student retention and recruitment, self-efficacy and engagement with Plant Sciences.

#### Key Findings

Students value explicit definitions of what constitutes high quality work, such as degree class standards for essays and examinations. They also value feedback and guidance which helps them to improve.

Students benefit from overviews of course structure and content which explicitly link topics addressed in lectures, practicals and small-group teaching activities.

Online environments can be developed to provide students with overviews of course content as well as specific resources tailored to support teaching and learning of difficult concepts.

Co-interpretation activities in which staff and students engaged with research findings provided additional insights, validated project analyses and highlighted areas for further research and development.

#### Implications

Models of quality need to be shared between staff, students and examiners as part of a commitment to making learning processes and success criteria explicit. Feedback needs to be constructive and suggest ways of improving.

Staff should be made aware of the importance of linking course elements. Student learning across teaching environments can be improved by face-to-face and online communication between staff.

Staff and students need to be engaged in discussions about the role and potential benefits of online learning in order to inform the development of effective support for teaching and learning.

Appropriate research evidence can be used to inspire reflection and discussion about teaching and learning with staff and students. Staff and students can be seen as research participants as well as providers of research data.

# The Research

## The need

The Department of Plant Sciences uses three main modes of teaching, typical of a science subject at the University of Cambridge: lectures, practical classes, and small-group tutorials. Tutorials at Cambridge comprise very small groups, usually up to 4 students to one member of teaching staff, for one hour a week. Within the University, tutorials are known as 'supervisions'. Lectures and practical classes are common practice within UK Higher Education, but the supervision system is regarded as one of the benefits of undergraduate study at Cambridge (although there is a similar system at Oxford).

In course evaluations, students typically show great value and appreciation of the supervision system, although a recent Cambridge University Students Union (CUSU) survey reported that students may experience a great deal of variation in the quality of supervisions provided by their particular college. As a result, it called for mandatory training of supervisors, echoing the previous years' QAA institutional audit (2003).

In response to this, our research has focused on analysis of the supervision environment in order to find out how best to support our teaching staff to provide equally valuable supervision experiences for all students on the 2nd year Plant Sciences course ('Part IB Plant and Microbial Sciences', or 'IB PMS') and also to identify opportunities for supporting student learning outside of tutorials. There were a number of specific questions which were of interest:

- To identify what characterised teaching and learning at Cambridge, particularly in the supervision teaching setting;
- To identify and foster effective practices with the potential to improve student experience and learning outcomes, and as a result to inform decisionmaking by teachers, as to how, when and with whom to employ specific practices;
- To identify potential opportunities for the support, enhancement or extension of learning through the application of new technologies, and to develop supporting online resources.

These questions were posed with a view to using the results to develop staff teaching practices, improve student learning and engagement with the subject, and enhance recruitment and retention of students within the discipline.

## Research approach

The project approach can be thought of as an action cycle (shown at the foot of the page), with an emphasis at each step upon engagement with Plant Sciences students and teaching staff ('practitioners'). The cycle began at the 'identifying a problem or need' step, prompted by the CUSU report. The project began in November 2005, and during the first year of the project (up to October 2006), following the initial diagnosis phase, work focussed on reconnaissance and development phases. Reconnaissance, coupled with practitioner evaluation, included various data gathering activities with staff and students (see 'Building the evidence base'). These initial research findings were reported to teaching staff in a workshop for interpretation of our data and discussion about development of teaching resources.

In turn, the outcomes led the development of resources to support new practices (see 'Translating the evidence into teaching resources'), which were implemented in the 2006-2007 academic year. Since the introduction of the new resources, various methods have been used to assess the success of the interventions (see 'Have the interventions been successful?'). In the final phase of the project, the emerging information from evaluations has been fed back into refining the resources themselves in light of staff and student opinions, fostering reflection and reassessment of the problem

## Building the evidence base

Following the initial literature review, research activities focussed on forming a solid evidence base. This was achieved via focus groups with students, semi-structured interviews with teaching staff, video analysis of small group teaching within the Department, and the administration of self-efficacy and practice-value gap questionnaires to students. Both questionnaires were administered to students at the beginning and end of the 2nd year course for the duration of the project (2005/06, 2006/07, and 2007/08 academic years). (See 'The Warrant' on page 4 for further details).

## Results

Several key themes emerged, including:

- Making learning explicit: Sharing learning objectives and criteria for success.
- Contingent teaching: Exploring student understanding and responding accordingly.
- Authentic learning: Relating concepts to 'real-world' examples.
- Student self-regulation & independent learning: Encouraging students to take responsibility for their learning.
- Constructive alignment, synthesis and throughlines: Visualizing the 'bigger picture' of the course, and links between topics.
- Transparency & accountability: Regarding the course examinations and assessment systems.



## Translating the evidence into teaching resources

The themes were applied to the design of new resources for both students and staff. For students, these included a new online virtual learning environment (VLE; see figure above right) and workshops. A key novel feature of the VLE which was directly influenced by research findings included arrangement of lecture materials in a wiki so they appeared as a network of inter linked topics rather than simply a static list of pdf files (constructive alignment, synthesis and through-lines). Extra resources were provided to support topics which students typically found particularly 'troublesome' and bore hallmarks of 'threshold concepts' (Meyer and Land, 2003).

Students were also given new workshops added to their practical class timetable; e.g. 'How to write an essay' addressing the criteria used by the department to mark essays in examinations, and using transcribed genuine examination essays as a starting point for discussion. For staff, a virtual collaboration environment (VCE) was deployed for sharing ideas and resources for supervisions. Workshops were also run to address key issues highlighted by students - for example, how to give formative feedback effectively.

## Have the interventions been successful?

A number of different indicators of impact have indicated that the interventions have had a positive effect upon staff and students within the department. Indicators of efficacy have included continued administration of the student practice-value and self-efficacy questionnaires at the beginning and end of each subsequent 2nd year class (in addition to the first year which formed a key part of the evidence base), and collecting data about students' choices of third year subject. The efficacy of the new VLE was addressed specifically in an online questionnaire to students, accompanied by analysis of site usage data, which was then fed back for co-interpretation with students in a focus group. Similarly, the site usage data for the staff VCE was analysed, and an online questionnaire sent to gauge staff opinion of it and the workshops.

When comparing the pre- and post-intervention years, the student self-efficacy survey showed significant improvements in confidence about three specific plant science top-

ics; these particular topics closely aligned with ones which had been identified as threshold concepts and had been enhanced with additional resources within the student VLE. The efficacy of the VLE and the resources within it was assessed through both an online questionnaire to students and analysis of site usage data.

Usage data showed students had engaged with the site and made use of its learning resources, particularly during the revision period. Variability in the characteristics of student use highlights the benefit of designing a flexible VLE, providing resources in different formats to allow students to personalise their learning by choosing the resources most useful to their individual needs. This was also born out by the questionnaire data; on the whole, students found the site very useful; but the extent to which individual students used different types of learning resources varied. The site usage data was presented to students within a focus group for co-interpretation. From this it was clear that students do not see the VLE as a substitute to teaching in lectures, but as a companion. There was an indication that there are a great deal of different reasons which would prompt a student to use the VLE, and that it was particularly useful at the end of the year for revision. Similarly, usage data and responses to a questionnaire show that the teaching staff VCE has been used extensively for reference.

The introduction of the new resources has been accompanied by a marked increase in student retention within the discipline. At the end of the second project year (the first class to experience the interventions), 69% of the IB PMS class chose to study plant sciences in their third year, compared to 38% at the end of the first project year (pre-intervention).

## Major Implications

The six key themes identified by the initial literature review and evidence base have proved to be a robust representation of key issues to consider in teaching at the University. In terms of translating research evidence into teaching provision, it is a useful practical framework for development of new resources. The themes have been repeatedly highlighted by data gathered across the full course of the project in Plant Sciences, along with the sister projects in the Engineering Department,

the Faculty of Classics and also projects based at MIT. In addition to their value as a framework for pedagogical development, they have also been invaluable as a cross-disciplinary vocabulary for discussing pedagogical issues spanning the whole of the TfLN.

An item which has consistently emerged as being highly desirable, but least practiced, is the notion of sharing models of quality between staff and students. For example, students' desire for formative feedback, and to clarify what defines the degree class of written work. This was addressed via workshops carried out with supervisors (in the department and the wider university) to discuss ways of giving formative feedback, provision of exemplar essays for students, and essay writing workshops for students. Additional questionnaires to other biological subjects at Cambridge have highlighted that the importance of this factor extends far beyond the Plant Sciences course.

Another important issue was highlighting the inter-relatedness of lecture topics, and links to the 'real world'. The project found that technology can help address this; in particular, by converting lecture notes into a dynamic network of wiki pages, in comparison to the static lists of individual pdf files commonly used in higher education VLEs. In assessing the efficacy and understanding site usage of the VLE and online resources, with a view to better informed development and provision in the following year, it proved invaluable to engage students in 'co-interpretation' activities to illuminate data gathered.

### References

Entwistle, N., Hounsell, J. and McCune, V. (2002) Approaches to Studying and Perceptions of University Teaching-Learning Environments: Concepts, Measures and Preliminary Findings. ETL Occasional Paper 1.

Lucas, W. and Cooper, S. (2005) Measuring Entrepreneurial Self-Efficacy: Paper presented at the EDGE conference 'Bridging the Gap: Entrepreneurship in Theory and Practice' Singapore.

Meyer, J.F.K. and Land, R. (2003). Threshold Concepts and Troublesome Knowledge (1). Linkages to Ways of Thinking and Practising. In C. Rust (Ed.), *Improving Student Learning: Theory and Practice - 10 Years On*, Oxford: OCSLD, Oxford Brookes University.

Trigwell and Ashwin (2003) Undergraduate students' experience of learning at the University of Oxford (Oxford: University of Oxford).

## Recent Outputs

Carmichael, P., Jordan, K. Johnstone, K., Tracy, F. and Truscott, H. (2006) 'Enhancing Small Group Teaching in Plant Sciences: A Research and Development Project in Higher Education' Paper presented at BERA Conference, September 2006, Warwick.

Tracy, F., Jordan, K., Johnstone, K. (2007) 'Using the wiki the wrong way: a case study in Plant Sciences' Paper presented at the SOLSTICE Conference 2007, Edge Hill University.

Tracy, F., Jordan, K., Johnstone, K., Carmichael, P. (2007) 'Using evidence informed approval to create online learning resources' Paper presented at the BLU Conference 2007, 14th June, University of Hertfordshire.

Johnstone, K., Carmichael, P., Tracy, F., Jordan, K. and Truscott, H. (2007) 'Developing Evidence-Informed Practice in Undergraduate Teaching and Learning at the University of Cambridge', in: University Collaboration for Innovation: Lessons from the Cambridge-MIT Institute (Rotterdam: Sense Publishers).

Jordan, K., Tracy, F., and Johnstone, K. 'Student Interaction with a Sakai VLE in Plant Sciences.' 7th Sakai Conference, Amsterdam, June 2007.

Carmichael, P., Burchmore, H., Tracy, F., and Johnstone, K. (2007) 'Threshold Concepts: An emerging Interdisciplinary Research Agenda in Higher Education', in: University Collaboration for Innovation: Lessons from the Cambridge-MIT Institute (Rotterdam: Sense Publishers).

Tracy, F., Jordan, K. and Johnstone, K. (2007) 'Reshaping Academic Practice and Relationships within the Department of Plant Sciences' Paper presented at the SRHE Conference, December 2007, Brighton.

Jordan K. and Johnstone, K. (2008) 'Using interactive 3-D models in teaching' Higher Education Academy Bioscience Spring Bulletin 2008.

## The Warrant

A robust evidence base has been collected over three years, which has allowed longitudinal comparisons and triangulation across multiple quantitative and qualitative data sets.

Use of practice-value questionnaires is a novel approach in higher education; however, it is established in educational research more generally. The items were derived from inventories developed by the ETL project (Entwistle, Hounsell and McCune, 2002), and by Trigwell and Ashwin (2003) in their work on small group teaching at the University of Oxford. The approach was trialled and piloted prior to biennial administrations for three years.

Self-efficacy questionnaires were based on a format established by Lucas and Cooper (2005), adapted to explore general scientific skills as well as specific Plant Science topics. Focus groups were piloted with a sample of students by educational researchers at the Centre for Applied Research in Educational Technologies (CARET) to foster a 'neutral' discussion space.

Rigorous peer scrutiny has been ensured by the presentation of project data and analyses to audiences of disciplinary experts, educational researchers and educational technologists at seminars and conferences.

In September 2007, the project won the inaugural British Educational Research Association (BERA) Sage 'Research into Teaching' award in recognition of its high quality application of research activities upon informing teaching practice.



<b>Project website:</b>	<a href="http://www.tfln.org">http://www.tfln.org</a>
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The Teaching for Learning Network (TfLN) has grown out of pedagogical development activities funded by the Cambridge-MIT Institute (CMI), a collaboration between the University of Cambridge and the Massachusetts Institute of Technology (MIT). TfLN has been established in order to extend and expand these activities.

Both the University of Cambridge and MIT have distinctive educational characters. Part of the goal for TfLN is to determine what specific practices and approaches to teaching and learning contribute to these - while at the same time seeking to identify areas of commonality across the two institutions and higher education as a whole.

TfLN provides support for faculties, departments and other groups in undertaking research and development projects with a specific focus of improving teaching and learning. In 2006-2007 these will be located within Cambridge and MIT; subsequently, the network will extend to include partners in other higher education institutions.

Directed at Cambridge by Keith Johnstone (Plant Sciences), David Good (Social and Political Sciences) and Patrick Carmichael (Centre for Applied Research in Educational Technologies), the TfLN has been designed as a network supporting both intensive collaboration within its constituent projects and 'at-a-distance' sharing of approaches, interpretative frameworks, findings and outcomes.