A framework for conceptualising the impact of technology on teaching and learning

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ABSTRACT

Although there is great interest, and considerable investment, in adopting technology within Higher Education, it is less clear what this change means to the people who implement or experience it. Presently, there is no consistent framework used to study and explain this phenomenon. In this paper, we propose a framework that can structure and guide work in the area. Work carried out as part of a Kaleidoscope-funded project (see Price *et al*, 2005) to explore the impact of technology, providing an overview of current research in this area is described, outlining a framework of approaches to researching this topic, and providing an example of empirical work that fits within this methodological framework. Findings from the case study reported here focus on the role that models of teaching and learning play in the process of technology adoption and will be used to elaborate on the themes emerging from the review of existing research. The paper will conclude by considering the framework's role as a foundation for further work in this area.

Keywords

Impact of technology, Teaching roles, Teaching practice, Conceptual framework, Higher education

Introduction

In the current educational climate new promises of technology for education or teaching and learning are widespread. Such prospects can lead to policy decisions about technology adoption being based on rhetoric or assumptions about the effectiveness of technology. In addition the rapid advancement and changing potential of technology further complicates the value of such assumptions. Such policy decisions have far reaching implications but we know little about the actual impact of this on teaching and learning in higher education (Conole, 2002).

Understanding the impact of technology-enhanced learning for staff in higher education is important if better-informed decisions are to be taken about how and why certain technologies can or should be adopted for teaching and learning. By understanding these aspects the process of technology implementation and adoption can take on a form that is more likely to be successful for those that it is aiming to support (namely the teachers and learners). Furthermore, understanding impact informs us about the value of technology for teachers (and learners), informs the design of technology, and suggests ways in which technology implementation can be supported, both from a technical point of view and for personal support.

Since the adoption of any given technology will be influenced by how it disrupts existing practices, it is important to understand how technology changes teaching roles and practices in order to ensure that we make *wise* use of technology (Lea, 2001) by: *(i)* informing educational policy, *(ii)* informing staff development, *(iii)* understanding the best to way to integrate technology into teaching, and *(iv)* informing technology design.

To pursue this agenda, a Jointly Executed Integrative Research Project (JEIRP) was funded under the Kaleidoscope Network of Excellence (http://www.noe-kaleidoscope.org/). The project sought to explore the notion of 'impact' in relation to the adoption of technology, and specifically, to relate this to roles and practices in higher education. The principle outcomes of this project included (i) a review of the literature, (ii) the development of a conceptual framework consisting of a model of 'impact',

linked to methodologies suitable for studying this topic, and (iii) examples of empirical work. Each of these will be considered in relation to the wider research field in the sections that follow.

Background

Many commentators argue that technology can transform educational practice, typically as an element of wider organisational transformation such as the development of mega-universities (Daniel, 1998) or as a consequence of competition in international educational markets (Hannah, 1998). Others have taken a less deterministic position, but see a link between technology and changing educational practices such as the creation of more flexible opportunities for learning (e.g. de Boer & Collis, 2005). Clearly, technology is associated with changes in practice but the nature of this association is complex and contested, not least because it forms just one influence amongst many upon academic identities (see, e.g., Henkel, 2000 or Taylor, 1999). Where the influence of technology is studied, it is primarily in terms of novel or innovative initiatives – saying little or nothing about the impact of established technologies, or what happens when use of a technology becomes 'mainstream'.

As part of the Impact JEIRP, a literature review was undertaken that sought to explore these issues (Price *et al*, 2005). In spite of the complexity described above, it was possible to conclude that the introduction of technology is associated with a number of changes:

- Increasingly flexible opportunities for study, in terms of time and location (Bates, 2000);

- The formalisation and industrialisation of curriculum work (Cornford & Pollock, 2002);

- A sense of insecurity amongst educators about their lack of understanding and/or skills in relation to these new forms of teaching (e.g. Mishra & Koehler, in press);

- A consequent growth in academic development initiatives, generating interest in new approaches to working with academics (e.g. Sharpe, 2004);

- The emergence of new roles, such as learning technologists, raising political concerns about responsibility for areas such as curriculum development (e.g. Torrisi-Steele & Davis, 2000); and

- A changing conception of what it means to be a 'teacher' (Lairson, 1999), which may now be envisaged as a facilitator, organiser of knowledge, producer of educational content, *etc*.

These complexities have not stopped policymakers mandating new kinds of practice, or new areas for development. In the UK, the Dearing Report and the recent government e-Strategy have promoted industrialised models of curriculum development and attempted to introduce standards for the development of electronic materials; in Bulgaria, university-level distance education has been regularised by law, and a loan agreement with the International Bank for Reconstruction and Development has led to the "Modernisation of education" project; and while there is no national policy for teacher development in Norway, this area of work has been promoted by the Department for Church, Research and Educational affairs and is the subject of most universities' strategic plans. However, there is a widespread belief that there is a gulf between hype around e-learning and peoples' experiences (e.g. Conole, 2004; Robertson, 2003), signalling the importance of reconciling these through research.

What was apparent from this review was the paucity of convincing research that was able to reconcile these agendas. This was due, primarily, to the lack of any integrative framework for the area. In the next section, the methodological problems that have led to this situation will be outlined.

Methodological considerations

The situation of change outstripping understanding, outlined above, has not previously galvanised research. To date, there is no unifying methodological approach or theoretical position structuring work in this area. Developing appropriate and effective methodologies for investigating the impact of technology on teaching practice is crucial. Much research so far has been centred around funded

implementations, testing preconceived ideas rather than exploring need or even current practice. Other research shows little evaluation beyond the informal 'the students liked it'. The majority of research involves case studies; evidence is rarely amalgamated and there is no clear agenda of research needs. This is understandable, since the complex, shifting context makes it difficult to define terms such as 'impact' and 'effectiveness' (Oliver & Conole, 2003). Without fixed points for comparison, and with multiple influences affecting practice, attributing causality to a particular intervention (such as a new technology) becomes extremely difficult to do in any credible way (Oliver & Harvey, 2002). More specific evaluation looking at the difficulties as well as what went well would inform us better on the overall impact of the technological implementation.

One thing is evident - that there is no obvious research method to adopt in relation to this problem (Price et al., 2005). Instead, different approaches seem well suited to particular aspects of this field. In response to this, it is proposed that these issues can be clustered according to the kinds of research approaches that are suitable to use when studying them. Reviewing work in the field to date, it was possible to distinguish between studies that used different kinds of data as evidence of impact. These differences are significant, in that they reflect fundamental differences in how 'impact' was conceived within the research. Classifying research papers according to their epistemological commitments, we could distinguish between work that sought to *describe* impact, work that sought to *explain* how impact took place and work that, in effect, *conceptualised or promoted* particular kinds of outcomes.

Consequently, we suggest that one way to group these research issues is as being:

- Anticipatory (such as the discourses and rhetoric of policy, design and intentions, opinion and attitudes);
- Ongoing (processes of integration, including practices of staff development); or
- Achieved (summative studies, particularly of technology that is no longer considered 'novel').
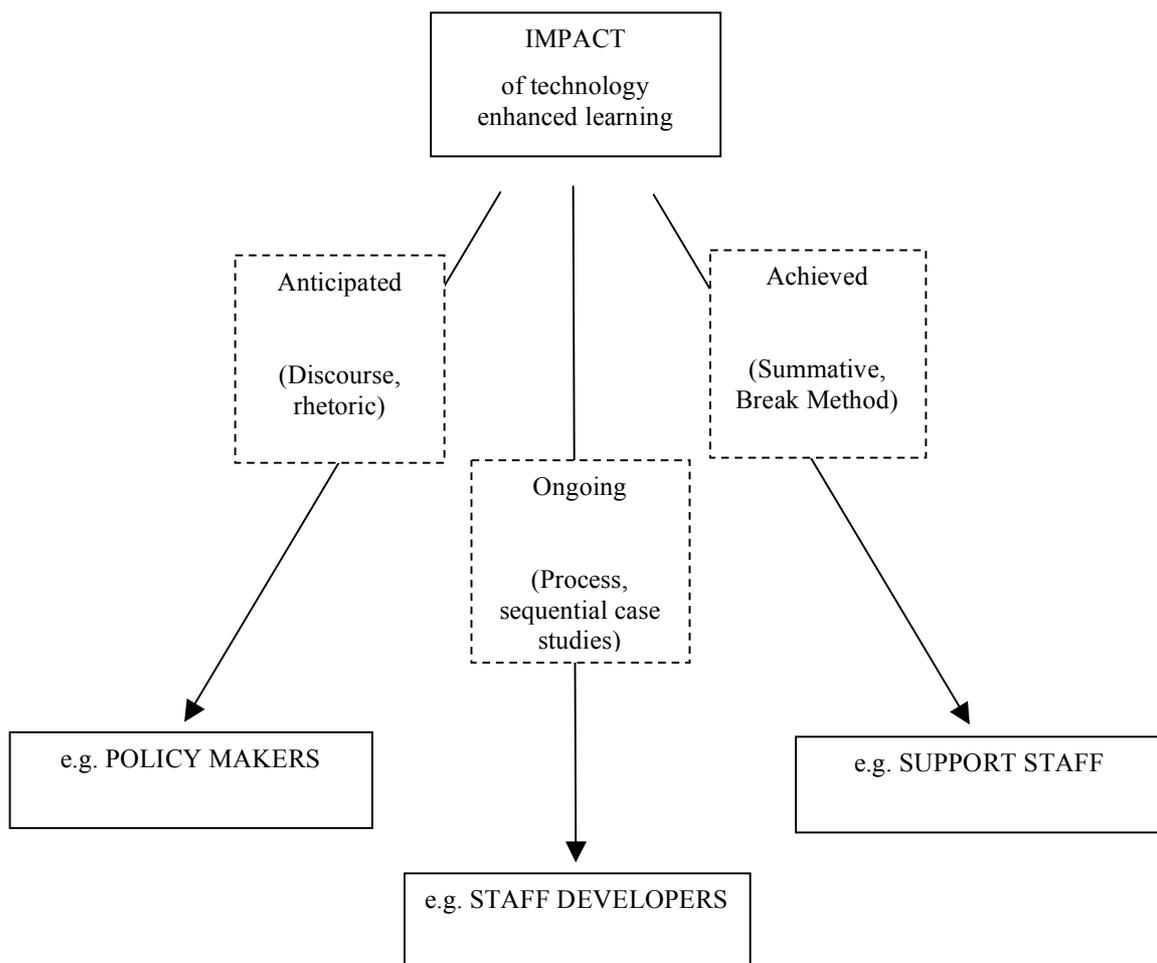
Figure 1: An overview of approaches to the topic, indicating example audiences

The underlying nature of each of these 'positions of technology' differs and suggests the employment of different methodologies. For example, *anticipated* impact might be studied using discourse analytic approaches; to understand the impact of *processes* of integrating technology a longitudinal method may be appropriate, perhaps involving sequential case studies; to understand *achieved* impact might require retrospective evaluation or the identification of the practices that rely upon a particular technology. Figure 1 shows the structure that framed the empirical work undertaken in the project.

This framework was designed to highlight the link between varied conceptions of impact and the research methods deemed appropriate for investigating the topic. The purpose of this is twofold: firstly, to explain why the research in this area to date has been so fragmented; and secondly, to help guide future work in this area. If impact is conceived of as an ongoing social construct, negotiated through discussion (e.g. Shaw, 2002) then a summative review is inappropriate; what is required is a study of the way in which people use talk (and text) to achieve particular changes. If impact is understood as a change in the structure organisation, as defined by its policies and procedures, then such ephemeral talk is incidental; it becomes more important to focus on the policies and strategies that define institutional working (de Freitas & Oliver, 2005). However, if what is sought are assurances of the value of some approach, or promises of this success being replicable elsewhere, then comparative studies and experimental designs might be appropriate.

In effect, this framework has enabled us to identify three traditions of work that, whilst they may complement each other, cannot easily be conflated; each proceeds according to its own tradition of knowledge production and legitimation. Rather than attempt to address all of these, then, it becomes important to locate work within this area in relation to one of these strands of work in order to position it (and the researchers' assumptions) more clearly.

In addition to helping us identify appropriate methodologies, this framework suggests communities that would best be informed from outcomes of each of the strands of empirical work. The groups indicated in Figure 1, for example, are not the only people who might be interested in work of this kind. However, they are useful examples of distinct groups who might have an interest in particular questions that would form part of each tradition of work. It is relatively unusual for research work to be explicit about its intended audience; this is something far more common in evaluation work (Patton, 1997). Following the spirit of Patton's utilization-focused evaluation work, whilst we recognise that various groups (academics, for example) might have a general interest in work in any of these traditions, certain groups are more likely than others to actually act upon research outcomes of particular kinds.

So, for example, studying the *process* through which technology has been adopted might inform staff development strategies, whereas studying the *achieved* impact of some initiative would inform us about successes and difficulties in practice, which may be of direct relevance to the work of support staff. Academic staff themselves, of course, might be interested in any or all of these areas.

This framework was used to guide the empirical work undertaken during the project (fully described in Oliver *et al*, 2005). A series of case studies to explore the impact of the implementation of a 'new' technology on the roles and practices of academic staff in higher education were carried out as part of the 'ongoing' strand of research. To illustrate this, a selected study from the empirical work is presented below, focusing on the impact of technology on the role that models of teaching and learning play in the process of technology adoption. It would be impractical, within the scope of this paper, to attempt to illustrate all three traditions, described above. Consequently, the study reported here focuses on the process of technology adoption, and its relevance to a particular audience (staff developers) will be considered at the end of the analysis.

Methodology

Teachers develop particular models of teaching and learning, which are used to inform their teaching practice. From the initial literature review (Price *et al*, 2005) a series of questions were identified that were pursued in subsequent empirical work. Do these models influence the way technology is used or does technology enable new models of teaching and learning to develop? What role do teachers' models of teaching and learning play in the implementation and use of technology? One question is whether integrating technology into teaching results in a change in teaching practice or just a transfer of a particular practice from one situation to another, e.g., communication from face-to-face to on-line.

This case study explores the impact of technology implementation in the initial stages of adoption of Blackboard (a virtual learning environment) into two different courses within a Higher Education

University. One course involved a pilot study set up by the university to trial the use of Blackboard in a PGCE course, with a view to more general implementation in the following year. The pilot study involved all administrative and academic staff on the PGCE course. The other was an innovative project to introduce Blackboard as a way of supporting learning through discussion groups for doctoral students. The primary function of the technology here was anticipated to support voluntary discussion groups, both as on-line discussion and to build on face-to-face interaction. The main function of the discussion groups was to provide personal learning support and social interaction for the doctoral students.

As the focus here was on understanding how academics made sense of the changes in their practice, a series of interviews were undertaken to enable us to explore their own explanations and motivations. Interviews included four academic staff, three of which were subsequently interviewed after a period of one month, and with two members of staff with a remit for supporting pedagogic uses of technology.

Initial interviews took place prior to technology implementation to find out the participants attitudes towards institutional policy, the technology and its perceived utility for them and their teaching, and their anticipated understanding of the impact that this technology for them. Subsequent interviews were undertaken to compare these positions with opinions after implementation had begun, to establish whether or not previous expectations were realised. Semi-structured interviews were designed to ensure that appropriate information was elicited, but also to allow for unanticipated responses and facilitate more detailed exploration of views that may contribute significantly to the data.

Each initial interview was structured around the respondent's perceptions of the following: the rationale for using the chosen technology, its features and functionality, the policy decision and manner of implementation; the perceived benefits and/or disadvantages for teaching and learning; the perceived effects on teacher/ learner roles; anticipated difficulties, including individual concerns; expectations regarding training and their familiarity with technology (the proposed or otherwise). Follow-up interviews were structured around the following, with additional questions arising from the first interview particularly relevant to each individual: how the implementation was progressing; how they felt about the technology now; ways in which the technology has been useful or not; ways in which the technology has affected teaching practice and/or role as a teacher; their need for training. All interviews were recorded and then transcribed for analysis.

The first step in the analysis involved identifying specific instances that related to themes from the literature review. Analysis of this complex, emergent relationship between practice and technology can be undertaken using the perspective of Activity Theory (Kuutti, 1996). This involves analysing the way in which people (subjects) use tools (which may be physical, symbolic or conceptual) to achieve objects (intentions), within the context of a community that maintains certain rules (tacit codes of practice) and organises work in particular ways (the division of labour). This form of analysis draws a distinction between different levels of activity: the activity itself (a strategic-level description of intentional tool use in context), the series of actions that constitute it (specific conscious uses of tools, in context, to achieve tactical components of the overall task) and the myriad operations that constitute each action (each of which is so simple and routine that, unless a problem occurs, we remain unaware of undertaking them; they are not consciously perceived). This distinction allows the creation of nested accounts of practice that encompass both strategic and 'automatic' acts.

Finally, the results of this analysis were considered in relation to the audiences identified in figure 1, to draw out implications for action. Outcomes from the interviews presented here focus primarily on findings related to the impact of this technology implementation on models of teaching and learning, and corresponding implications for the process of technology adoption, and staff development, support and training.

Findings

Current models of teaching are frequently used to underpinning predictions of ways in which technology will be used. Respondents in this study often talked about their predicted role or practice in relation to their current teaching roles or practices. For example, one teacher providing a support role on-line equated this with a similar support role in face-to-face situations; the role of teacher as facilitator on-line was equated with that of facilitating any teaching situation; dissemination of information on-line expressed as being similar to using e-mail or paper in face-to-face situations.

This attempt to reuse familiar practice in a new context may be appealing (since it attempts to build on established expertise and an extant professional identity) but it is problematic. The degree to which

such practices can be transferred from one situation to another is unclear, raising the question of whether such a change in technology necessitates a change in approach, too. In other words, within these case studies, is it just the tutor's perception that they are merely transferring the same practice from one situation to another, rather than requiring the practice itself to change? Or, because of the new context, environment or technology, is practice necessarily modified, with *emergent* changes in practice arising as a consequence? To explore these issues, several examples can be highlighted from this study:

Models of learning by discussion

Several respondents in this study highlighted the significant role that peer support plays in learning on PGCE and doctoral courses. In traditional teaching settings this support often takes place in familiar ways, such as, face-to-face discussion. Berge (1995) identifies the importance of social interaction on-line as being critical to the success of such group interaction, in developing group cohesiveness, unification and working towards mutual goals. Hand in hand with the desire to facilitate this kind of interaction on-line, is an underlying assumption that technology will provide the medium to do so. However, experience suggests that achieving this is fraught with complexity, due to the permanent and public nature of on-line expression. One respondent observed:

> "As trainee teachers they go through some fairly traumatic self assessments and finding they're not very good at it at first. Whereas in face to face situation you can make it very comfortable for people to talk about problems that they're having – people will say they've had a terrible session, they were terrible etc.. and then we can talk about it. On-line there's a marked difference writing such things in text and to remain for the duration of the year because they were terribly aware that to be candid was very exposing – your tutors on-line, it's in text, it's on the record and the desire to appear confident was extremely important to them when they were on-line."

In contrast, on-line discussion groups were also highlighted as being useful in supporting learning, by enabling students to share different perspectives, especially about their experiences in their teaching practice.

> "They will go into their school for example, talk about lessons and assessments and go on-line and discover that there are various different ways of doing it. And there is some discussion usually about the pros and cons of the different systems…. they find that there isn't one best way… here's a diversity and they understand that there's a diversity of approach."

This was seen as especially important given the range of approaches to teaching and students' physical isolation while on teaching practice, and is seen as critical to enabling them to be more self-reflective. Another respondent also pointed out the huge impact that on-line discussion groups can have on teaching and learning. In this case on-line discussion was task driven and carefully crafted. Students were required, for example, to share what's going on in their experience in schools and learning in other contexts, to comment on each other's experiences, and to critique various bits of input from tutors. The awareness of others on-line, and the asynchrony of interaction were thought to make an impact on the quality of communication. For tutors this means taking on the role of 'moderator', which requires the skill to appropriately craft tasks, to comment at the end of the discussion, but generally not to intervene in between. This kind of practice can support students (here trainee teachers) to "learn in very self sustained ways, collaboratively without the need for constant tutor intervention". In this environment participation was compulsory, but not assessed, similar to the requirement to attend face-to-face seminars but contribution itself is not assessed.

Research also suggests the importance of students feeling *'safe'* in an environment for dialogue and communication to take place (Salmon, 2004). In an on-line environment it is harder to know how people are judging you by what you say and how you express yourself due to the lack of other familiar social interpretive clues that go along with face-to-face interaction or even voice-to-voice interaction e.g., facial expression, tone of voice. One respondent emphasized the importance of creators of discussion groups being aware of such issues:

> "So I think that illustrates the complexity of what is going on here and what people feel when they're typing something in about, well what is this going to say about me, what will other people say, how will they judge me. And there's all this going on that perhaps when people are less experienced in creating a group they wouldn't really think about it."

Such complex interaction between the technology, the situation and students' needs can affect the amount and kind of dialogue that may take place. In addition, the dialogue is 'public', 'permanent' and 'reviewable' in a way that conversation is not, thus potentially changing the nature and content of interaction. This can apply to discussion about learning topics, as well as personal issues. For example, Hammond and Wiriyapinit (2004) found that although on-line groups were active within discussions, they were restrained when there was potential for disagreement, maintaining significant levels of politeness. Such interaction is likely to reduce the degree to which critical reflective learning can take place.

Role of facilitator

Part of a teacher's role in traditional face-to-face teaching is being a facilitator of learning, and this role is seen as being equally important in technology mediated learning situations.

> "I think […] the role of the facilitator is key. And I think the role of the facilitator in any learning event is key, and the stance that they take and the way in which they take up either the new technology, or any change in classroom practice in a face-to-face situation, will determine the response of the participants."

In order for such technology-mediated groups to be successful the role of a facilitator is considered central – as in any teaching situation. But how much does this perception depend on the rhetoric of 'teacher as facilitator' without yet thinking about what the role of facilitator really means?

In this case study the role of facilitator with Blackboard was expected to take on various forms. One included planning discussion sessions as well as aiding the progress of discussion.

> "If I were facilitator, then yes I think it would because I would need to plan, I would need to spend time thinking what I would need to say to the students, how to get the discussion going, how often I need to look to see of there are any messages. …. I think I'd probably need to think about it in some way every day."

A further expected role of facilitators was 'modelling', which was claimed by one respondent to influence the style of interaction. For example, the facilitator could engage by sharing unpolished thoughts and ideas, thus encouraging students to do so. Indeed, as part of the 'necessary conditions for successful online instruction', Berge (1995) proposes that modelling appropriate online behaviours prepares students for engagement in independent online interaction.

Another important facilitator's role was to create a 'safe' environment for the students to interact in, where they would feel comfortable and confident enough to engage in discussion. For example, feeling inferior to other students may affect how much and how often they participate.

> "When I went to the first session [beginning of the course], one of the questions was, 'What do you fear?' And people said 'Well I fear that I'm not up to the level' and that's a really important thing too."

However, as the technology implementation progressed initial expectations of the role of facilitator began to alter, and other ideas for this role emerged, according to whether the facilitator was a tutor, a member of the teaching and learning support staff or a student.

> "Of course there might be a time where I started a group off and its perfectly fine without me, or I could see some person in it that I'd think, ah they'd be good, they'd be better than me, I'll encourage them to facilitate. And then I could just step away and look at it occasionally."

Another respondent described the nature of interaction as different online than in face-to-face situations, influencing the role that the teacher plays as 'facilitator', e.g.,

> "The way we craft the tasks is such that *they* talk on line, we as a moderator only comment at the end of a discussion, unless there's a serious reason for intervening, we let them talk. In a face to face seminar, I can't imagine not talking myself as a tutor, although we carefully monitor ourselves not to dominate, and all the rest of it, and the end of the day in the discussion, you join in don't you."

In summary, this study revealed a number of differences and potential changes to the role of facilitator in on-line discussion groups, for example, the identity and roles of participants may change if students take on the role of facilitator. This may be the same role in name, but when transferring a concept

already employed without technology to a technology-mediated situation, the particular role or practice involved may be different.

Role of tutor as support/ monitor

Teachers also see themselves as taking a role in monitoring students, both in terms of supporting their motivation and learning, and in terms of attendance. But does it change with technology, or differ in an on-line environment such as Blackboard? One respondent considered student support to be especially important for maintaining student motivation for continuing the course, and described this support role as being the same within a virtual learning environment (VLE) as within a physical learning environment. A VLE system (not Blackboard in this instance) that was originally being used enabled monitoring of student interaction. This was used to assess levels of motivation, and where concern was raised, allowed appropriate input by the tutor. Such intervention was considered successful on a number of occasions, and was taken as evidence (by the participant) that face-to-face practices had been transferred to on-line teaching. In a face-to-face situation, signs of diminishing motivation were, for example, non-attendance or reduced contribution at meetings. Similarly, in the on-line environment this respondent is looking for signs of disinterest, unhappiness, or loss of motivation in a student early enough to intervene.

> I'm looking for some kind of contribution, any contribution, I look for basically and if I don't get that then I know there's probably something wrong. It's when people are chipping in their bits and then all of a sudden it goes quiet. That's the danger sign. You do pick up on odd stuff like that – its just transferring what you normally do in normal situations to a virtual environment.

Monitoring student attendance at seminars or lectures is another role that tutors see themselves as already undertaking, and is a fairly commonplace and accepted practice. However, monitoring student interaction through use of discussion boards was perceived as a challenging issue by two respondents in this study. Concern was expressed over the potential to become too "Big Brotherish", with the facility to monitor all input, and the potential for value judgements of inputs to be made in ways not possible in transient face-to-face situations (cf. Land & Bayne, 2005). This raises several questions that need to be considered in the process of adopting this technology.

Analysing the findings using Activity Theory

The findings here suggest that preconceived ideas about mappings between technology characteristics and teaching/learning practices may need to change. The degree to which transfer of practice can occur without modification seems to depend on the function of the practice itself, with some practices being more easily transferable than others e.g., monitoring student interest/ input as oppose to discussion, especially of a personal or emotive kind on-line. Reaching a good understanding of the complex relationship between technology, context, interaction, learning outcomes will be an ongoing evolving process, requiring a certain amount of adaptability from both staff and students.

Within an Activity Theory conceptual framework it is possible to revisit the cases outlined above to provide a deeper level of analysis. For example, consider the support provided by the tutor. At the strategic level (the level of Activity), the move online results in no significant change: the overall object is still that the tutor provides support to their student, looking for signs of disinterest or unhappiness. This remains the tutor's responsibility, and the tools used (watching for symbolic events such as non-participation) are the same. This explains the claim that the role of the tutor remains the same within the new environment.

At the level of actions, however, differences start to emerge. The way in which signs of non-participation are noticed changes. Rather than looking for non-attendance by glancing around a room, the same object is achieved using a different tool – such as the student monitoring functions within the virtual environment. Thus, although the object remains the same here, the system as a whole (the inter-relationship of subject, tool and object in their social context) changes, not least because the tools being used are now different.

At the level of operations, the differences are substantial. Rather than operations such as 'scan the room', 'listen for things to go quiet', there are now operations such as 'click this link to generate a list of contributors', 'click this link to reveal students' patterns of reading the online materials', and so on. The entire activity system at this level has changed. At this fine-grained level of analysis, the role of the teacher is almost entirely different online than face-to-face.

What this reveals is how the move to teaching online renders the role of the teacher both the same *and* different *simultaneously*. The purpose and strategic direction may remain unchanged, but the methods of achieving this alter in significant ways. This also explains a number of related phenomena, such as the relatively frequent breakdowns in teaching online (compared to established teaching), until the new operations that are required are mastered. This means that a higher level of effort and commitment is needed *until operations become routine*. It also explains how successful practice becomes invisible – once the breakdowns at the operational level are resolved, this entire layer of teaching is undertaken without conscious intervention. (This makes it even more likely that successful teachers online will see no real difference with their teaching face-to-face, because they will become unaware of the majority of the ways in which their practices are different.)

This echoes Cousin's analysis (2004) of the metaphors used for VLEs – the way in which they act to preserve a sense of conventional classroom teaching (or at least, those parts most amenable to measurement and automation) in order to provide teachers new to teaching in this way with "a stable transition" (p.121). One potential consequence of this, Cousin notes, is an attendant conservatism in forms of teaching. However, the analysis offers here provides some explanation of why this conservatism might arise – and why teachers might view it as a good thing, because it preserves their sense of what is important about teaching.

However, it does seem likely that components of these systems might be differentially affected. Tools will change more often than objects, for example. In particular, it might prove interesting to study the rules that govern behaviour in different settings, since it is not clear how these differ.

Implications for staff development and training

As outlined in the methodology, the final step in the analysis was to consider how the findings related to specific audiences. In this section, the implications of the above analysis for those who work with academics will be considered.

These interviews brought to light important issues surrounding the use of technology that point to the central role that staff development could play in the design and implementation of technology for teaching. A primary focus for the participants was on how to use the technology, and developing technological expertise. Providing ongoing and flexible training that presents the technology in a straightforward way, promoting a positive and relaxed attitude in staff towards the technology itself, is clearly essential.

However, the rhetoric surrounding technology innovation is well known to raise expectations of what can actually be achieved with technology. Knowing the limitations as well as the potentials of particular technologies in relation to teaching and learning would enable staff to have a more realistic view of what the technology can do, and a clearer understanding of how it might be integrated into their teaching practice. Weller (2002) points out that teachers need to have much more than just technical competence if they are to be successful online: "they need an understanding of the dynamics of online communication and interactions and need to learn effective ways of facilitating and teaching online".

Another interesting implication is that personal learning (as opposed to formal training) has an important role to play in the process of adoption. One respondent researched other people's experiences using on-line communication technologies that indicated potential pitfalls and failures, and was usefully integrating the findings into the planning of the technology use. For example, Cowan's (2005) research revealed trainee teachers' feelings of vulnerability in discussing their experiences in online groups. This resulted in the respondent thinking in more depth about how to work with the technology to achieve her goals. Understanding more clearly how dialogue works on-line, what kind of dialogue students do and don't engage in, may be an important part of the process of adopting communication technologies.

Furthermore, accounts were given that exposed differences in action and interaction when integrating technology, and the potential implications for models of teaching and learning. Exposure to a range of models of technology use during these early stages of implementation could form a productive part of staff support. Understanding differences in interaction with technology and how this affects learning is crucial to designing effective activities, content and learning goals. "Learning to use technology to effectively mediate the communications process is a critical skill to be acquired early in the teaching process" (Gunawardena 1992, cited Collins & Berge 1996). A superficial reading of this might suggest that this will lead to generational differences within the teaching population; however, there is more

likely to be a link with length of service than age *per se*, and the use of the singular – "technology" – hides the ongoing introduction of new tools into teaching, which will result in a fairly complex profile of people conversant with any specific kind of resource, whose skill may or may not remain relevant over time, or who may choose to 'skip' a particular technology but engage with the next.

Conclusion

Although there is great interest in the impact of technology on education, work in this field has been fragmented. In this paper, a framework for studying the impact of technology has been described and applied. The primary outcome of this work has been to demonstrate the usefulness of the three-part model for studying impact. The division into anticipated, ongoing and achieved impact has proved helpful both in organising the work and in terms of the selection of research methods.

The study outlined above can do no more than illustrate one tradition of work. In doing so, it provides a partial instantiation of the research framework outlined earlier. Further studies – such as those outlined in Oliver *et al* (2005) – would be necessary to demonstrate the other traditions of work.

Importantly, however, this case demonstrates a number of principles that arise from using the framework. Firstly, it was unnecessary to consider policy reviews or comparative studies; such research was only of indirect relevance to the particular understanding of 'impact' being explored here. This is useful when synthesising existing research, enabling a more systematic approach to be taken without resorting to a dogmatic position on research 'quality', defined purely on methodological grounds (Oliver & Conole, 2003). Secondly, as a corollary to this, locating work within one tradition simplifies the research design process by suggesting a relatively contained variety of approaches suitable to studying problems of this type. Thirdly, the framework directly addresses the problem of research utilization by drawing on principles developed in the field of evaluation. The explicit emphasis on audience serves to raise awareness of this, although it is only a first step towards improving the processes of producing and using relevant research.

This framework can thus act as a foundation for ongoing work on this topic. The clarification of related but distinct conceptions about what 'impact' might mean has helped to disambiguate existing research claims; in doing so, it has enabled the development of a more principled approach to the design of work in the area. Whilst the framework is not definitive – further work could be undertaken to refine it – it does, nonetheless, represent a step forward in thinking about research in the area.

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