Interpreting Complexity: a case for the sociotechnical interaction framework as an analytical lens for learning technology research

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Abstract

In this paper we highlight challenging issues in current learning technology research, particularly in relation to emerging collaborative technologies and the growing body of evidence on the learner experience. The complex nature of the interplay of social, technical and environmental factors is examined along with an overview of the key theoretical models which are currently in play. Limitations are identified in the learning technology literature in which a technological determinism is often evident, despite repeated calls for an approach which takes fuller account of the technology's pedagogical, organisational, social and technical aspects. We propose that interdisciplinary collaboration has the potential to help us address the demanding task of analysing these interconnected factors, and may also go some way towards mitigating over-charged claims of the impact and effectiveness of learning technology against the reality of its use. The focus of this paper is on sociotechnical approaches, particularly those derived from a social informatics tradition, which to date appear to have received little attention in learning technology research. We identify potential benefits in applying these approaches to today's learning environment which encompasses fast-moving technology developments along with changing communicative behaviours among learners, whether on campus, in the workplace or in everyday life. Most importantly, sociotechnical frameworks address the issue of technological determinism by explicitly recognising that agency also resides in individual learners, social structures, the design of learning artefacts and context in which the learning takes place. In order to demonstrate the value of such approaches, we go on to outline findings from the application of one of these concepts, namely a sociotechnical interaction network (STIN), to a transnational networked learning context. The paper concludes by proposing that these approaches in general, and the sociotechnical interaction network concept in particular, are important conceptual tools in dealing with issues currently confronting contemporary learning technology research, such as the spread of web 2.0 and mobile technologies and the increasingly complex social and technological contexts of many learners. They may also provide a valuable means of exploring the increasingly blurred distinction between abstract and formal learning, and situated informal learning, particularly in relation to the workplace.

Keywords

Sociotechnical frameworks; learning technology research; collaborative learning; web 2.0

Introduction

In this short paper we argue that there have been limitations in the learning technology literature, some of which are related to an implicit technological determinism in many accounts. Sociotechnical approaches developed in technology studies, and in particular the study of information systems (IS) and information and communication technologies (ICT) provide a rich source of concepts which are under-used in the learning technology literature. We illustrate this with a brief summary of our own use of one of these, Kling et al's (2003) 'sociotechnical interaction network'. We conclude by arguing that these approaches in general, and the sociotechnical

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interaction network concept in particular, are important conceptual tools in dealing with issues currently confronting contemporary learning technology research, such as the spread of web 2.0 and mobile technologies, the increasingly complex social and technological contexts of many learners, and the increasingly blurred distinction between abstract and formal learning, and situated informal learning, particularly in relation to the workplace.

Limitations in learning technology literature

We have asserted previously that understanding the complex relationship between learning and technology requires a theoretical framework which takes into account a diverse range of socio-technical and environmental factors (Walker & Creanor, 2009). Historically, attempts to interpret this relationship through a purely mechanistic lens have displayed significant weaknesses, most notably in the dissonance between claims made for the effectiveness of technology for learning and empirical evidence from real life experiences (e.g. Selwyn, 2007; Laurillard, 2005).

The literature reveals an often uneasy relationship between pedagogy, socio-technical factors and agency, with a persistent technological determinism continually challenging a deeper understanding of the nature of this elaborate interplay. The unrelenting advance of technology in education often appears resistant to repeated pleas for evidence-informed pedagogy (Laurillard, 2009; Conole & Oliver, 2007; Mayes & De Freitas, 2007) and is continually fuelled by political agendas and strategic funding opportunities (Hughes, 2008; Conole, Smith & White, 2007; Clegg et al, 2003).

This has been evidenced most recently in the widespread adoption of collaborative technologies such as mobile devices and web 2.0 applications which, while not designed primarily for learning, are being embraced by educators in a 'creative explosion of new ideas' (Laurillard, 2009:5). Indeed we are warned of 'a crisis looming and a paradox emerging' (Traxler, 2009:70) over issues of agency, ownership and control in light of the rapid evolution of these devices and their widespread adoption by learners. It can be seen too in the attention commanded by immersive 3D virtual worlds as their educational potential becomes more apparent (Bayne, 2008; Bronack et al, 2008), and in the acceptance of social networking as a well-established presence in the lives of many learners (Jones & Ramanau, 2009; Creanor et al, 2008).

It is becoming increasingly challenging for educators to keep pace with, and make sense of, the speed of change, yet it is essential to create opportunities for networked learning which will meet learner expectations and develop the capacity for collaborative learning now demanded by the workplace (e.g. Nielson, 2009). It is against this background that a shift in emphasis appears to be taking place, from a predominantly evaluative approach to an increasingly theoretical analysis of the educational potential of these constantly evolving collaborative technologies (e.g. Code & Zaparyniuk, 2009; Savin-Baden, 2008).

Whilst the need for an inter-disciplinary approach to theory is acknowledged (Oliver et al, 2007; Steeples & Jones, 2002), the epistemological foundation for learning technology research derives predominately from traditional theories of learning, with social constructivism continuing to lead the field (e.g. Jones & Bronack, 2008; Parker & Chao, 2007; Felix, 2005). Nonetheless, it is clear that the boundaries between learning and the wider socio-technical environment are becoming increasingly blurred. Recognising this, research into networked learning has invoked a broader range of theoretical frameworks, including, among others, network theory (e.g. Jones, 2004), actor network theory (e.g. Fox, 2002), complexity and chaos theory (e.g. Barnett, 2000) as well as the concept of communities of practice (e.g. Ryberg & Larsson, 2008). With the exception perhaps of Lave and Wenger's (1991) communities of practice or Wenger's (1998) learning communities model, there is little evidence in the literature of widespread adoption of these frameworks within 'mainstream' learning technology research or practice where the networked learning metaphor may not appear immediately relevant, particularly in a campus-based, blended learning context (e.g. Bonk & Graham, 2006: Oliver & Trigwell, 2005). As attention shifts increasingly towards the affordances of collaborative and social networking however, new theories are beginning to emerge which relate learning technology and social practices more closely, harnessing the concepts of 'the collective' (Dron and Anderson, 2009) and 'connectivism' (Siemens, 2004), which, while still relatively untested, provide alternative lenses through which learning in the web 2.0 world may be examined.

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It would appear then, that alongside a growing recognition of the multiplicity of factors which can influence learning in a technology-rich context, there is a greater appreciation of the need for appropriate socio-technical frameworks which can make sense of these new interactions and analyse their impact. Although more established traditions have been explored to some extent, particularly in relation to networked learning, there remains a limited understanding of how the increasingly connected learning context might benefit from a closer inspection of existing socio-technical models.

Sociotechnical approaches

An often implicit assumption in much learning technology research is that technology itself is conceptually straightforward. In its strong, explicitly deterministic, form this asserts that a particular technology largely determines the kind of use that happens once it is introduced. A weaker version, closer to what Kling (2000) has termed the 'standard tool' model of ICT, may emphasise the fit between a technology and a pedagogy either choosing/developing a pedagogy to fit the technology or choosing the technology to fit a pedagogy. Such views often oversimplify the processes of ICT design and use involved; a wide range of cultural, organisational, social, political (and Political), economic, technical, gender and other processes that are at play in the real-world introduction of technologies, in ways which are often contingent and indeterminate.

There is a wide range of perspectives and on technologies which attempt to capture this complexity in for differing purposes, in different ways and at different levels, such as sociotechnical systems (Emery & Trist, 1960), soft systems (Checkland, 1984), social informatics (Kling, 2000), social shaping of technology (Williams & Edge, 1996) and social construction of technology (Bijker & Law, 1992). Perhaps the best known of these in the learning technology literature is actor network theory. We cannot introduce and consider these variously complementary and competing approaches here but merely highlight their range and note that they have generated a rich set of concepts with which to think about the complexity of human-technology relationships. While these approaches differ quite radically, a common concern is to avoid technologically determinist accounts of technology and they share a number of recurring features:

- the social and the artefactual are closely related in the production and use of technologies, such that it is rarely, if ever, helpful to try to consider them separately
- the ways technologies are used are substantively context-dependent
- the distinction between technology design and use is frequently blurred
- the focus of research is typically on the design/and or use of technology 'in the wild'
- they frequently claim to be 'critical' theories either in the sense of questioning many of the assertions made about technologies by enthusiasts, manufacturers, policy makers and others, and/or in the sense of being emancipatory, for example by highlighting the need for user and stakeholder participation in effective designs

In the following section, we illustrate the value of a sociotechnical approach to deepening our understanding of the interaction of learners and technology through an example from our own research, in which we apply the concept of a 'sociotechnical interaction network' (STIN) (Kling et al, 2003) to a case study of computer-mediated distance learning[1] from the world of transnational trade union education.

Thinking sociotechnically: the example of the sociotechnical interaction network

In our own collaborations (Creanor & Walker, 2005; Walker & Creanor, 2005; Walker & Creanor, 2009) we have particularly drawn on the 'social informatics' perspective on technology closely associated with the work of Rob Kling (e.g. Kling, 2000). The term has two broad meanings. Firstly, according to Kling, social informatics is a "body of research that examines the design, uses, and consequences of information and

[1] Computer-mediated distance lerning (CMDL) was the term used in the original project. We have reinstated it here in response to a reviewer's comment that our (agreed, rather loose) use of the term 'technology-enhanced learning' itself reflects a degree of technological determinism.

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communication technologies in ways that take into account their interaction with institutional and cultural contexts" (Kling, 2000:217; Kling et al, 2000). It is a "field that is defined by its topic (and fundamental questions about it) rather than by a family of methods, much like the fields of urban studies, or gerontology" (Kling, 2000a:218). Understood in this way SI effectively defines the topic of analysis as ICT in its social and organisational contexts, in effect as a critique of technologically determinist or 'standard tool' models of technology. The second meaning refers to the concepts and theories generated by such approaches. Horton et al (2005) have pointed out, from a European perspective, that this is a rather broader field with a richer range of research traditions than Kling himself appears to credit in his summaries of archetypal SI research (e.g. Kling, 2000). As well as defining the field, Kling and colleagues have made substantive contributions to the understanding of technology, as outlined below.

In a recent paper we have used Kling et al's (2003) concept of the sociotechnical interaction network (STIN) to analyse a case of cross-border networked learning in trade union education (Walker & Creanor, 2009). The sociotechnical interaction network (STIN) takes a network view of the relations between the material and the social, in which the technological is seen as co-constitutive with the social, in that the technological elements cannot sensibly be discussed independently of the social aspects. Behaviour is not simply dictated by the affordances of a particular technology or artefact, but through participants interacting with both people and artefacts which may themselves also be part of other sociotechnical interaction networks. The STIN embodies several conceptual differences from the 'standard model' of technology use (Kling *et al*, 2003). Firstly, the analytic focus is ecological, deliberately looking beyond the affordances of the technology or the narrow relationships between participants and artefacts in a particular network. Secondly, a limited view of the 'user' is replaced with a wider view of participants as social actors who have multiple roles and relationships which can affect behaviour in a STIN under analysis by linking that STIN to others in multiple ways. This reconception of the user as a social actor reflects a view that the the technology is not at the centre of the 'user's' world, but is one thing among many human and non-human elements with which they interact in the process of accomplishing something. Thirdly, technology is viewed as open to local adaptation and social influence ('configurational'), rather than simply offering a limited set of functions[2]. The STIN traces and represents the key interactions between people and technologies.

To sketch our case study very briefly, learner-participants were trade union members and officers from unions in two or more European countries who took part in transnational blended online/face-to-face learning episodes addressing a range of trade union-related topics. The courses were designed and delivered by experienced trade union educators with knowledge of online learning from their own national practices, with academic support. In various ways the courses all involved some elements of online working, using the First Class conferencing system. Our analysis focussed on the human/technology relationships in these networked learning events. Following are two[3] examples of how thinking in terms of sociotechnical interaction networks directed our attention beyond the immediate online activities to examine aspects of the learners' environments and the organisation of the learning event.

Firstly, we considered how learners integrated technologies into their pre-existing technology-related environments and practices. This might frequently involve complex domestic or organisational arrangements. In our case study a particular set of issues arose around the use of the conferencing system's client software. The client software did not use standard internet protocols, leading to it being blocked by some organisations' firewalls. While the project's own technical support could give guidance on how to configure firewalls, the actual process for many learners centred on the negotiation of with their local organisations' technical staff to open the firewall to the client. For these learners, accessing the server required a set of social/organisational as well as technical links to be negotiated. Perhaps ironically, for learners who accessed the servers from home (in many cases because they didn't have organisational 'support') generally experienced less difficulty; the sociotechnical interaction networks in these cases were considerably simpler..

[2] The sociotechnical interaction network has a number of similarities with actor network theory in the way it conceives of technology. There are, though some important differences. Most notably, STINs do not assume a symmetry between the human and the material as in the ANT concept of the actant.

[3] Space does not allow discussion of a third aspect here – the evolution of STINs over the life of a networked learning event.

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Secondly, and following on from our consideration of aspects of learners' local environments as sociotechnical interaction networks, we viewed the networked learning event as a form of sociotechnical interaction network which aimed to knit together these diverse local networks for the purpose of learning. The effectiveness of the learning in our event was significantly disrupted when a training session in the use of the conferencing system planned for an initial face to face workshop was missed because the tutor experienced unforeseen travel problems. Because one group of learners was already familiar with the system, they subsequently used it broadly as the tutors had planned. The other group instead carried out their online collaboration using their usual email addresses, rendering it invisible both to the other group and to the tutors. Although the planned learning outcomes were in fact achieved by all participants, the subsequent evolution of the online phase of the learning event was very different from the way the tutors had originally envisaged it. The technical and organisational problems were closely intertwined: it made little sense to try to consider them separately.

Both of these examples illustrate the close, and in practice inseparable, relationships between the technological and the social in networked learning. The sociotechnical interaction approach to modelling a networked learning event allowed us to draw out the detail of the processes in play in learning episodes which, at first glance, may appear unremarkable. It provides a framework for identifying key spects of the context of networked learners and learning. It also illustrates findings common in wider studies of information systems. Firstly, it illustrates that patterns of design and use of technologies are highly context dependent. The ability of learners to participate effectively in this case was influenced strongly by whether they tried to take part from home or from work, and in the latter case on their ability to negotiate with others. Secondly, it demonstrates the path-dependence of technology use: differing groups of users patterns of use were heavily influenced by prior exposures to technologies once the planned training failed. The apparently small, local contingency of a missed train can have significant consequences for the conduct of three month learning event..

Conclusion: the value of sociotechnical approaches to networked learning

We have argued that sociotechnical approaches to conceptualising technology design and use go beyond the mechanistic and the technological determinism of much learning technology research. We have illustrated this through our application of one these approaches, the sociotechnical interaction network to, a case study of networked learning. This has highlighted how effective use of learning technology needs both to be accessible to learners (as well as tutors, administrators and others) who may be working in very different social and technological settings. Simply looking at technology, or indeed the learning outcomes, would tell us very little about the conduct of this event.

A stronger research focus on the contexts and specificities of networked learning events and applications will help us to avoid over-generalisations based on particular successes (or failures). It is likely that claims made on behalf of technologies would be rather more modest than is often the case at the moment.

Beyond these general arguments, though, we would argue, however, that they have a very particular value in the current state of learning technology research. Firstly, this is because many of the technologies currently under investigation are particularly 'malleable', 'configurational' or 'highly intertwined' with the social. The social elements of many social media technologies are particularly obvious and they cannot be studied independently of the social arrangements that accompany them. For example, what is remarkable and interesting about the success of Wikipedia derives at least as much from the changing social arrangements and practices and their 'embodiment' in software as much as from the underlying programs and infrastructure.

Secondly, these technologies are being introduced in a period when higher education is undergoing profound change. There is, for example, increasing pressure to develop 'work-ready' graduates who have the independent learning skills so sought after by employers (Archer & Davidson, 2008), leading to a greater emphasis on authentic work-related learning activities and a growing interest in socio-technical models of learning which derive from organisational and workplace studies (e.g. Littlejohn et al, 2009).

Thirdly, recent learner experience studies have highlighted the complex and often subversive nature of technology use among learners (that is, the diversity and complexity of sociotechnical interaction networks with which learning technologies and practices interact). Many learners emphasised the importance of using technology to connect their learning to their wider social environments and personal networks in order to gain the support they needed for their ultimate success (Sharpe et al, 2009; Trinder et al, 2008). Applying a socio-technical interaction framework to these diverse learner behaviours may provide a more holistic and empirical

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view of both formal and informal aspects of learning which goes beyond that captured by current networked learning research.

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