

## **Using an evidence informed approach to create online learning resources**

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### **Abstract**

The Plant Sciences Pedagogy Project began in the autumn of 2005 sponsored by the Cambridge-MIT Institute (CMI). The project objectives within the Department of Plant Sciences at the University of Cambridge were twofold: to conduct research into undergraduate teaching and learning within the Department; and to develop online resources to support student learning. The research focused on the second year 'Part IB Plant & Microbial Sciences' (IB PMS) Course. A combination of focus groups, dual-scale questionnaires and semi-structured interviews were used to gauge both student and staff opinions on, attitudes towards, and expectations of, teaching on the IB PMS course. This resulted in a solid evidence base, with several key themes emerging that were confirmed by multiple approaches. This evidence base was then used to inform and shape the construction of the students' course site and the new resources to be housed within it. The site was developed in the Universities' adaptation of the Sakai Virtual Learning Environment (VLE) platform, known as CamTools, for which technical support was provided by Centre for Applied Research in Educational Technologies (CARET). There can be a strong temptation to use all the options offered by available information technology for their own sake and CamTools is rich in pre-programmed software 'tools'. Therefore the evidence informed approach was adopted to identify appropriate tools for implementation. The CamTools/Sakai online environment proved to be extremely versatile and allowed the development of bespoke online learning resources for students; this resulted in an online learning environment which best matched the needs of the course and its students.

### **Introduction**

The Plant Sciences Pedagogy Project commenced in the autumn of 2005 as part of a teaching and learning research initiative funded by the Cambridge-MIT Institute (CMI) (Carmichael *et al.*, 2006; Johnstone *et al.*, 2007). The project objectives within the Department of Plant Sciences at Cambridge were to conduct research into undergraduate teaching and learning, with the aim of

developing new resources to support both students and teachers. The majority of resources developed were made available within a Virtual Learning Environment (VLE) called CamTools.

The research focused on the second year undergraduate course, known as the 'Part IB Plant & Microbial Sciences' course (IB PMS), which is one of the subjects that contribute to the Natural Sciences Tripos at the University of Cambridge. Technical support for the use of CamTools was available within the University from the Centre for Applied Research in Educational Technologies (CARET), who developed our VLE from software called Sakai.

Sakai is described as an 'Online Collaboration and Learning Environment' (<http://www.sakaiproject.org>). It is based on 'Community Source' software, which is maintained, upgraded and developed by a community of partner universities, of which the University of Cambridge has been a member since autumn 2005.

<input checked="" type="checkbox"/>	Home	Description of the project, recent announcements, discussion, and chat items.
<input checked="" type="checkbox"/>	Announcements	For posting current, time-critical information.
<input type="checkbox"/>	Assignments	For posting, submitting and grading assignment(s) online.
<input type="checkbox"/>	Chat Room	For real-time conversations in written form.
<input type="checkbox"/>	Discussion	For conversations in written form.
<input type="checkbox"/>	Drop Box	For private file sharing between instructor and student.
<input type="checkbox"/>	Email Archive	For viewing email sent to the site.
<input type="checkbox"/>	Gradebook	For storing and computing assessment grades from Tests & Quizzes or that are manually entered.
<input type="checkbox"/>	News	For viewing content from online sources.
<input type="checkbox"/>	Post'Em	For uploading .csv formatted file to display feedback (e.g., comments, grades) to site participants.
<input type="checkbox"/>	Presentation	For showing and viewing slideshows of image collections from Resources.
<input type="checkbox"/>	Resources	For posting documents, URLs to other websites, etc.
<input type="checkbox"/>	Roster	For viewing the site participants list.
<input checked="" type="checkbox"/>	Schedule	For posting and viewing deadlines, events, etc.
<input type="checkbox"/>	Section Info	For managing sections within a site.
<input checked="" type="checkbox"/>	Site Info	For showing worksite information and site participants.
<input type="checkbox"/>	Site Stats	For showing site statistics by user, event, or resource.
<input checked="" type="checkbox"/>	Syllabus	For posting a summary outline and/or requirements for a site.
<input checked="" type="checkbox"/>	Tests & Quizzes	For creating and taking online tests and quizzes.
<input checked="" type="checkbox"/>	Wiki Map	For accessing content from <a href="https://camtools.caret.cam.ac.uk/access/content/group/4ca5131b-31553257b41c59/Admin/camtoolJmol.htm">https://camtools.caret.cam.ac.uk/access/content/group/4ca5131b-31553257b41c59/Admin/camtoolJmol.htm</a> within the site.
<input checked="" type="checkbox"/>	Jmol 3D Molecules	For accessing content from <a href="https://camtools.caret.cam.ac.uk/access/content/group/4ca5131b-31553257b41c59/Admin/camtoolJmol.htm">https://camtools.caret.cam.ac.uk/access/content/group/4ca5131b-31553257b41c59/Admin/camtoolJmol.htm</a> within the site.
<input checked="" type="checkbox"/>	References	For accessing content from <a href="http://www.connotea.org/user/IBPMS">http://www.connotea.org/user/IBPMS</a> within the site.
<input type="checkbox"/>	Web Content	For accessing an external website within the site.
<input checked="" type="checkbox"/>	Wiki	For collaborative editing of pages and content

**Figure 1:** Summary of available 'tools' within a CamTools worksite.

The local system within the University of Cambridge is named 'CamTools'. CamTools soon became adopted by various researchers within the university for use as a virtual research environment (VRE), for online collaboration and project management. From October 2006, it has also been used to host sites for undergraduate course materials, replacing the Universities' previous 'CourseWork' VLE, which had originally been developed by Stanford University. The Sakai environment is highly versatile, comprising a collection of 'tools' which are all optional and can be tailored by the user. Figure 1 shows all the tool options available for the IB PMS course site; Figure 2 shows how this site appears to students, with the available tools at the left. It was tempting to use all of the available tools to maximize project output, but this approach would risk losing sight of the best requirements for the learner. Instead we used an evidence informed strategy to determine which tools would be implemented in order to provide an environment which best matched the needs of the course and its students.

The screenshot shows the CamTools interface for the University of Cambridge. At the top, there is a navigation bar with 'My Workspace' and several course-specific links: 'Biochemistry: Techniques 06\_07', 'Biol of Cells 2006\_7', 'Biol Cells: NST1A 06\_07', and 'PMS: NST1B 06\_07'. A 'Logout' button is in the top right. The main content area is divided into three columns. The left column contains a vertical menu with links: Home, Site info, Wiki, Wiki Map, Syllabus, Schedule, Announcements, Jmol 3D Molecules, References, Tests & Quizzes, and User Guide. Below this is a 'Users present:' section listing 'K.L. Jordan'. The middle column is titled 'Worksite Information' and contains 'Options' for 'Department of Plant Sciences', 'Part IB Plant and Microbial Sciences', and 'Course Resources & Wiki'. It features a central image of plant cells and a 'Tour the site here' link. A note at the bottom of this section says 'Note that this site is best viewed using Internet Explorer'. The right column is titled 'Recent Announcements' and lists several items with dates and authors, including 'David Coomes on Species Area Curves', 'IB PMS Juniper Practical - Monday 30 April and Tuesday 1 May', 'IB PMS Easter Term', 'Student Questionnaires - College affiliation', 'Rhizobium Seminar - Thursday 15 March', 'IB PMS Week 8 Practical: Learning Workshops', 'iGEM Competition 2007', 'Summer Studentships at Rothamsted Research', 'Student Presentations', 'Floral Dip - Thursday', 'CUSU CamTools Consultation', and 'Additional presentation topic and field course information'. At the bottom of the page is the 'Plant Sciences Pedagogy Project' logo.

**Figure 2:** The IB PMS course site homepage.

A combination of focus groups, dual-scale questionnaires and semi-structured interviews were carried out within the Department to gauge both student and staff opinions on, attitudes towards, and expectations of, teaching on the IB PMS course. This formed a solid evidence base, with several key themes emerging supported by multiple approaches. This evidence base was then

used to inform and shape the construction of the students' course site in CamTools and the new resources to be housed within it.

### The evidence base

A range of different forms of evidence can be used to drive pedagogical practice. As reviewed by Sebba (2004), these can include large scale statistical evaluations and forecasts; the results of inspection, monitoring and appraisal activities; and research evidence which involves practitioners themselves as co-researchers in the collection and analysis of evidence. This study falls within the latter category, with Plant Science specialists conducting the research within the Department. The research itself consisted of four approaches: a literature review, student survey, student focus groups, and interviews with tutors. The project comprised an action cycle including analysis, fact-finding, conceptualisation, planning, implementation and evaluation of action (McKernan, 1991).

The student survey comprised a dual-scale questionnaire containing thirty items. Each item had two five-point Likert scales, which students used to rate the item in terms of both 'frequency of practice' and perceived 'value'. This is notably different from traditional single-sided Likert scales (Likert, 1932) and double-sided Likert scales (Taylor *et al.*, 1995) in that the student assesses each item in terms of two distinct and orthogonal variables. A typical item was presented as shown in Figure 3.

Practices					Values									
Always				Never				High	Low					
<input type="checkbox"/>	Tutors spend time trying to understand difficulties I may be having with my work					<input type="checkbox"/>								

**Figure 3:** The dual-scale format of the student survey.

The questionnaire draws on a design used in the Improving School Effectiveness Project (ISEP) (Robertson and Sammons, 2001; MacBeath and Mortimer, 2001) and subsequently in the Teaching and Learning Research Programme's 'Learning how to Learn' project (James and Pedder, 2006). The questionnaire items themselves were derived from the list of practices identified by the ETL project (Entwistle *et al.*, 2002), and from inventories developed by Trigwell and Ashwin (2003) from their work on small group teaching at the University of Oxford.

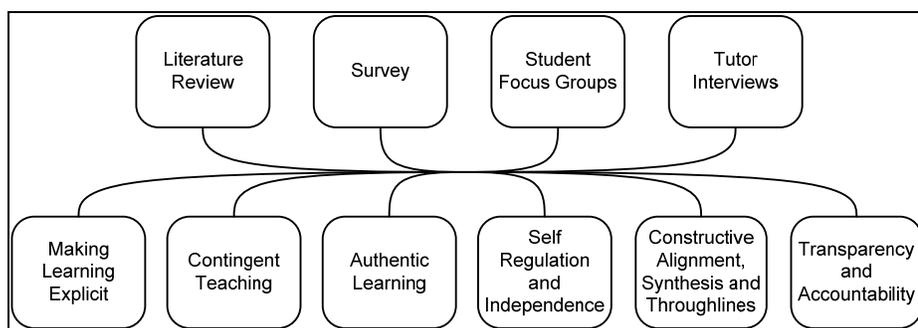
The student focus groups were conducted by educational researchers at CARET to encourage free speaking in an environment disassociated with the Plant Sciences Department. They were split across four sessions; the first three sessions were intended to elicit student opinion in key areas of learning, teaching and assessment, and the fourth session offered students an

opportunity to reflect more broadly and also to voice their recommendations and advice for improvements to undergraduate teaching provision.

Tutors and lecturers from the course were interviewed twice. The first set of interviews were conducted by CARET researchers using a semi-structured interview framework to assess attitudes to and beliefs about small-group teaching in the Department; the second set were conducted by Plant Sciences research staff to determine specific areas of the course which students find troublesome and the resources currently used by tutors to support them. Some of these particularly troublesome concepts have emerged as potential threshold concepts as characterised by Meyer and Land (2003) which have been described elsewhere (Carmichael *et al.*, 2007).

## Emerging themes

An initial literature review of concepts and theories associated with teaching in Higher Education highlighted a number of teaching strategies that have been found to be effective in small-group environments. These strategies were classified into themes, which have been applied to and influenced by the analysis of research data from the Plant Sciences Pedagogy Project (Figure 4).



**Figure 4:** Summary of themes emerging from research activities.

Making learning explicit was characterised by clarification of what is required to succeed on the course, for example, by sharing and reinforcing learning objectives and providing examples of essays of a range of different standards. Contingent teaching (after Wood, 1997) was also highlighted, in which teachers use diagnostic questioning of students to inform how they will respond, offering ‘scaffolding’ of individual learning through phased interventions. Students particularly flagged up a desire for authentic learning, relating concepts to ‘real-world’ examples and encouraging them to ‘think like scientists’ (after Roth, 1999).

Particularly emphasized by staff was a broader commitment to promoting student self-regulation and independent learning which was concerned with overcoming passivity and teacher-dependence and to some extent encouraging group work as well as self and peer-assessment. In both the survey and focus groups, students expressed a certain difficulty in visualizing the 'bigger picture' of the course, how different topics of Plant Sciences link and influence each other, as students tend to think of each lecture module in isolation. There is therefore a requirement for constructive alignment, synthesis and throughlines. The course examinations and assessment systems are an ever-present concern for both staff and students, and a rich (and in some aspects, wholly inaccurate) student 'folklore' exists surrounding the examination system, highlighting a greater need for transparency and accountability.

### **Translating the evidence into a VLE**

The most dominant tool utilised within the Plant Sciences VLE is the wiki, which has been used to host lecture notes. The wiki feature allows quick and easy creation and editing of information pages. Within the wiki, the resources are organised by term to make the course structure clearer. Within each term section, students can find their lecture notes with hyperlinks to other relevant areas of the course and a search tool that can quickly show students how a particular topic links to another through common themes. At present, the wiki holds the lecture notes in a format which does not allow student edits, to preserve factual integrity (Tracy *et al.*, 2007), but this format is much more dynamic than the previous online provision of lecture notes as pdf files. This provision of lecture notes in the form of an interlinked network as opposed to a list of discrete files also provides a good platform to link in other online resources as and when appropriate within the lecture material and aims to address themes of constructive alignment, synthesis and throughlines.

The student survey clearly showed that students would like to have access to exemplar answers to exam questions so that they can see the standard that is required of them to gain different grades. Provision of exemplar essays resonates with the themes of making learning explicit, and transparency and accountability. We have provided this in CamTools by embedding annotated past exam essay answers into the wiki and linked them to the terms and lecture notes that they are associated with. The survey also showed that students feel their tutorial time is wasted by testing their recall of facts. As an alternative to this kind of questioning in tutorials, we have developed online self tests that students can complete in their own time. These tests have also been embedded in the wiki at appropriate points, allowing for greater self-regulation and independence.

Other items linked into the wiki lecture notes (which could not be provided by lecture notes in separate files) in response to student opinions include links to

online journal articles as they are referred to, helping to place the lecture topics within the wider Plant Sciences context and thus providing authentic learning. Also embedded were links to online flash animations, video explanations and a tool to display 3D molecular structures to provide greater support for key topics. By constructing the wiki in a logical way and making links between topics explicit, this responds to the students' need for greater transparency in the structure of the course which they identified in the focus groups and also emphasises constructive alignment and throughlines. How the new wiki-based resources map on to the themes identified by the research methods is summarised in Figure 5.

	Making Learning Explicit	Contingent Teaching	Authentic Learning	Self Regulation and Independence	Constructive Alignment, Synthesis and Throughlines	Transparency and Accountability
Links to definitions of glossary words	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Links to related lectures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Links to journal paper references	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Links to relevant websites	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Exemplar and annotated essays	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3D molecular images	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Multiple choice questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Video and animations associated with key topics	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Figure 5:** Mapping of novel online learning resource provision to the emergent themes from research activities.

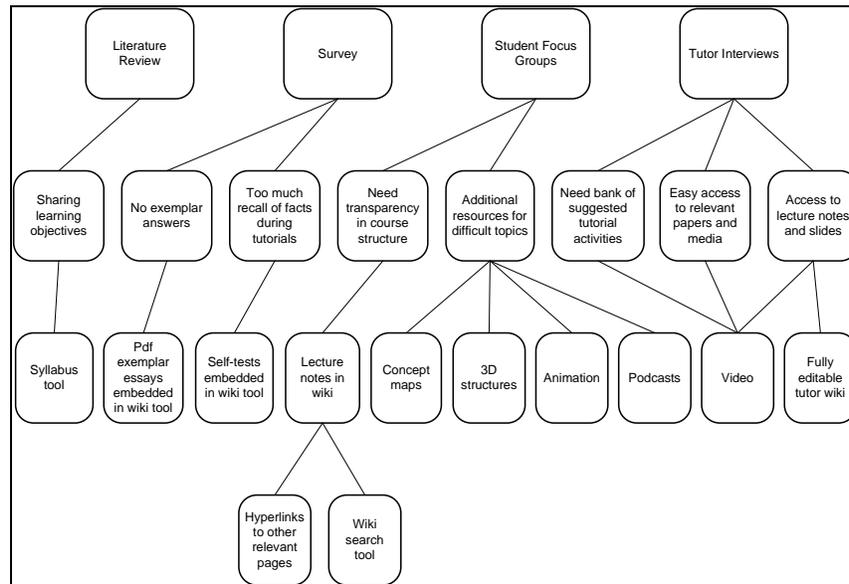
The literature review highlighted 'sharing learning objectives' as an important requirement for successful teaching. Using the syllabus tool in CamTools, students and tutors can access information about the aims and potential outcomes of studying this course. By providing this information we hope to improve understanding about how the course is run and how students will benefit from participating.

During interviews, tutors asked that a resource be provided where they could share ideas for tutorial activities, get easy access to papers and media associated with their topics and access to lecture notes and slides. We addressed this by creating a similar CamTools site specifically for tutors, which provides guidelines on teaching tutorials associated with lecture courses, and all tutors are encouraged to edit and contribute to the site to promote sharing ideas, resources and effective teaching practices.

## Conclusions

Where e-learning and online resources are concerned, there can be a strong temptation to use technology just because it is available. Whilst the Sakai-based CamTools environment run by the University is very rich in electronic 'tools', we wanted to use the environment rationally, and have used an evidence-informed approach to create an online environment which responds to the specific needs of the students and staff on the course.

During the evidence-gathering phase of the project, a number of over-arching themes emerged. Overall, the relationships between research activities, evidence found and online solutions is summarised in Figure 6.



**Figure 6:** Relationships between research approaches, evidence gleaned and electronic resources implemented.

The project is now in an evaluation phase, during which similar approaches – focus groups, student questionnaires – together with electronic site usage

data will be used to assess the success of this tailored approach. Initial feedback suggests the CamTools site has been very well received by students and staff alike, within the Department of Plant Sciences and in even in other Natural Sciences Departments within the university.

## Acknowledgements

The project team would like to thank the staff and students of the Department of Plant Sciences and staff at CARET for their participation and support; and the Cambridge MIT Institute for its funding.

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## **Biography**

Frances Tracy is a post doctoral research fellow at the Department of Plant Sciences, University of Cambridge. Frances conducts research for the CMI funded Plant Sciences Pedagogy Project and the Teaching for Learning Network (TfLN), which provides support for faculties, departments and other groups in undertaking research and development projects with a specific focus on improving teaching and learning in Higher Education.

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