

Pedagogical, institutional and human factors influencing the widespread adoption of educational technology in higher education

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Abstract

This paper provides an analysis of the factors which influence the adoption of educational technology in higher education. It argues that the technology is mature enough, although care needs to be taken about definitions of terms used. The role of educational technology is analysed in terms of what we know about learning, and the conclusion drawn that we know enough about the design of educational technology environments, but that this knowledge is not widely applied. The paper then discusses the research about institutional factors which impact on adoption of new technologies in higher education, before concluding that the major factors affecting adoption are human, and these can only be addressed through effective leadership and change management.

Keywords

uptake of educational technology, change management, institutional factors

Introduction

Educational technology has evolved over the last decade. In the early 1990's, the emphasis of educational technology was on interactive multimedia — stand alone packages on computer hard disks or CD-ROMs, which integrated a range of media forms. As the internet evolved in the mid- to late 1990's, the focus shifted to largely text-based material available to anyone with appropriate access to it. Currently, with improvements in technology and bandwidth, fully interactive multimedia capabilities are available on the internet, and the focus is on learning objects rather than monolithic applications. At the same time, web-based learning management systems arose, and evolved into enterprise information systems. None of these changes have been driven by educational factors.

While educational technology will continue to evolve, the hardware, software and network infrastructure is sufficiently mature that the focus should shift to how to use the technology most appropriately to facilitate learning. This discussion will lead us into a consideration of the factors which influence the widespread adoption of e-learning.

Knowledge about e-learning

While a large number of terms have been used to describe the range of educational technology applications, the currently popular term is e-learning. However, there is confusion about what e-learning means in different contexts. People tend to use e-learning in a 'one size fits all' manner, and this confounds discussion about the appropriate use of e-learning, and confuses both practitioners and policy-makers.

There are distinctive differences between, for example, a use of a simulation learning object as part of a school laboratory class, a training CD used by a corporation, and a tertiary course offered solely online by an open university, but these are each commonly referred to as e-learning.

A recent paper (Phillips, 2004) has attempted to resolve this confusion by proposing four independent e-learning design dimensions. These are summarised in Table 1, together with their extreme values. The four dimensions are based on the interactions that a student may have in a technology-supported learning environment: with other students, with their teacher, with learning resources and with their computer.

Table 1: The four e-learning design dimensions and their range

Dimension	Extremes	
Student–student interaction (SS)	Individual	Social
Student–teacher interaction (ST)	Present	Absent
Student–resource interaction (SR)	Traditional (paper-based)	Digital
Student–computer interaction (SC)	Passive (navigation between screens only)	Interactive (interactions designed for learning)

Table 2: Examples of use of the four e-learning design dimensions

Simulation learning object IPTI	The student is likely to work individually The teacher is present Resources may be provided in traditional workbooks The student interacts with the computer
Corporate training CD IADI	The student works individually The teacher is absent Resources are digital The student is likely to interact with the computer
Open university online course SADP	Students are likely to work socially with one another The teacher is absent Resources are digital Computer use is passive , with interactions only for navigation

A demonstration of the usefulness of the dimensions is shown in Table 2, through an analysis of the three examples given above. Each scenario is characterised by four letters corresponding to the first letter of the chosen extreme of each type of interaction. Given that there are multiple combinations of the four e-learning dimensions, it is unlikely that each combination is equally likely to lead to effective learning. This issue will be discussed in more detail after we have considered what is known about learning in a tertiary context.

Knowledge about learning

The US National Research Council conducted a literature review of research results about how people learn (Bransford, Brown, & Cocking, 1999; 2000). Phillips (2005) has analysed this work from the context of higher education. Some relevant findings are:

- There is a clear distinction between learned problem-solving skills in novice learners and the specialised expertise of individuals.
- Individuals can be taught to be metacognitive and self-regulatory.
- Participation in social practice is a fundamental form of learning.
- For learning to be effective, it needs to be transferable to other contexts and it needs to have a long-term impact.

For tertiary students to become experts, they need to attain a deep, organised and contextualised understanding of their discipline, and the learning environment needs to support this. Bransford et al. (2000) indicate that learning environments should be:

Student-centric: acknowledging that students use current knowledge to construct new knowledge.

Knowledge-centric: acknowledging that knowledge needs to be accessible and applied appropriately in order to think and solve problems.

Assessment-centric: focusing on formative assessment supporting the learning process by:

- providing regular feedback
- providing opportunities for revision
- improving the quality of thinking and understanding.

Community-centric: acknowledging that learning involves social discourse between peers.

These four characteristics of an effective learning environment imply that the student takes part in activities which are intended to lead to learning, and these are drawn from outcomes that the students are expected to achieve. For effective learning to occur in a tertiary setting, the design of the learning environment should emphasise:

- A constructivist pedagogical philosophy (Duffy & Jonassen, 1992; Marra & Jonassen, 1993; Reeves & Hedberg, 2002).
- A deep approach to learning (Biggs, 1999; Gibbs, 1992; Ramsden, 1988; 1992).
- A student-centred approach to teaching.
- Outcomes-centred course design (Allan, 1996).

Application of educational technology

The previous section indicates that learning is an internal, cognitive activity which can be facilitated by contact with others and by taking part in purposefully designed learning activities. The role of educational technology may need reassessment in this light. Bransford et al. (1999) reported that educational technology can enable students to:

- Learn by doing.
- Receive feedback.
- Continually refine their understanding.
- Build new knowledge.

These characteristics point to educational technology acting as a tool. Unfortunately, much of the discussion around educational technology sees it as a means in itself. Clark (1983) used a related metaphor for educational technology, that of a vehicle which provides access to learning opportunities. He proposed that media were 'mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition' (p. 22). If the truck is not present, no learning can take place, but the truck itself does not lead to learning.

Returning to the e-learning design dimensions discussed in the first section, current research about learning with technology indicates that effective e-learning environments have the **SPTI** combination of dimensions:

- Students work socially with each other.
- The teacher is present.
- Resources are available in print (and also online for flexibility).
- Students purposively interact with the computer.

However, the variety of teaching contexts and the particular circumstances of learners often require that compromises need to be made in the ways that students interact with educational technology. For example, in some circumstances, students are forced to work individually, and in others they may not have a teacher close by to discuss and reinforce their understandings.

Some of these compromises can still lead to effective learning outcomes, if well-designed, while others, arguably, may not. Phillips (2005) has distinguished between the deep-learning, student-centred, outcomes-based approach which is espoused in the literature, and the surface-learning, teacher-centred, content-based approach currently used in many universities, using the terms *Espoused Theory* and *Theory-in-Use* (derived from earlier work by Jackson (1998) and Argyris (1976)) to describe this disjunction. The *Theory-in-Use* approach common in universities tends to adopt a 'transmission-of-content' approach, analogous to Clark's 'truck'.

The characteristics of the *Espoused Theory* have been combined into one graphical element in Figure 1, which also illustrates their emphasis on learning activities. The role of educational technology in enabling the design of innovative learning activities is also portrayed in Figure 1.

There are few, but sufficient, examples of educational technology applications which meet the characteristics of the *Espoused Theory*. A cogent description of representative products and their design criteria is given in Reeves and Hedberg (2002, Chapter 1), and they will not be repeated here.

However, the majority of examples of educational technology reported in the literature and available on the market have been developed according to a transmissionist model (Reeves & Hedberg, 2002; Schank & Cleary, 1995). In this misguided view, educational technology is seen as leading directly to learning, rather than as a tool to assist learning.

In terms of the e-learning design dimensions, such learning environments are characterised IADP (individual work with no teacher and digital resources used passively). Unfortunately, this approach underpins much of the debate about e-learning.

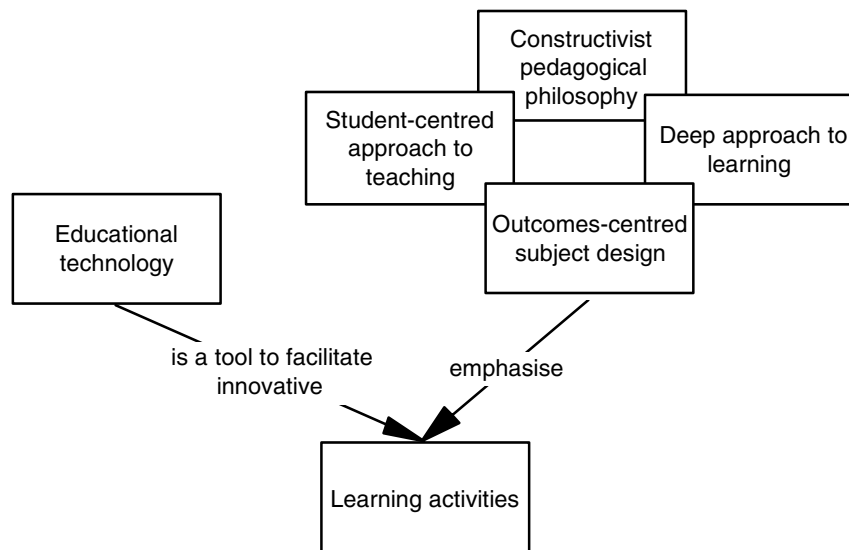


Figure 1: The role of educational technology in facilitating a deep learning, student-centred approach to the design of learning activities

A strong driver for the proliferation of inappropriate educational technology is the Instructional Systems Design (ISD) tradition (Briggs, Gustafson, & Tillman, 1991; Dick & Carey, 2000; Gagné, 1977; Gagné, 1992) mainly in the USA. This is a systematic approach, which, simplistically, breaks down a task into parts, takes students through the task step-by-step, and then tests their mastery of the task. While there are clear benefits to a systematic approach to design, traditional ISD theory inherently follows a teacher-centred, instructivist approach. The ISD approach has been critiqued by Laurillard (2002), who argues that, while logically principled, ISD is “*not empirically based, and therefore unable to build teaching on a knowledge of students*” (p. 77); and that the “*analysis into components of the teaching-learning process is not followed by any synthesis*” (p. 65). ISD is also being questioned by some of its practitioners (Gordon & Zemke, 2000). While it may be suitable for a manufacturing and military economy, ISD is not suitable for a modern economy in rapid change, needing a focus on lifelong learning.

The analysis in this section leads to three important conclusions:

Educational technology is a tool, not a means in itself. Like any technology, educational technology does not lead to learning, but, together with teacher support, it can facilitate effective learning activities.

There’s no such thing as e-learning. Learning is an internal, cognitive activity which can be facilitated by contact with others. Learning is not something which can be ‘delivered’, by human or computer. E-learning should be an adjective, not a noun.

The major issues associated with the effectiveness of e-learning environments are not related to technology. They are related to our understanding of learning and the mismatch between empirical results about how people learn and ways that institutions and individuals conceive of teaching.

What impact has educational technology had?

The research outlined so far indicates ways in which educational technology can be designed to be effective in higher education. However, this style of educational technology has not been widely adopted. Where educational technology has been widely adopted it has been through replication of traditional teaching techniques (Reeves, 2002).

There are several factors which have influenced the low take-up of effective educational technology. One factor is the individual beliefs about teaching and learning held by academic staff and educational designers who develop e-learning projects. These beliefs influence academics’ choices of pedagogical approaches and use of educational technology (Bain, McNaught, Mills, & Lueckenhausen, 1998a; 1998b; Kennedy & McNaught, 1997).

However, a range of other issues, beyond individual factors, influences the success of educational technology development projects. Alexander & McKenzie (1998) reviewed 104 teaching development projects funded by the Australian government which made significant use of a range of educational technologies. They identified a range of characteristics of educationally-effective projects, together with a range of factors leading to unsuccessful outcomes. These characteristics have been summarised and reorganised in Table 3 under three headings, educational design, project management and institutional issues. The educational design for effective learning issues in Table 3 are largely consistent with arguments presented earlier in this paper and will not be discussed further here.

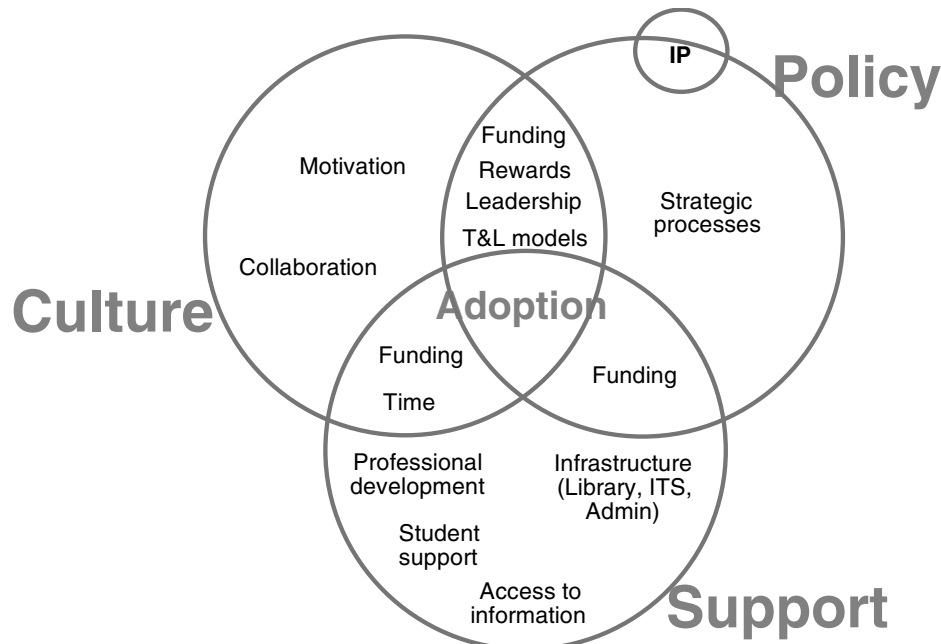
The second factor in Table 3 is project management and teamwork. Project management is essential if educational innovations are to be implemented and reach the 'classroom' (Bates, 1999; England & Finney, 1999; Phillips, 1997). Academics are not used to working in teams, especially multidisciplinary educational technology development teams, and team management is therefore important (Phillips, 2001). Institutional issues are the third factor displayed in Table 3. Any of these issues can impact on the effectiveness of an educational technology development project, and they are largely outside the control of the development team. These institutional factors will be discussed further here. Laurillard (1994) reviewed a number of evaluation studies of new technology, reinforcing several of the characteristics listed in Table 3. In particular, Laurillard identified two specific institutional issues:

- Full potential was not achieved because of organisational/ logistical/ technical problems.
- Senior management support influences success.

Similarly, a range of institutional issues were identified by McNaught, Phillips, Rossiter and Winn (2000) in a study investigating factors affecting the adoption of educational technology in Australian universities. This report identified a number of factors which, when all present, could lead to widespread adoption of ICT. Three major themes were identified: the institutional culture, the policy framework and the support infrastructure. McNaught et al. (2000) represent the three components as a Venn diagram in Figure 2, recognising that where change takes place there is an overlap between the three components, policy, culture and support.

Table 3: Characteristics of educationally-effective educational technology projects, derived from Alexander and McKenzie (1998)

Factor	Characteristics
Educational design	<p>The project:</p> <ul style="list-style-type: none"> • aimed to address a specific area of student need • used a learning design/strategy which has been well thought through • was integrated into the learning experience • prepared students for new learning experiences. <p>The designers:</p> <ul style="list-style-type: none"> • modified assessment of student learning • realised that students were unwilling to engage in higher level learning activities, especially when they were not related to assessment • did not utilise ICT for its own sake • evaluated both usability and student learning.
Project management and teamwork	<ul style="list-style-type: none"> • the development team included a skilled project manager • software development was adequately analysed, planned, scoped and designed prior to commencing the development • the anticipated outcome was realistic, in the context of the time and budget available • the project's context of implementation was planned • the project team had shared goals and could resolve conflict • members of the project team were committed • academic team members realised that they could not perform all the technical functions • staff on the project team valued the different skills required for successful project completion.
Institutional issues	<ul style="list-style-type: none"> • projects were embedded in the department's normal teaching • funding was available for implementation and maintenance of the project • the Head of Department/School and the Dean were supportive of the project • staff were supported through access to technical support and educational software development expertise • students had access to appropriate hardware, software and support • copyright and intellectual property issues were resolved • promotion and tenure policies recognised teaching developments.



IP = Intellectual Property; ITS = Information Technology Services; T&L = Teaching and Learning

Figure 2: Three element technology-adoption model

(Source: McNaught, Phillips, Rossiter, & Winn, 2000)

The policy theme includes leadership, specific institutional policies, the extent to which policies were aligned and congruent in a particular university and the strategic processes such as grant schemes which flowed from policies.

The culture theme comprises factors such as the extent of collaboration within institutions, the personal motivation of innovators, as well as characteristics of the institution such as staff rewards, teaching and learning models and attitudes towards innovation.

The third theme, support, represents the range of institutional infrastructure designed to assist and facilitate the adoption process, such as the library and information technology services, professional development of staff, student support, educational design support and IT literacy support for staff and students.

The conclusion was drawn that an institution which addressed all of the themes shown in Figure 2 would be likely to achieve high uptake rates of any educational innovation.

How can change be managed?

Two common approaches to achieving change in organisations are the top-down approach and the bottom-up approach (Anderson, Johnson, & Milligan, 1999; Bates, 1999; Miller, 1995). The top-down approach imposes central policies in attempting to achieve change, using power-coercive strategies, i.e. change is forced through strategic, financial or industrial means (Miller, 1995). The bottom-up approach, on the other hand, involves organic change arising from innovators and early adopters (Rogers, 1995), or through academics driving issues through the university by provoking discussion and contributing to democratic decision-making processes.

In terms of the model presented in Figure 2, policy is identified with the top-down approach, and culture is associated with the bottom-up approach.

A recent paper (Cummings, Phillips, Lowe, & Tilbrook, 2004) has contended that there is a third approach to achieving change in organisations, and that is a 'middle-out' approach. The middle-out approach is appropriately aligned with the support component in Figure 2. While McNaught et al. (2000) portray the support theme as reactive, implementing policies and supporting teachers in their work, our experiences at Murdoch University indicate that the support role can be proactive rather than passive, "driving change from the middle-out, through operational planning and project management, solving problems and facilitating a connection between central vision and chalk-face practice" (Cummings et al., 2004).

While each approach can be effective in driving change, for change to be fully effective and to achieve the maximum overlap in Figure 2, all stakeholders should be able to take ownership of the innovation.

Implications for practice

Given the arguments presented in this paper about the pedagogical and institutional factors which impact on the success of educational technology development projects, it is appropriate to consider the implications of this analysis to practice in higher education.

This paper indicates that:

- Care is needed to define precisely what is meant in discussions about educational technology.
- Learning environments should be designed using a deep approach to learning, a student-centred approach to teaching, and outcomes-centred course design.
- Educational technology is a tool to facilitate learning activities, not a form of learning in itself.
- There is a disjunction between current practice and what research says about effective learning.

The infrastructure underpinning educational technology is widespread and relatively mature, as are the development tools. Enough is understood about the pedagogy of e-learning to enable effective educational technology environments to be designed, apart from the high expense of such developments. It seems that the major issues impacting on wider and more appropriate use of educational technology are not related to technology, but to wider educational and institutional issues.

For widespread adoption of teaching innovations to occur, a holistic approach needs to be taken, integrating educational technology throughout the entire curriculum, and reconsidering assessment practices and policies. The focus becomes curriculum renewal at the programme of study level:

Integrated course design is also important at the course or departmental level. All too often, different parts of a course are planned either by different lecturers, or insufficient attention is given to structuring and making explicit the interconnections between parts of a course.

(Frielick, 2002, p. 18)

Human factors mitigate against the success of widespread curriculum change in a range of ways. For example, curriculum changes may be met with resistance by students, colleagues and heads of school. Students may be reluctant to move from a comfortable, spoon-feeding approach to study, to a more active role. The view that 'I'm paying to be taught, so teach me!' is increasingly apparent in modern universities. Teachers who have redesigned their subjects according to the constructivist, deep-learning, student-centred approach need to be able to justify their decisions to their students, and explain the future benefits to students of the approach in terms of employability and lifelong learning.

However, if colleagues teaching other subjects do not present similar messages to students, the innovative approaches are unlikely to be sustainable, despite their research grounding. Furthermore, the efforts of a committed team of teachers can be undermined by an unsupportive head of school.

If educational development is about creating environments that encourage deep approaches to learning, then change in the mental models of lecturers is a key aspect of the process.

(Frielick, 2002, p. 16)

While curriculum renewal according to sound pedagogical principles is starting to occur at some universities, much more attention will need to be paid to human change management issues. Leadership from senior managers and heads of school will be crucial if these initiatives are to succeed.

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