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## Reshaping Academic Practice and Relationships within the Department Of Plant Sciences

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### Abstract

At the University of Cambridge, a research and development project concerned with teaching and learning in small-group tutorials has been initiated in Department of Plant Sciences. Known as the Plant Sciences Pedagogy Project, it is part of the Teaching for Learning Network (TfLN), which includes members of the Centre for Applied Research into Educational Technologies (CARET), the Department of Engineering and the Faculty of Classics.

Provision of small-group tutorials plays a key role in teaching support for students at the University of Cambridge. However, variation in student experience of tutorial quality was raised as a point of concern in a recent student survey (Cambridge University Students' Union, 2004). Our research therefore focussed on analysis of the tutorial environment with the aim of finding out how best to support our teaching staff and to influence changes in teaching and learning practices within the Department. The Plant Sciences Pedagogy Project used a number of qualitative and quantitative educational research methods in order to identify key plant sciences specific teaching and learning issues. These methods included practice-value questionnaires, self-efficacy questionnaires, supervision video analysis, student focus groups and supervisor interviews, which were implemented over the course of two academic years. The research findings were used to inform the development of a number of new learning resources which were provided for students within a virtual learning environment (VLE), or in collaborative workshops. The impact of the implementation of these new resources was assessed in order to inform research and development for the next academic year.

In this paper, we describe the development of the research conducted in the Department of Plant Sciences and also chart the involvement of embedded researchers in the formation of the TfLN. The research structure is initially described in association with action research methodology but it is argued that the format has developed throughout the formation of TfLN so that it is best aligned with theories of social network analysis (Granovetter, 1973). This paper uses the theoretical perspective of brokerage between communities of practice (Burt, 2005; Wenger, 1998) to describe the role that plant science researchers have played in conducting research concerned with initiating changes in teaching and learning practices and also the subsequent co-configuration of the TfLN research community. Burt's (2005) four levels of brokerage are used to structure the discussion of these research processes, and the boundary crossing objects that have been used to support brokerage activities are described.

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## **Introduction**

The Plant Sciences Pedagogy Project was established in 2005 as part of the Cambridge-MIT Institute's Pedagogy Programme. It was initiated as a two-year research and development project concerned with small-group teaching within the Department of Plant Sciences at the University of Cambridge. Research was conducted by embedded researchers in the Department of Plant Sciences in collaboration with associates of the Centre for Applied Research into Educational Technologies (CARET). More recently, additional research partnerships with other departments within the university have been incorporated to form the 'Teaching for Learning Network' (TfLN). This paper seeks to describe the development of the research conducted in the Department of Plant Sciences and also to chart the involvement of embedded researchers in the formation of a newly expanded collaborative research environment through the lens of the theoretical perspectives of social network analysis, brokerage between communities of practice, and liminality.

Research in the Department of Plant Sciences focussed on teaching and learning in small-group tutorials for the second year undergraduate course taught by the Department. At the University of Cambridge, small-group tutorials are known as 'supervisions' and involve between two and four students meeting with a supervisor on a regular basis. In most faculties and departments, supervisors have considerable autonomy in how they conduct supervisions, although they are normally focussed on specific topics, and there are some received understandings about what is likely to occur within them. The resulting variation in student experience was raised as a point of concern in a recent student survey (Cambridge University Students' Union, 2004), and was one of the reasons behind the recommendation of an Institutional Audit that training be provided for new staff (Quality Assurance Agency, 2003).

## **Research aims and principles**

Research was conducted in the Department of Plant Sciences with a view to influencing changes in teaching and learning practices in supervisions. Many aspects of the teaching and learning environment in the Department were not documented so our research initially focussed on analysis of the supervision environment in order to determine how best to support teaching staff and also to enhance opportunities for student learning outside of supervisions. There were a number of specific questions which were of interest:

1. To identify what characterised teaching and learning at Cambridge, particularly in the small-group tutorial setting;



2. To identify effective practices with the potential to improve student experience and learning outcomes, and as a result to inform decision-making by teachers, both as groups and individuals as to how, when and with whom to employ specific practices;
3. To identify potential opportunities for the support, enhancement or extension of learning through the application of new technologies.

Two graduates were recruited from the field of Plant Sciences and embedded within the Department to conduct educational research in association with CARET and more recently within TfLN. These 'embedded researchers' were appointed on the basis of their backgrounds in Plant Sciences, and had no prior formal training in social science research techniques. The role of the embedded educational researcher is ill defined and unusual within the higher education arena. Within research initiatives associated with TfLN, involvement of embedded researchers based in departments has been found to be a highly effective strategy for conducting educational research that seeks to improve the quality of the teaching and learning conducted in a University environment.

This form of "real world" research conducted with a view to bring about social change has been described in the broadest sense as action research (Bogdan and Biklen, 2003). The structure of our first cycle of research also aligns well with Elliot's (1991) description of the fundamental aim of action research as being 'to improve practice rather than to produce knowledge.' This includes initial processes of planning, followed by implementation and then finalisation, with a review of the impact and efficacy of the research project. Different research initiatives were implemented for the Plant Sciences Pedagogy Project over the course of two years, including steps which formalised periods of consultation and co-interpretation of research findings with teaching staff and students. The research program was conducted in an iterative cyclical manner to allow for continual re-assessment of the research focus and aims (Figure 1.).



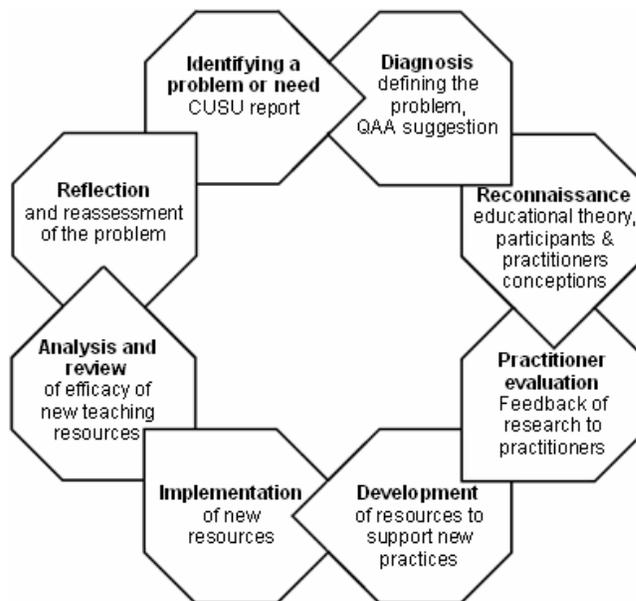


Figure 1: Plant Sciences Pedagogy Project Cyclical Research Structure

However, this is not to say though that our research fits into all classifications of action research. Involvement with TfLN enabled us to conduct our research in a flexible environment, unconstrained by traditional descriptions of research methodologies. The research used participatory approaches to engage teaching practitioners and students in the research process. The project itself was conducted collaboratively with members of the Department of Plant Sciences and developments were implemented as support for teachers as well as the teachers themselves making changes to their own practices. Our research structure has developed along with TfLN, such that it is currently best described in terms of social network analysis as a strongly-tied community which allows members to flexibly assign their own roles and responsibilities (Granovetter, 1973; Irvine and Carmichael, 2007).

### **Communities of practice**

Research Associates (as embedded researchers) in the Department of Plant Sciences have undergone a process of development throughout the two years of their collaboration with CARET and TfLN, which could be viewed in the light of the theory of brokerage between different communities of practice (Wenger, 1998; Burt, 2005). According to Wenger (1998), communities of practice are formed as groups of people pursue shared enterprises over time. Each participant in a community of practice finds a unique place and gains a unique identity, which is both further integrated and defined in the course of engagement in practice. If each community of practice is surrounded by a notional boundary then as links are made between different communities this can be described as boundary crossing, which is led by individuals conducting the process of



brokerage. Therefore, brokerage is carried out by individuals who can introduce elements of one practice into another. Wenger (1998) furthermore describes brokerage as a process of 'translation, coordination, and alignment between perspectives', but these processes could be viewed as progressively sophisticated, in that only the most successful brokerage will lead to the production of new shared meanings across the boundaries of several communities of practice. This view is developed by Burt (2005), who describes four levels of brokerage through which value can be created by filling 'structural holes' between different groups or networks of people. This framework of levels will be used in this paper to describe the different stages of brokerage associated with both inter- and intra-departmental communication, and in the formation of TfLN.

### **Development of brokerage skills throughout the research cycle**

The two embedded researchers appointed to the Plant Sciences Pedagogy Project found their strong academic and educational backgrounds in Plant Sciences to be valuable for communicating and collaborating with students and academics in the Department. However, translation into the educational research arena involved moving away from their post-positivistic view of research and experience with highly quantitative research methods towards gaining an appreciation and understanding of research conducted with a constructivist perspective that includes the use of qualitative research methodologies.

An evidence base was initially constructed for use as the basis of discussions with teaching staff, and to aid in the development of interventions and changes in practice. To this end, a wide range of data was collected in the course of the project with the intention of documenting teacher and student perspectives on current practice and potential areas for development of that practice. A mixed methods approach was used including questionnaires, video observation, focus groups and interviews with staff and students. Throughout the research cycle, weekly meetings were held with educational researchers and information technologists at CARET where both staff and student perspectives were communicated to members of different communities. All of these activities could be classed as Burt's first level of brokerage, which involves making 'people on both sides of a structural hole aware of the interests and difficulties in the other group' (Burt 2005).

Brokerage of this description was carried out by researchers with a relatively limited understanding of the practices occurring in different communities. Rather than this being a restriction for communication, it could be argued that acting as legitimate peripheral participants in several communities created an ideal situation for transferring ideas or practices between them (Wenger 1998). Another description for peripheral participation is the concept of liminality, which



has been described by Turner (1977, 1982) as the notion of being 'betwixt and between' social structures. More recently this notion has been adapted in the field of management and organisation studies to be used in a more metaphorical sense and applied to the position of temporary workers in organisations (Garsten, 1999). An increasing reliance on transient workers to create knowledge collaboratively, causes learning to occur at the limits of organisations within networks and teams that cross organisational divides (Tempest and Starkey, 2004). It could be argued therefore that occupying a liminal state within the fields of Educational Research, Information Technology and Plant Sciences maintained our freedom to translate, coordinate and align the research objectives between them (Garsten, 1999).

As the evidence base was established during the initial stages of the research cycle, an analytical framework emerged from the analysis of data, which was used to categorise and triangulate findings from research methods and to link with key themes and concepts relevant to teaching and learning in higher education (Irvine and Carmichael, 2007). This framework was then instructive in supporting the second level of brokerage, described by Burt (2005) as 'seeing how a belief or practice in one group can create value in the other'. A summary of the evidence relating to student perspectives of the teaching environment was presented to teaching staff at the practitioner evaluation stage of the research cycle and used to stimulate discussions about interventions and additional support that could be put into place to meet student needs. The framework was used to structure the feedback of evidence to teaching staff, highlighting a number of associated educational theories and concepts as well as their potential for integration into new teaching practices.

In response to these discussions, new resources were developed to support student learning and teaching staff. A major outlet for the dissemination of this support has been through a virtual learning environment (VLE) called CamTools, which was adapted by CARET to the University of Cambridge environment and populated by Plant Sciences Pedagogy Project researchers in the Department. Design and population of the VLE was directed by analysis of student and staff needs and was influenced by discussions with learning technologists at CARET and other VLE users at conferences or within the University. Many of the electronic resources in the VLE were developed collaboratively with teaching staff and researchers within Plant Sciences. The authentic nature of these themes has made them useful tools for organising the dissemination of research findings to staff and students, where they were found to effectively stimulate discussion in workshops, focus groups and interviews. They thereby acted as intra-disciplinary boundary crossing objects making links between different tiers of the academic environment. A number of workshops were run in order to provide support to staff and students about key issues that were highlighted within this framework, such as the provision of formative feedback. The grounded and



clearly applicable nature of the framework themes within the higher education arena fostered the commitment of researchers to use them to create direction in their research and development efforts.

During the final stage of the research cycle a process of analysis and review of the impact of provision of teaching and learning support was carried out. Comparisons of student values and self-efficacy beliefs at the beginning and end of two academic years showed increases in student confidence for a number of plant science specific concepts and the development of a deeper level of understanding. Teaching staff reported appreciation for the provision of environments in which they could discuss teaching practices and share ideas as well as experiences. Student recruitment and retention numbers have also shown a marked increase, which is a particularly powerful outcome to report to back to all members of the Department.

### **Brokerage within TfLN**

Expansion of the TfLN research community to include additional embedded researchers within other departments necessitated the development of skills associated with Burt's (2005) third level of brokerage, 'drawing analogies between groups ostensibly irrelevant to each other'. Again the analytical framework was valuable at this stage to create a structure for the alignment of research aims and issues between the different departments. For example, although research in the Department of Engineering was directed towards development of new laboratory practicals (in contrast to the aim of developing support for small-group teaching within Plant Sciences) the issue of constructive alignment as an area in need of development within the course was mirrored in both departments. Research tools developed specifically for use in the Department of Plant Sciences were found to be sufficiently well grounded and adaptable to be put through a process of de-contextualisation and re-contextualisation for use in other research projects. These tools were made accessible within a virtual research environment set up for the TfLN, which has supported transfer and collaboration outside of the face to face meeting environment. In this way our collective research in TfLN has moved beyond the sharing of best practices in a process of knowledge reproduction (Sfard, 1998) and has become a driver for innovation and knowledge creation (the 'third metaphor for learning' identified by Hakkarainen et al, 2004).

The fourth level of brokerage described by Burt (2005) is 'synthesis of new beliefs or behaviours that combine elements from several groups'. This process of co-configuration required the embedded researchers involved in collaborative research with members of CARET take on an equal level of responsibility for the development of research objectives and strategies. It is therefore necessary for all team members to have a shared appreciation for certain educational



principles in order to help align collaborative discourse and research themes. Previous academic experiences can influence epistemological beliefs and theoretical perspectives, which in turn can affect beliefs about educational research and potentially create conflict within a mixed disciplinary environment. Viewing our research activity as a process of collective learning, TfLN not only reproduces knowledge from the field of educational research and disseminates it within different contexts, but has also constructed new knowledge and research methodologies to support the development of teaching and learning in higher education (Nonaka and Takeuchi, 1993). This form of brokerage makes use of all the previously described participative and reificative boundary crossing objects, which over time, will be elaborated and contextualised into a variety of different forms.

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