Disciplinary patterns in adoption of educational technologies

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Abstract

In UNSW a cross-discipline Fellowship in Innovating Teaching and Educational Technology (ITET) sought to build communities of practice that would transform the University's learning and teaching practices and systems. One cohort of 21 ITET Fellows provided cognitive maps of their strategies for using educational technology as they entered the programme. Analysis of the maps showed that academic discipline affects both the way that educational technology is perceived and the resulting strategies for its use. There are implications for educational support staff, in that their own professional knowledge and values may clash with those of the teachers they are working with. There are also implications at institutional level, in that the optimum mix of central and discipline-based support may vary across institutions and from one institution to another.

Context and background

The University of New South Wales (UNSW) in Australia is a large metropolitan campus-based university, with major research and teaching activities in areas such as medicine, commerce, engineering and the applied sciences. UNSW is a research-focused university in which campus-based study is the norm, especially at undergraduate level. Nevertheless, the use of online learning is rising steadily, from 17,000 student registrations in October 2001 to almost 50,000 in 2004.

UNSW's strategy for improving its learning teaching has included an initiative to bring together teachers from different disciplines who are interested in using educational technology to address teaching quality issues in their disciplines. Between 2001 and 2004, there were four full-time 6 month Fellowships programmes in Innovative Teaching & Educational Technology (ITET). These were centrally funded as a strategic initiative at institution level, providing a total of 66 Fellowships. In 2004–5 a fifth programme, this time funded by Faculties themselves, is a key component of UNSW's programme to develop an integrated eLearning system.

Evaluations of the Fellowship have shown that it is making a substantial contribution to organisational change. However, this is showing results faster in some parts of the organization than in others. The evaluations also showed that cultivating interdisciplinary communities of practice in educational technology, although essential, is no trivial task and may have its limits.

The study reported here forms part of one cycle of an action research approach to evaluating the impact of the ITET Fellowship as a whole. This paper addresses a specific question that emerged from an earlier cycle involving analysis of textual data from previous Fellowship discussions. Discipline differences appeared to be potential barrier to the building of new communities of practice around educational technology, and there was a need to know more about how disciplinary factors are influencing the early adopters who form the core of our new communities.

Each participant is coming from, and returning to, a different disciplinary environment, with different constraints and opportunities. So, although we can document the Fellowship as a process and its overall outcomes, the links between the process and the outcomes are complex. The relationship between discipline and educational technology was one of the components analysed in a study of the strategies of individuals in the fourth Fellowship group.

Theories on discipline differences

In *Academic Tribes and Territories* Becher used data gathered in the 1980s across several institutions to develop a model of the relationship between disciplinary social organization – the tribes – and the types of knowledge they work with – their territories. Disciplinary knowledge can be described in terms of a hard–soft spectrum. Generally, science and engineering would be placed at the 'hard' end of the spectrum and the arts and humanities at the 'soft' end. A second dimension is the pure–applied spectrum. Figure 1 shows an example of how different disciplines might be placed in this framework. The placing and configuration of disciplines will vary between institutions. (Becher & Trowler, 2001).

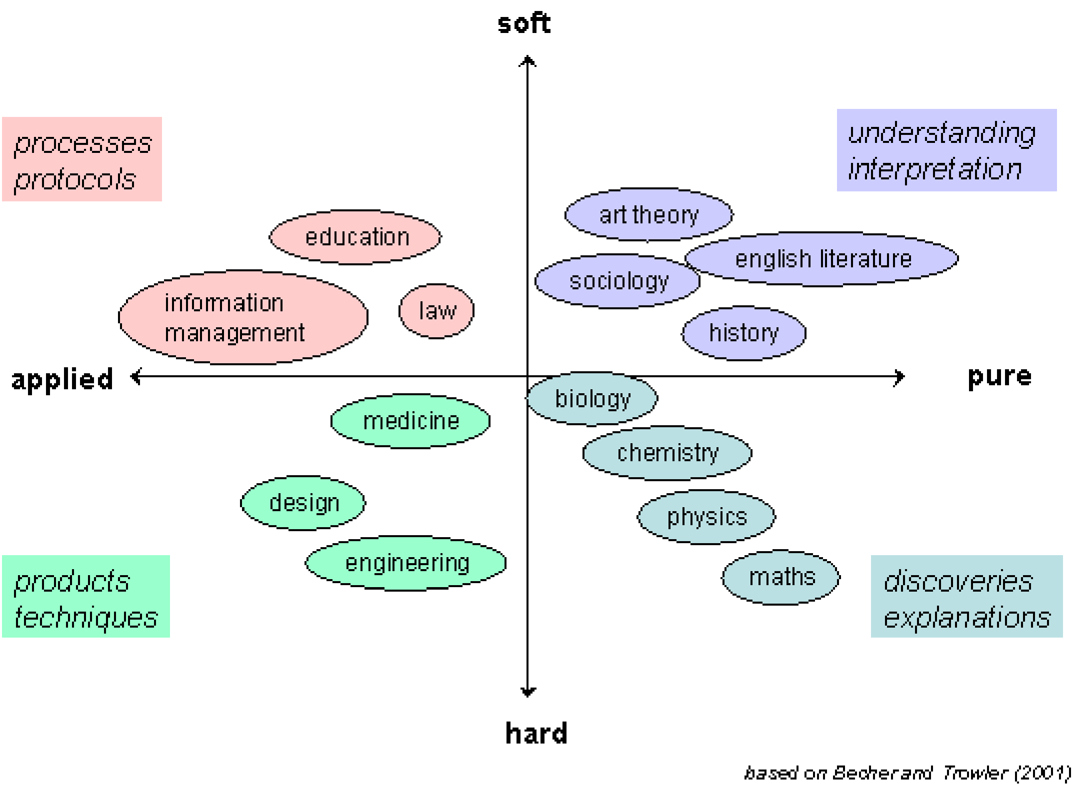

Figure 1. Knowledge territories

Becher and Trowler also note patterns in the relationships between disciplinary knowledge and the way the different disciplinary communities organize. For example, they contrast organisation and communication processes in 'urban' and 'rural' disciplines. In urban disciplines, such as 'big science' many researchers share a single specialist area, communicate frequently and work in large teams. In rural disciplines specialisms rarely overlap and researchers often develop their own niche specialism. Timescales for sharing and publication are much longer, and communication is less frequent. Figure 2 illustrates this.

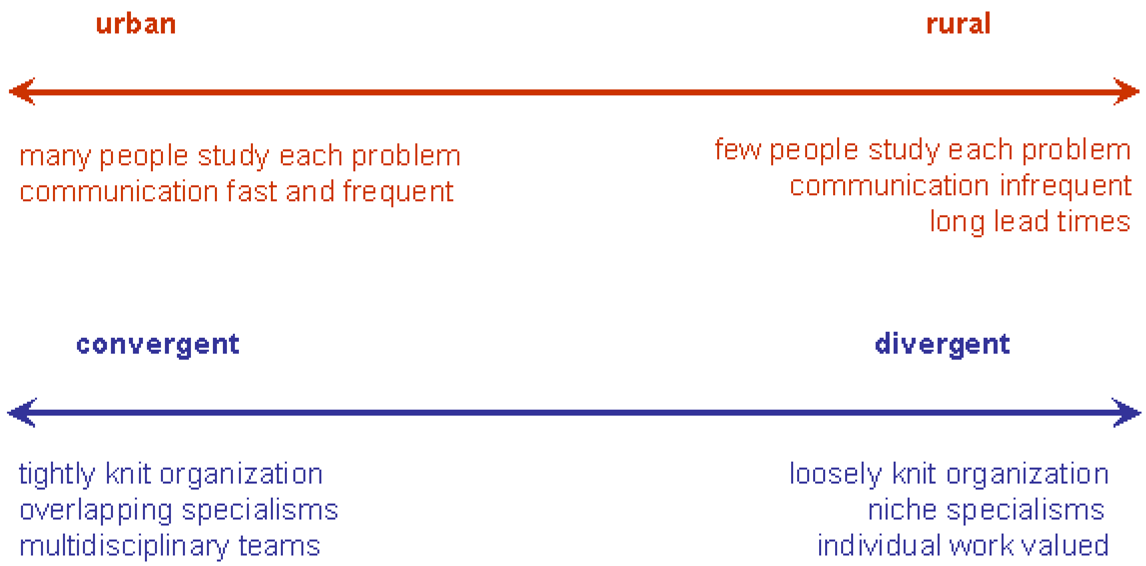

Figure 2. Characteristics of academic communities (tribes)

The use of these dimensions (hard/soft, pure/applied, urban/rural, convergent/divergent) to characterize a discipline context is, like all models, a simplification of a much more messy, complex and context-specific reality. Nevertheless Becher's model is a way of mapping out and understanding the links between knowledge structures and social processes such as power and language. As such, it provides useful framework for exploring how the patterns of disciplinary knowledge and organization affect the adoption of educational technologies.

For example, we might observe that in general scientists and engineers are more comfortable with the concept of digital learning objects than academics from the humanities. For the former, knowledge and learning are about, or even embodied in, physical objects. For the latter, knowledge and learning are individual or social processes.

Each academic community has tacit knowledge, both technical and personal. The discipline environment also shapes individual decisions and career options. All of this will influence how individuals and groups approach online learning and educational technologies in general.

There are arguments for creating a commonly understood discourse that can make explicit the various disciplinary teaching and learning regimes – and their differing concepts of identity, tacit assumptions, codes of significance, rules and recurrent practices. Unless these are surfaced and acknowledged, they cannot be changed (Trowler & Cooper, 2002). The ITET Fellowship is based on an assumption that introducing new educational technology can be a catalyst for innovative approaches to learning and teaching. A precondition for its success will therefore be that tacit knowledge about learning and teaching is indeed surfaced and shared through a common language (codified) during the Fellowship programme.

Work in another context – that of cardiac surgery teams in hospitals across the USA (Edmondson, Winslow, Bohmer, & Pisano, 2003) – confirms that the balance between tacit and codified knowledge influences performance with new technologies. The same general conclusions about the differing roles of early and late adopters within a professional community could be applied to teachers in higher education.

However, sharing knowledge and ideas about learning and teaching among diverse disciplines can be hard work. (Perkins, 1999) notes that disciplinary knowledge can be troublesome, in that it can be inert (unused and unconnected to experience), ritual (routine and meaningless), conceptually difficult (counter-intuitive) and foreign (from an unfamiliar perspective or culture). The complexity of disciplinary learning environments includes 'threshold concepts' within disciplines – ideas that lead to a qualitative and irreversible change in understanding and subsequent learning and behaviour (Meyer & Land, 2002). These concepts integrate and transform previous knowledge and may sometimes even lead to a transformation in personal identity. When threshold concepts are part of tacit knowledge – unexamined understandings shared within a community of practice (Wenger, 1998) – this can be particularly troublesome.

Even highly educated university teachers are likely to experience other disciplines as troublesome in these ways. In order to engage with each others' teaching issues they may have to engage with threshold concepts, without which it is impossible to understand the purpose or meaning of a body of knowledge (Meyer & Land, 2002).

Educational technology developers are also part of this problem. Writers on educational technology often explicitly promote a cognitive constructivist perspective – for example Jonassen et al. (1993). Applied to staff development in university teaching this would imply that we acknowledge and respond to teachers' experiences, rather than simply require that they abandon their previous views in favour of a new orthodoxy. But in some disciplines, where there is a strong positivist tradition and a well established body of knowledge, the value of constructivism is sometimes questioned, for example in arguments against 'discovery learning' of science and mathematics (Matthews, 2002). In a more pragmatic approach to constructivism, which uses different processes for different kinds of knowledge, 'teaching by telling' may have its place (Perkins, 1999).

The literature confirms earlier experience with the ITET Fellows; that the characteristics of discipline knowledge and disciplinary communities are a key influence on learning and teaching practices. It is therefore likely that they will also affect teachers' choices in adopting educational technologies.

Methodology

The influences on university teachers adopting new technologies are highly context-specific. Becher and Trowler (2001) note that the configuration of university disciplines is also institution-specific. The pace of external developments, for example in Australian government policies affecting higher education (Nelson, 2002a, 2002b, 2002c; Nelson., 2002; NOIE, 2002, 2004; Spring, 2004), means that influences are also highly time-specific. It would therefore be neither possible nor appropriate to explore this question using a large-scale long-term quantitative study across numerous institutions, with positivist methodology and statistical analysis, such as that done by Edmondson et al. on new technology in US hospitals (2003).

Here a qualitative approach is used to elicit context-specific motivations and strategies among one group of early adopters, at one point in time. The researcher is an active participant in the context rather than an external observer, and the data collection method is designed as part of this context.

Data collection method

The data for the analysis reported here are cognitive maps produced in interviews with all 21 ITET Fellows who were about to start the Fellowship programme in 2003.

Cognitive mapping is often used as part of a strategy development process in organisations. It is a way of eliciting and representing visually how individuals perceive influences in their environment, and form their decisions and plans. The interviewee defines separate concepts (events, goals, processes, etc.) that they believe are influential; in this case in relation to their reasons for exploring new educational technologies. Then they specify the causal or influence links between these, in terms of what might help or hinder each event, process or goal.

In this context, cognitive maps are appropriate because:

- The maps are a visual representation, more suitable than (linear) spoken or written text, for describing the multiple influences in individual thought and action.
- The participants can articulate and think through complex tacit connections during the interview. So the interview itself helps to develop and clarify strategies for using educational technology, by making the tacit connections explicit.

The process therefore allowed for exploration and recording of the connections between the participants' disciplinary knowledge, their departmental context and their use of educational technology.

Each interview took an hour, with the mapping process taking 30–45 minutes of this. At the start each participant was given a sheet listing pedagogical and organizational issues that Fellows had raised during previous programmes, from which they could, if they wished, select a prompt for discussion of their own issues. The issue list came from thematic analysis on transcripts of previous discussions among ITET Fellowship groups, and represented the full scope of issues already raised. Each map was created live during the interview, using Decision Explorer software, with the interviewee providing the concepts and deciding how to link them; prompted by questions and using a 'laddering' process to elicit influences and goals at different levels (Eden & Ackermann, 1998).

During the mapping, the interviewees identified which concepts were about their:

- discipline environment
- actions they had taken or would take
- capabilities they had or sought
- their own values and beliefs
- their professional identity or role.

These categories were based on a simplified version of Dilts' model for eliciting the structure of personal strategies (Dilts & Bonissone, 1993). Most interviewees had little difficulty in specifying categories, although one or two maps left a small proportion of concepts uncategorized. Giving each category a different colour and shape created a clear visual pattern, which helped the participants to engage with manipulation and development of the maps.

Analysis of maps

In an action research context such as this, the researcher starts with a great deal of background knowledge, and with personal knowledge of the participants in the study. While this aids the interpretation of intentions as expressed in the maps, it is also a potential source of contamination during qualitative analysis that involves recognition of patterns. The use of the mapping and spreadsheet software functions rather than visual interpretation of the whole maps served as a check that the analysis was based on genuine patterns in the maps themselves, rather than any preconceptions on the part of the researcher.

The analysis of discipline influences upon the adoption of educational technologies, drew on the Becher 'tribes and territories' framework – which can be represented as a 3-way mutual set of influences between knowledge, community and individual (see Figure 3).

Analysis of earlier ITET Fellowship discussions helped to identify the scope of the discipline characteristics that would be relevant using.

disciplinary knowledge prioritized – e.g. whether skills or concepts

discipline/department characteristics – e.g. colleagues as having less interest in IT, resistance to change, research prioritized over teaching

individual role/motivation – e.g. intrinsic or extrinsic motivation, established in role or new member of department

focus of interest in educational technology – e.g. own use or department, pedagogical or practical.

The resulting model for analysing the maps includes all the influence links shown in Figure 4.

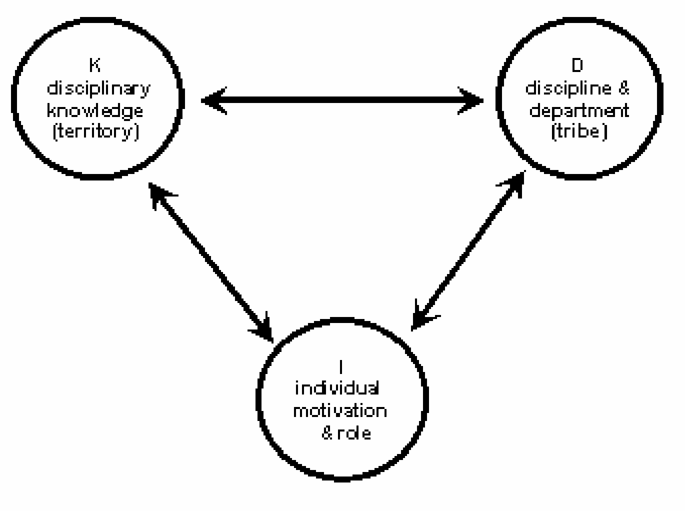

Figure 3. Mutual influence between knowledge, community and individual

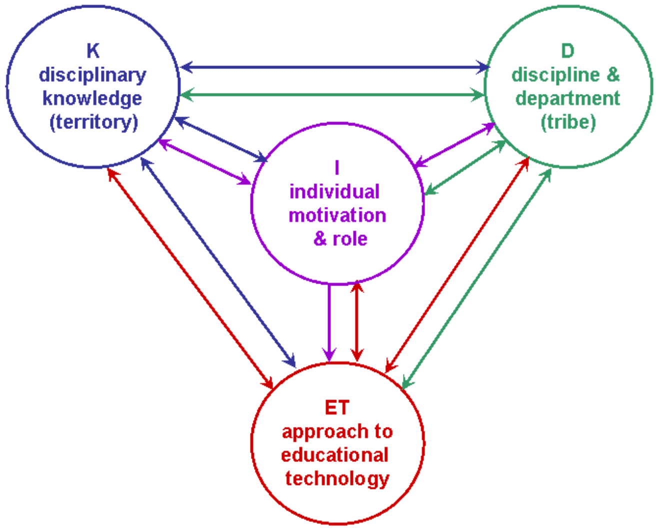

Figure 4. Map analysis framework

Map analysis involved:

- going through all the maps individually and summarising the strategies represented, in terms of the model shown in Figure 4
- identifying common patterns in the nature of the concepts, and the links between them, using the analytical tools in the mapping software
- grouping strategies showing similar patterns
- identifying which of the four broad discipline knowledge categories were represented in each group.

Applying the model

The first step was to go through the maps, re-coding by colour each of the concepts as referring to one of the four areas of concern shown in Figure 4. Each map then represented an individual's strategy as network of paths through these towards a goal in one area, or perhaps several goals. For example, an individual (I) has an intrinsic interest in how students acquire disciplinary knowledge (K) and belongs to a department (D) that is looking for more efficient use of teaching resources. These combine to motivate the individual (I) to explore educational technology (ET) as a way of helping students to gain core disciplinary knowledge (K). In this example, the main goal is related to disciplinary knowledge.

Representing the strategies in this way allowed analysis of the maps for:

the distribution of concepts among the four areas of concern

the issues represented in each area

the number and density of links between them in the maps.

To look for patterns in the way that discipline knowledge and organization together shape the adoption of educational technologies, the individual dimension was excluded. This halved the number of links to consider and made interpretation easier – see Figure 5.

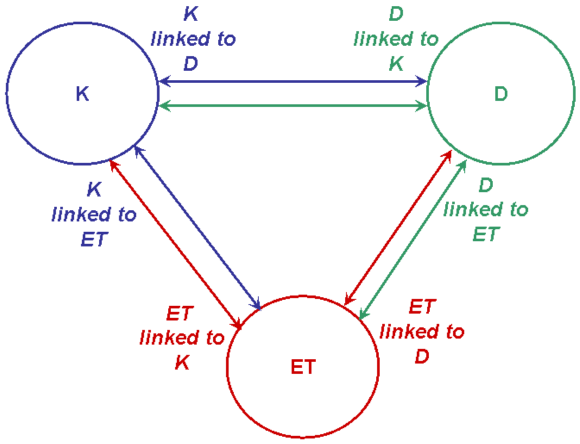

Figure 5. Map interpretation simplified by removal of individual dimension

Two ways of summarising each map provided a basis for identifying disciplinary patterns

lists of the concepts that were linked in the ways shown, generated using the mapping software and exported into a spreadsheet

a small summary chart showing the numbers of each type of concept and link.

By using both of these together, and where necessary referring to the complete map for clarification, it was possible to identify similarities between maps and group them accordingly.

Results

Patterns emerging

Table 1 is a textual description of the common strategy identified in each group, showing the discipline categories represented.

Table 1. Strategy groupings identified

Group	Generic strategy for use of educational technology
1 (2 hard applied)	External changes in the profession (industry and student context) mean that students are now missing out important experiential learning. Educational technology can provide substitutes for this learning.
2 (2 hard applied)	There are external changes in the profession (industry and student context) and internal changes in the department (class sizes, resource constraints). IT has become a required skill in the discipline. As teachers we need educational technology resources to help students learn effectively in this context.
3 (2 hard applied)	Understanding of information technology is central knowledge for students, who also expect to use it for learning. We already use educational technology and are seeking educational knowledge to do this better.
4 (3 hard applied)	We have a responsibility as teachers to give all students skills and choices. By providing new learning media, educational technology can enhance students' skills development and can expand their access to study options.
5 (1 hard applied)	Internal (department and curriculum) changes could result in my specialism being under-represented. Educational technology can help to make the subject more engaging to students, and perhaps attract more people into the discipline.
6 (3 soft applied)	External (technological or industry) changes are redefining professional knowledge and skill requirements. New approaches to professional development are needed, for students or colleagues.
7 (3 soft applied)	The development of some core knowledge requires faces-to-face discussion; whereas other skills can be developed elsewhere. Students are not learning enough in the class. Using educational technology for skills development and delivery of information will free classroom time and improve classroom learning.
8 (2 hard pure + 1 soft pure)	Students are not engaging with core concepts. Interactive media can help students to engage with core concepts. The availability of resources for teaching innovations is an issue within the department.
9 (2 soft pure)	Knowledge is created through research, and students need to develop research skills. I can demonstrate to others the value of educational technology for carrying out and communicating research.

The nine groupings that emerged from the detailed analysis of map links were, with one exception, sub-groupings of the four discipline categories. Commonalities occurred more in the nature and density of interlinking between areas than in its causal direction – perhaps indicating an inherent limitation in using a causal mapping process to represent an individual's strategy for systemic interactions within a complex environment.

Discussion of results

Patterns in strategies for adopting educational technology

Strategies1–4 all occur in the hard applied disciplines in which, according to Becher and Trowler, academics are likely to be more influenced by pragmatic and industry concerns than by internal disciplinary norms and processes. Educational technology is a tool to solve practical problems in teaching, and its use is not separate from the development of core disciplinary knowledge – which is itself about products (including hardware and software) and techniques (including use of computers). The different generic strategies identified correspond broadly to Faculty and School groupings. However, some might also be explained by differences between established teachers, well integrated into their departmental cultures, and those newer to the department. The one exception to this is strategy 5, where educational technology is used to defend the status of specialist knowledge, as a way of dealing with departmental change. This may relate to some of the change responses described by Knight and Trowler (2000).

Strategies 6 and 7 both occur in the soft applied disciplines. The acquisition of skills is a common component. Strategy 6 focuses on professional issues, with little explicit mention of the role of educational technology. This may mean that the role of technology as a tool is implicit, or that it is merely a tool for acquisition of knowledge, and not considered to be part of the knowledge. Strategy 7 explicitly identifies educational technology as a way of freeing classroom time for important knowledge. The technology is treated as external to knowledge, which is about what people do and how they do it – processes, protocols and procedures.

Strategy 8 includes both maps from the hard pure disciplines. It focuses on concepts and an established body of knowledge. In UNSW the hard pure disciplines are all part of the Faculty of Science. Most provide service courses for large numbers of students from applied disciplines in Science and other faculties. This is a substantially greater challenge for teachers than teaching students who are majoring in their own discipline. One of the maps from a pure discipline categorised as soft, also shows this pattern. The common factor could be a body of accepted disciplinary knowledge, including several of the Meyer and Land (2002) 'threshold concepts' which need to be explained to students before they can use them to shape interpretation or discovery.

Strategy 9 occurs in the soft pure disciplines. Knowledge is defined by research practice. Information and educational technologies can be useful in this context; as tools for accessing information rather than as medium for developing new knowledge. However in soft pure disciplines, technology is not necessarily used as a research tool. Where the discipline/department cultures are 'rural', as is common, researchers will be free to pursue their own methods and priorities with relatively little pressure to adopt new technologies. Younger researchers may create new niches using new technology, bringing change longer term. But the various disciplinary imperatives for adopting educational technology, present in other discipline categories, do not exist to the same extent in the soft pure disciplines.

Discipline distributions

The distribution of discipline groups represented in the data was:

hard applied – 10 maps

hard pure – 2 maps

soft applied – 6 maps

soft pure – 3 maps.

Comparing this mix with the overall mix for all ITET Fellows, a sample of 65, showed that this group is typical of the ITET Fellows as a whole. A check against (rough) figures for staff by discipline across UNSW, applying the same categorization criteria, showed over 75% of staff are in the hard applied disciplines (see Figure 6). The ITET Fellows are therefore more evenly mixed by discipline than the institution as a whole, probably as a result of a selection process which sought representatives from all discipline areas in each group.

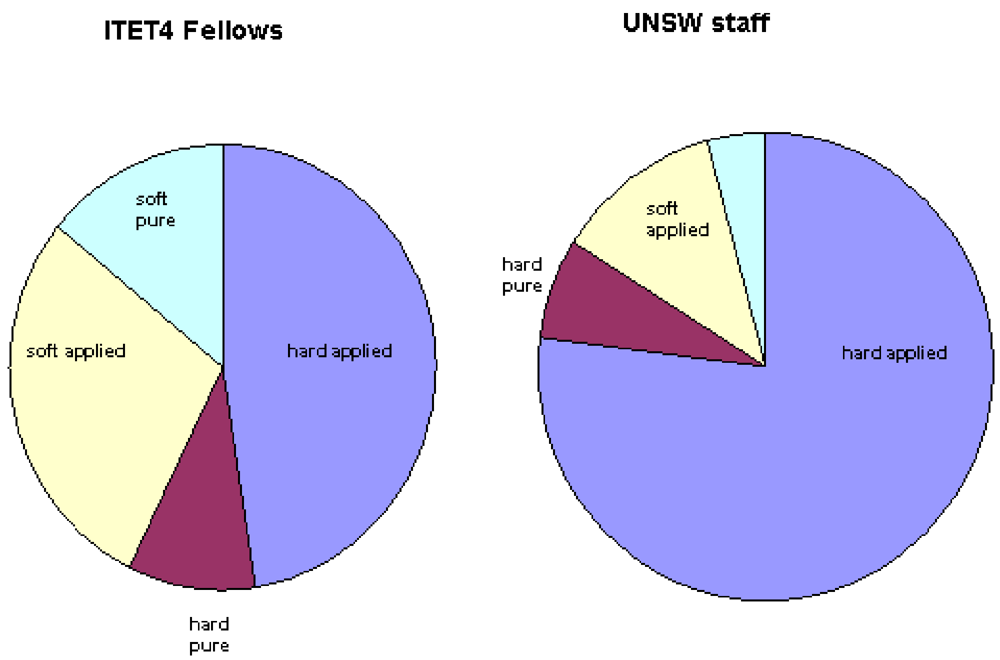

Figure 6. Discipline distributions in sample

Significance

Using the framework in Figure 4 did show up some disciplinary patterns in the strategies for use of educational technology. Although the sample is too small to be statistically representative of disciplines in general, or even within the institution, interpreting the results in relation to Becher's model confirms that disciplinary background does influence how and why an academic seeks to use educational technology. The configuration of disciplines and curricula within an institution, for example service teaching relationships, also seem to influence priorities for use of educational technology.

This is significant if we are seeking to establish cross-discipline communities of academics who use educational technology, in that it shows some of the different perspectives that will need to be addressed in developing a common language.

Implications

Implications for educational developers

Professional educational developers will also be influenced by their disciplinary backgrounds. A cognitive constructivist perspective, for example, might be classified as 'soft applied' knowledge. This could lead to prioritizing discursive activities and communication skills. In a distance education setting, the online environment has been able to provide this, and much of the research in online learning is based on distance study, for example (Salmon, 2000). However, in a campus-based university, the soft applied disciplines may prioritize classroom interaction, and see the online environment as merely a way of finding and transferring information and not as a core learning medium.

Educational technology has a more central role in the hard disciplines, where, on-campus or off-campus, it is a medium for developing knowledge – but a type of knowledge in which discourse is less important than acquiring practical skills and working with established concepts. Online learning is easily accepted; but the value of online discussion and groupwork may be questioned, despite its potential for developing the written communication and teamwork skills required by future employers. Educational developers coming from hard applied discipline traditions may therefore tend to focus on developing sophisticated media as conceptual tools, at the expense of realising the potential of the online environment for developing the 'softer' skills, such as teamwork and interpersonal communication, which remain tacit.

Perkins' (1999) pragmatic approach to constructivism would imply that educational developers accept disciplinary differences in the adoption of educational technologies – rather than promote 'one-size-fits-all' solutions which fail to meet context-specific needs. As noted above, this can involve hard intellectual work, in understanding what, exactly, these needs are. It also raises a question about how to use the technology to extend and enhance learning processes rather than simply reinforcing current teaching practice.

Implications at institutional level

One desirable outcome of the ITET programme would be a greater institutional awareness of, and ability to manage, diversity in disciplinary approaches within a common learning and teaching strategy. If individual teachers are to act as change agents in this process, they will require some metacognition of where their own discipline fits into the bigger picture. A shared language of learning and teaching is only part of this. It also involves a willingness to engage with the learning needs of other disciplines – especially in the context of service teaching for other disciplines with different cultures and knowledges.

Institutional support for educational technology development may involve a central unit or faculty-based units, or a mix of both (as in UNSW). The diversity and mix of disciplines across the institution are relevant both to the degree of devolved support required and the nature of central support. Should central funding be allocated mainly for developing skills in facilitation of online discussion and groupwork, or for developing digital media to aid conceptual understanding? These involve staff with different skills sets, who will inevitably have their own professional priorities. Disciplinary tribes and territories are relevant here too.

Another institutional (and disciplinary) variable is the number of distance programmes and students. Although campus-based, UNSW has a number of distance study programmes, particularly taught postgraduate or professional development studies. Distance programmes can help to introduce innovative uses of educational technology in disciplines that would otherwise fail to see their potential for campus students. For example, online discussion may be introduced as a substitute for classroom tutorial discussion for distance students. The teachers then gain skills, and experience educational benefits, which they come to realise are also valuable for campus-based students, as was the case for one of the ITET Fellows (McAlpine & Ashcroft, 2002). Where there is no such experience of distance education, the use of educational technology may initially be limited by disciplinary influences and assumptions.

Conclusions

The use of cognitive mapping to explore the relationship between academic discipline and strategies for the use of educational technology revealed some significant patterns. This showed that the framework developed by Becher and Trowler (2001) to describe disciplinary influences in academic communities can help in understanding a teacher's initial priorities for use of educational technology.

The study provides some evidence in favour of specialist educational development support for particular disciplines, in order to engage with local needs, cultures and priorities. However, the literature suggests that there is also a need to work through discipline differences; to develop a broader common language for codifying and sharing understanding of the benefits of educational technology. Without such codifying and sharing, the potential educational benefits may not be fully realised.

The participants in this study were about to take part in an intensive cross-disciplinary Fellowship programme. A similar analysis of their strategies after the end of the programme may show to what extent they were able to share and develop their ideas for use of educational technologies to improve student learning.

Evidence of discipline differences in this context could help to inform the work of educational technology developers elsewhere. Discipline differences are also relevant at institutional level. The way academic disciplines are configured in a university will have a bearing on decisions about which educational technology support services are centralized, which are devolved, and what cross-discipline initiatives are feasible. The presence of distance programmes may also influence openness to new technologies and practices. There is therefore no 'one size fits all' solution, and this study has identified some of the factors that could be significant in optimizing each university's strategies for developing its use of educational technology.

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