

Flexible learning in teacher education: myths, muddles and models

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While there has been widespread take-up of the concept 'flexible learning' within various educational environments—and equally frequent references to the flexible 'natures' of the computer and communication technologies that often underpin flexible learning initiatives—the relationship between technologies and flexibility is not a simple one. In this paper we examine some of the more persistent myths about technologies that are intertwined with discourses of flexibility. We highlight some of the more common 'muddles' that these myths can lead us in to and argue that the 'mess' that so often results from well-intentioned moves to 'be more flexible' is largely a result of the ways that CCTs, or indeed any new educational technology or strategy, is theorized. Drawing on a recent study of online teaching and learning in higher education, we outline a new framework for examining these and related issues as they apply to teacher education.

Introduction

The term 'flexible' is now commonplace in the discourses of higher education in Australia. The word, which is found in combination with terms like 'delivery', 'teaching' and 'learning' literally means pliant, tractable or characterized by a ready capability to adapt to new, different, or changing requirements. When it is used to describe teaching or learning in Higher Education settings, it typically means either other than, or in addition to, lectures, workshops or tutorials to teach a course. Often, computing and communication technologies¹ (CCTs) either explicitly or implicitly figure large in these new ways of teaching and learning. The status of the term is indicated by the saying in some Australian universities that: 'Enthusiasm for flexible learning is inversely proportional to the distance you are from the Vice Chancellor!' (Holzl, 1999). The enthusiasm of Vice-Chancellors for flexibility in teaching and learning appears to derive from two sources: a perception that flexible delivery is more effective and efficient in terms of getting teaching resources to students, and secondly, that one form of flexible delivery, online teaching, offers possibilities for generating revenue from overseas fee-paying students.

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The term 'flexible' is also increasingly used to imply an educational *good*. What matters, it appears, is that the circumstances for teaching and learning carry the label. What is generally implied is that students have more and perhaps better opportunities in which to learn. But little attention has been given to what these new forms of flexible educational practice mean for teachers or for students.² For instance, rather than emphasizing the additional circumstances for learning, developing new, flexible contexts for learning may also add to demands on students and staff to work with various new technologies that support flexibility. While we do not want to suggest that to pursue flexible approaches to teacher education *necessarily* implies using CCTs, the arguments we develop in the paper, though based upon the use of CCTs, are, we suggest, generally applicable to *any* innovation or change in educational practice.³

CCTs have been used to support educational practices long before the term 'flexible' became vogue, and while those who see virtue in greater flexibility are not necessarily proponents or even acquaintances of the proponents of CCTs, the two agendas are clearly not inimical. Nevertheless, it is important to distinguish a long-standing interest in and enthusiasm for the use of various CCTs to support teaching and learning in Higher Education from the more recent emphasis on flexibility. Indeed, much of the development of online teaching can be seen in terms of a broader agenda concerned with increasing the flexibility of delivery of courses. While there has been institutional interest in and encouragement of the use of CCTs in university teaching over a long period, it is only recently that institutions have taken a much more proactive position *vis-à-vis* online teaching. In this respect, it is useful to distinguish what might be called *corporate* approaches from what we have labeled *maverick*⁴ approaches. The corporate approach is characterized by an institution-wide adoption, often mandated, to employ a particular software package⁵ to develop and deliver online courses. On the other hand, the maverick approach is characterized by an individualized approach in which resources are custom-built, perhaps developed on site, but certainly do not enjoy institution-wide use and, more often than not, receive little institutional support.

Both approaches have their merits and drawbacks. Both approaches are more often than not motivated by an interest in improving teaching, although curiosity about and enthusiasm for a new technology can often drive *maverick* approaches. Motivations such as cutting costs and, where possible, generating revenues are imputed to corporate approaches but there is also a 'keeping up with the Joneses'⁶ element that has fuelled the development of a *corporate* approach to online teaching in many universities. There is, however, an additional influence which does not receive much attention.

This is, roughly, the gist of the present crisis: with virtually all orthodox grounds and justifications of their once elevated position either gone or considerably weakened, universities (at least in the developed and affluent countries—in the 'modernizing' countries they may still play the role of factories supplying a heretofore missing educated elite) face the need to rethink and articulate their role in a world that has no use for their traditional services, sets new rules for the game of prestige and

influence, and views with growing suspicion the values they stood for (Bauman, 2001, p. 134).

At the heart of the new world order which is the focus of work for scholars like Bauman, Castells, Sassen and many others, are CCTs. There would be none of the phenomena that are grouped under the term 'globalization' without telecommunication networks and computers. The university, like many other social institutions, has attempted to respond to changed circumstances and it is here that we can most usefully locate the press to more flexible forms of teaching and learning. That is, flexibility is part of a broader agenda of universities learning to operate in a global and national educational marketplace, in which educational 'products' are purchased and traded and in which, like other industries, the phenomena of disintermediation, disaggregation and re-aggregation threaten the values of the traditional university.

Broadly, then, flexibility can be seen as a 'how' response—that is, as a change to the *way* in which teaching and learning occurs. Equally important, but not attracting as much attention, are challenges to the 'what' and the 'why' of university teaching.⁷ Rahhalah Haqq (2001) puts it this way:

Academic disciplines in the west are increasingly facing a crisis of legitimacy. Traditional approaches to knowledge-construction and maintenance in the western academy, rooted in nineteenth century intellectual and institutional norms, are increasingly being seen by many observers as outdated and irrelevant to contemporary concerns. Several factors have contributed to this crisis, including increased privatization of academic institutions, wider availability of academic information on the Internet, and the global media emerging as a transnational guiding and legitimizing force above and beyond institutions of higher education.

Thus, the move to flexible ways of teaching and learning has to be seen as part of a much broader shift in which universities work to remake themselves in what some have labeled 'new times' (Kenway *et al.*, 1995). Given these broad challenges, it is important that the academy not only locates debates about flexible teaching and learning in the broader context briefly alluded to here but also, because of the material and human costs of changing the contexts for teaching and learning, addresses the muddled thinking that has so far accompanied the promotion of flexibility in Higher Education, at least in Australia. It is this latter aspect of the problem that we address in this paper. While we acknowledge the larger context in which these developments have occurred, we direct attention to what might be regarded as the nitty gritty of flexible teaching and learning: the work associated with the design, development and, importantly, the maintenance of teaching flexibly.

What follows is a mapping and a debunking of some of the persistent and important myths or muddles that are associated with the use of technologies in education, in this case, CCTs. As we have argued, the use of CCTs for the purposes of discussing flexible learning does not imply that flexibility is inextricably linked with CCT use. The persistent myths and muddles identified in the paper largely derive from the ways in which CCTs—or, in fact, *any* new technology or approach in education—is theorized. In this paper, we will outline a new framework for

examining these and related issues as they apply to teacher education. The framework has been developed in a recent study of online teaching and learning in higher education.⁸

Muddle 1: CCTs enhance or improve learning

In the early 1980s when vendors were establishing a market for CCTs in education, much of the promotion of these technologies emphasized improvement. Typically, it was improvement in student learning, improvement in access to employment by students and, after the WWW developed in the 1990s, improved access to information. Such was the success of the early improvement claims which accompanied the use of CCTs in education that they are now used routinely and unproblematically to support new CCT-based practices in many forms of teaching in higher education.

The improvement argument can be found in almost all promotions of CCT use; that is, a case is always made, for example, to improve office efficiency, improve sales, improve profits, improve the accuracy of missiles and so on. The basis of the improvement argument derives from the nature of the implementation of *any* new technology. If we have a technology, a way of doing things which is, in crude terms, an assemblage of people and things, then to justify replacing or adding to this existing way of doing things, a claim has to be made that things will be done better, faster, more efficiently and so on with the implementation of the new technology. This is what Lee Sproull and Sarah Kiesler (1991) identified in their studies of communication technologies and named 'first level effects'—'the planned efficiency gains or productivity gains that justify an investment in new technology' (1991, p. 4). However, as they go on to argue, the only *certain* outcome of implementing a new technology is that *things change*: '... people pay attention to different things, have contact with different people, and depend on one another differently'. Whereas some of the change may be judged to be good and improve aspects of the way things were done, *it is simply not possible* to know in advance that this will necessarily be the case. Moreover, because using a new technology results in changes, comparisons between what was the case and what is the case after implementation, become difficult if not impossible.

Thus, the implementation of any new technology needs to be seen in terms of the *changes* that will always derive from the new ways people relate to one another as they develop new ways of doing things. Whether this can be judged to be good, bad, to improve or not, can only be made on a case-by-case basis. This way of understanding the implementation of a new technology has not curbed an ongoing interest in researching CCTs in education as if the consequences of their deployment are predictable. What are sought are generalisabilities of outcomes. A large volume of research concerned with *effects* of new media in education now exists. Reeves (1998) provides a useful synthesis which suggests that effects, if any, are modest. The effects studied in this kind of research typically are based upon measurements of performance, usually on a standardized test. Groups of students are 'treated' with exposure

to computer use of some kind while other groups are given an 'equivalent' form of instruction, and then the results of both groups are compared. A recent report⁹ which attracted the attention of *The economist* described results showing that students did *worse* on standardized tests when they used computers. Research of this kind, particularly in an era of neoliberal economic thinking and regardless of how it may be judged in terms of its design, methodological assumptions and theoretical framing, reduces the way implementations can be understood to what can be measured by a pre-existing metric, a test of some kind. It is like testing the pulling capacity of cars by attaching ploughs to them.

The problem of understanding what happens when new technologies are deployed is of interest in many other fields. Paul Strassman has asked similar questions about the investment in CCTs in business. Until recently, an *improvement* rationale was in common use to support CCT investment in business. Strassman (1997) has demonstrated that there is *no* correlation between expenditure on CCTs and profitability or efficiency. He goes on to argue that investment in CCTs is now coming to be understood as a *risk*, rather than as producing assured increases in productivity, and that each instance of investment in CCTs needs to be considered on its own in order to analyze outcomes. Thus, any attempt to re-order teaching or business or any other field of human activity should be studied not from the point of view of anticipated or expected improvements but with a more open view to the unpredictability and complexity of altering or attempting to alter an existing way of doing things.

Muddle 2: innovations like CCTs diffuse through existing education systems

An important aspect of the way CCTs are understood is the theorizing of their take-up and adoption. In the study of technological change, the diffusion innovation theory of Everett Rogers (Rogers, 1962, 1983, 1995; Rogers & Shoemaker, 1971) has been most influential. In education, this has appeared in what has been called factor or category-based research (Bigum, 2000). In this view, innovations like on-line teaching have a kind of momentum of their own. They are promoted by change agents, are picked up by early adopters, rejected by resisters, and succeed or fail depending upon the coincidence of a large number of influences or factors.

While it is always possible to shoehorn a particular case into the pre-determined categories of diffusion innovation theory, the result tends to be little more than an exercise in taxonomy. There is a limited set of possibilities for each of the category types the theory propounds—for example, participants can only be one of: innovators (venturesome); early adopters (respectable); early majority (deliberate); late majority (sceptical); laggards (traditional) (Clarke, 1999). That is, all users and non-users have to fall into these pre-determined categories. Leaving aside the problems of assigning users to each category, there is no capacity for a user who, for instance, might adopt early, stop using, and then pick it up again, only to reject at a later time. If the implementation of an innovation was simply a matter of relying on the predictive capacity of a taxonomy, then one might expect, at the very least,

a much better capacity to anticipate, plan and implement educational innovations. As Clarke (1999) observes, the theory 'is at its best as a descriptive tool, less strong in its explanatory power, and less useful still in predicting outcomes, and providing guidance as to how to accelerate the rate of adoption'. The problem for a theory of change that relies on pre-established categories is that it is limited in its capacity to account for new and unanticipated arrangements or orderings. It can only represent what occurs in terms of categories developed prior to the implementation of the innovation.

A more serious problem of diffusion innovation theory is that the innovation or the technology is understood to pass through the adoption process largely *unchanged*—that is, the social or educational is seen to either conform or not conform to the requirements of the innovation. Such a view is consistent with technological determinism, the view that technologies are autonomous forces that mould or shape the social. Contemporary views hold that technological determinism overly simplifies what occurs when an innovation is adopted by ignoring the messy, *negotiated* nature of all innovations. But as Bromley (1997, p. 54) notes, technological determinism is still common in education:

Criticism of technological determinism is hardly new. Indeed, a well-established body of literature has been developing for decades, with contributions from across the disciplines. But this line of work has had remarkably little impact within education, and especially within the field of educational technology, which continues to be dominated by an idealized view of science and technology long since abandoned by scientists themselves. Technologically determinist accounts of educational computing remain distressingly pervasive.

Muddle 3: CCTs are just tools

This claim or slogan has been used to talk about CCTs in education from the earliest days. It places emphasis on the fact that CCTs are merely devices to do things, like hammers, automobiles, or refrigerators. Commonly, there is an implication that there is a *neutrality* associated with these technologies—that their use is largely determined by the user, and that there is no need to consider the design and characteristics of these technologies other than in terms of how to make best or appropriate use of them. This particular view is consistent with a kind of social determinism, that it is the social which is autonomous and which shapes and moulds any technology.

As a slogan, the 'just a tool' claim is often used to reassure would-be users. As a means of thinking about CCTs in education, it poses important problems, not the least of which is that if it is 'just a tool' then the failure of CCTs to live up to their promised educational benefits can be sheeted home totally to teachers. This muddle is a kind of inverse of muddles #1 and 2, which both presuppose a technology that is more or less immutable and which is accepted or rejected and which has effects. In the case of the 'just a tool' muddle, the emphasis is on the other side of the social/technical binary. An illustration of the use of this slogan as an argument can

be found in the debate about the ownership of guns and their role in killing people—specifically, the ‘just a tool’ argument posits that ‘guns don’t kill people, people do’ (see, for example, Grint & Woolgar, 1992). This logic, which depends on the separation of the human from the non-human, is a simple expression of social determinism.

On the surface, the separation of the social and the technical appears obvious, even sensible. After all, the body is defined by its boundaries which provide a way of distinguishing what is and is not ‘body’; however, as a wide range of scholars (see, for example, Haraway, 1991; Deitch, 1992; Turkle, 1995; Hayles, 1999) have shown, thinking in terms of human/machine combinations, or cyborgs, is more useful than maintaining a boundary that is increasingly eroded as human bodies take on and take in all kinds of prosthetic devices, from eye and ear transplants to artificial limbs, organs and hair. While fixed prosthetics are perhaps relatively easy to make a case for hybridity around, it is perhaps less obvious for the devices that are removable. Some of these, like dentures or contact lenses, have a status that is a little more connected than, say, things like mobile phones or guns. In the case of the gun, as Grint and Woolgar (1992) argue, it is the user-gun hybrid which acts, not the gun nor the user alone: ‘gun-less killers do not shoot people any more than killer-less guns do; but the fusion of human and non-human can lead to devastating results’ (Grint & Woolgar, 1992, p. 156). In other words, the association of human and non-human, language bearer and non-language bearer, need not be of the visceral kind. Nespor (1994, p. 8), for example, offers an account of knowing along similar lines:

... the way I make meaning when I’m sitting in the local bar arguing with someone about knowledge is different to how I make it right now as I’m writing this. In the bar meaning is constructed in conversation and it varies according to whom I’m talking, our level of sobriety and so forth. In my office I can consult books, articles, fieldnotes, interview transcripts and earlier drafts of this text. The difference between what I ‘know’ in the two settings isn’t my ability to articulate some head knowledge that remains constant across the two settings, nor do the books, people or other elements of the contexts simply ‘add to’ some knowledge that already exists in my head. Rather, in the two settings I’m part of different cognitive systems (I’m a different ‘I’).

This perspective opens much of what might have previously been regarded as social or technical as a much less certain *sociotechnical*. As Law and Bijker (1992, p. 290) put it:

Purely social relations are found only in the imaginations of sociologists, among baboons, or possibly, just possibly on nudist beaches; and purely technical relations are found only in the wilder reaches of science fiction.

The issue of how to deal with the language bearers, the humans and the non-language bearers, the non-humans, is therefore *the* important consideration in any theorizing of innovation or the adoption of new technologies in education. It is at the nub, as we have shown, of the commonly used muddles associated with the use of CCTs in education. There are many more examples of muddled thinking that could

be mapped, but all of them can arguably be traced back to a separation of the social and the technical. Flexible delivery in teacher education is, therefore, a current and important site at which the debates about technologies and education are being played out.

Towards a framework for technologies in education

The framework we describe here draws on the 'sociology of translation', or what is sometimes referred to as *actor-network theory* (ANT) (Callon, 1986a, 1986b; Latour, 1988). With its origins in the sociology of science and technology, ANT arose, in part, from the asymmetrical way in which successful and unsuccessful innovations were analyzed; that is, by way of illustration, it might be argued that a particular regime of flexible teaching did not work because the lecturer was dull and unimaginative. A different regime might be judged to have worked because the lecturer was pedagogically sound, inventive and hard-working.¹⁰ Rather than taking these categories as explanatory, an ANT sensibility locates them as things to be explained.

ANT employs a particular notion of *heterogeneity* to describe the formation and stabilization (or not) of projects and innovations. The term 'heterogeneity' is used to refer to the mixed, that is, social *and* technical, nature of what are termed *sociotechnical* assemblages (Callon & Latour, 1981; Hughes, 1983; Latour, 1986). Bijker and Law (1992, p. 7) put it this way: assemblages or networks embody 'social, political, psychological, economic, and professional commitments, skills, prejudices, possibilities, and constraints.' In ANT, materiality and sociality produce themselves (Law & Mol, 1995). Thus, in terms of flexible delivery in teacher education, an ANT framing would consider all entities that make up the assemblage. So, for instance, in the case of online teaching, it would likely include¹¹ students, lecturer, Head of unit/school, Dean, technical support staff from local to institutional level, software including the vendor and maintenance personnel, system software for PCs and servers (plus vendor, plus maintenance personnel), hardware (plus vendor, plus maintenance personnel), physical settings and other resources for students, lecturer/tutor and so on. The extent to which any or all of these actors are a part of the negotiation which leads to particular practices becoming more or less routinized is the focus of ANT-informed research, which generally asks questions of the kind: How did it get to be like this?

In broad terms, an ANT-based account draws attention to the negotiations that need to occur in order for a stable assemblage to be formed. The number of actors that need to be brought into alignment to achieve an outcome like online teaching is considerable. When their unruliness¹² is also taken into account, the task is not a small one. Not only is work required to draw actors into the assemblage, *ongoing* work is required to maintain¹³ the assemblage so that the newly negotiated roles for all actors are kept in place. For the assemblage to remain in place, the actors need to be habituated in their roles. In some instances, this could mean inscribing roles onto particular actors; for instance, configuring computers in student laboratories to load a particular web page on boot up or building a lecture theatre to accommodate

fixed microphones and fixed cameras to support video conference-based teaching. In the former case, the computers in the laboratory can be relatively easily reinscribed, whereas in the latter instance the room is less easily reinscribed. Other instances of making assemblages associated with flexible teaching and learning more durable include 'standardising'¹⁴ on a particular platform for the delivery of web-based courses, 'requiring' all staff to put all of their courses online, and attaching the university student administration system to the online delivery system.

In the formation of an alliance, ANT makes a particular point about the nature of the innovation over time. The assemblage or network, the new approach or technology is something that is 'translated' a lot or a little with every recruitment. It does not, as is assumed in diffusion innovation theory, remain a fixed entity. As Bruno Latour (1996, p. 13) puts it, '[i]t's essential to continue to generate interest, to seduce, to translate interests'. To a university administrator, then, software that provides a standard way of putting materials online is translated to be simple and easy for staff to put courses online, or it may be translated as software that will improve online teaching. Equally, the software translates the administrator who then becomes, among other things, the administrator who promotes the virtues of the software. To staff in the universities at which online teaching has been mandated, the software becomes a necessary component for self-advancement, and/or software to improve student learning.

Nor is it only a matter of making a translation to effect a recruitment. That is, in Sproull and Kiesler's (1991) terms, promising an improvement of some kind. Once an actor has become associated with an assemblage, you cannot relax and assume it will stay in place. Roles need to be policed and, where possible, sociotechnical configurations need to be made more durable. What tends to happen in many innovations in education, though, is neatly summarized by Diana Laurillard (1993, p. 8), who wrote: 'Research and development projects on educational media pay quantities of hard cash for development, lip-service to evaluation, and no attention to implementation.' It is often assumed that, once an innovation is in place, it will take on a life of its own and more or less run itself. This is the socio-technical equivalent of a perpetual motion machine. Yet, the observation Laurillard offers appears to operate in many instances of educational innovation.

Performing teacher education flexibly

In the kind of account of the development of any educational innovation that derives from an ANT framing, it might be assumed that the end-point assemblage is something that operates or has effects and that is in most sense singular, that is a system for delivering online teacher education, complete with online lecturers, students and so on. But, as Anni Dugdale (1999, p. 116) argues, 'if the subject is 'decentred', then it may be ... that the object is also *and always* decentred' (see Law, 2001; Mol, 2001), and, further, 'if decisions, subjects, or indeed objects, cohere, then it is because they are both singular and multiple' (Dugdale, 1999, p. 132). This

is clearly not the way in which the technologies of the flexible are represented in the various discourses that support online teaching in higher education.

It is here that the framework we are employing draws from what has become known as the performative turn in science and technology studies (Law, 2001; Mol, 1999). In short, what this means for, say, online teaching is that online teaching is *multiple* rather than singular. It is more than one because it is performed in different ways by different actors in the assemblage. It is less than many because the performances are connected in a variety of ways. Importantly, there is no essence, or thing underneath all the performances. Online teaching is the various performances.

The performative turn represents an ontological claim that understands the object order not as a given but as something that is regarded as shaky and unstable. In this frame, an object is never a singular thing, but rather a mesh or assemblage of performances which are, in some measure, connected or coordinated. The ontological move is that objects do not exist in and of themselves. All there is is performance. As Law and Singleton (2000, np) put it:

The differences between realism and pragmatism are important, but neither share the performative assumption that reality is brought into being in the process of knowing. Or, to put it more precisely, neither would assume that the object that is known and the subject that does the knowing are co-produced in the same performance, that the epistemological problem (what is true) and the ontological question (what is) are both resolved (or not) in the same moment. The improbability of the performative turn, then, is that it deals as much with ontology as with epistemology. In particular, its implausibility may be that it appears to say that anything can be performed into being.

In this framing, flexible learning in teacher education is seen as a network of actors that are brought into existence through a large set of inter-meshed performances, performances that constitute and are constituted by actors. In terms of teaching and learning online, we can argue that the way a Vice Chancellor performs online teaching in her institution is not the same as the way a system administrator performs it, nor is it the same as the way that library staff, lecturers and students perform online teaching and learning.¹⁵ The sheer number of actors brought into being and who perform online teaching flags the difficulty of obtaining a successful performance or set of performances.

The other, and important, point that needs to be made is that not just *any* performance is possible. As Law and Singleton (2000, np) argue, 'performances are difficult to put on unless they build on the networks that are already in place'. This claim is consistent with a body of literature that reports conservative outcomes associated with the use of new technologies in various organizations (Cuban, 1986; Winston, 1986; Hodas, 1996; Winston, 1998).¹⁶ In terms of teaching online and teacher education, any new performance or set of performances must 'surf on existing networks' (Law & Singleton, 2000, np). In other words, performances that are recognized as teacher education shape and determine, allowable performances of teaching online. Further, from an ANT perspective, teacher education itself is not

something that inheres to a set of practices or products; rather it is something that is performed and, at the same time, performs.

Bringing together the socio-technical performance of teacher education with socio-technical performances of flexibility, be they online or via some other way, is not simple. More important, how we frame this work matters. As the performance grooves or patterns are laid down and are repeated, they provide a kind of template or limit to what can come next. In this respect, as the celebration of being or becoming flexible continues, we need to be ever aware of how particular performances of flexibility close down what is possible, rather than, as the rhetoric suggests, open up performances of teacher education.

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Notes

- 1 We prefer the descriptive terms computing and communication to attributive terms like information, new or learning which are often used to talk about using computers and telecommunications. We use the term broadly to include such technologies as broadband, multimedia and the Internet in all its manifestations.
- 2 Beckett (1998) offers a useful account which is typical of those who are less enthusiastic about being 'flexible'.
- 3 Franklin (1990) argues that technology is most usefully understood as practice, formalized practice, the way things are done.
- 4 Craig Smith was the team member of the ARC project who coined the term for the non-conformist, individualistic approaches to online teaching that we studied.
- 5 WebCT and BlackBoard are two commonly used packages in Australian universities.
- 6 This motivation was clearly evident in the early days of computer use in schools (Bigum *et*

- al., 1987), when many schools acquired these technologies simply because the school down the road had them.
- 7 This is, of course, not the case for university courses which are specifically concerned with the use or study of CCTs. What is and is not included in a network and who decides is not a simple matter. Latour's (1996) dictum of 'follow the actors' and allowing them to decide where the limits of the network are has attracted criticism (Grint & Woolgar, 1997).
- 8 An ARC-funded study (1990–1991): Bigum *et al.*, *Investigating online learning in higher education settings: an actor-network approach*.
- 9 A brief account of Joshua Angrist and Victor Levy's (2002) research was published in *The economist*, 26 October 2002.
- 10 The basis of innovation diffusion theory can be seen in these kinds of analyses.
- 11 What is and is not included in a network and who decides is not a simple matter. Latour's (1996) dictum of 'follow the actors' and allowing them to decide where the limits of the network are has attracted criticism (Grint & Woolgar, 1997).
- 12 We use the term 'unruliness' to indicate that all actors are not simply waiting around to be drawn into an assemblage to produce online teaching but are part of other, perhaps competing assemblages, and they need to be extricated from some of these in order to establish the new associations required to produce the effect of online teaching and learning.
- 13 The term maintenance is commonly applied to hardware and software. In ANT terms, the term applies to *all* actors.
- 14 Phil Agre (2000) analyses the issues relating to standardization that arises from the use of CCTs in universities.
- 15 Papers in preparation that derive from the ARC study (referred to previously) provide details.
- 16 This is not surprising. Indeed, most of the many patterns associated with the use of various technologies in education and that are reported in the literature map into this framework.

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