Chapter 10
Learning Technology in Context: A Case for the Sociotechnical Interaction Framework as an Analytical Lens for Networked Learning Research

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Introduction

In this chapter, we argue that there have been limitations in the learning technology literature related to a widespread implicit technological determinism. While the concept of networked learning goes some way to redress this, a more systematic use of sociotechnical findings theories developed in the fields of technology studies and information systems can help us to avoid mechanistic accounts. This has frequently contributed to gaps between the claims made for learning technologies and the reality of their use. The study of networked learning as a distinctive aspect of learning technology practice has countered this to some extent by placing the emphasis on communication and connections (Goodyear et al. 2004; McConnell 2006) and their relationship to learning (Dirckinck-Holmfeld 2010). Indeed our critique is underpinned by the definition of networked learning proposed by Jones and Steeples (2002) who describe it as:

> …learning in which information and communication technology (C&IT) is used to promote connections: between one learner and other learners; between learners and tutors; between a learning community and its learning resources (2002, p. 2).

This understanding of the relationship between learning and technology does not necessarily require a new theory of *learning* (Mayes and de Freitas 2007). Rather, it emphasises the social, rather than individual or knowledge-process aspects of learning (Goodyear 2002). This socio-cultural perspective is particularly relevant in the evolving landscape of networked learning where learners are

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appropriating mobile, Web 2.0 and social media technologies and educators are seeking to use them to enrich the learning experience. It also resonates strongly with the democratic and inclusive nature of the trade union education context within which much of our own research has been conducted (e.g. Creanor and Walker 2005; Walker and Creanor 2009).

In the networked learning domain the focus has often been on the impact of asynchronous discussion forums, in the main within carefully designed formal learning contexts (e.g. Kear 2004; Ellis and Calvo 2004), and often problematising the issue of communication in terms of "best fit" for the technology platform (McAteer et al. 2002; Hammond 1999).

> … engaging in online textual discourse, attenuated over time and space, or packed densely into a realtime chat, is a central practice of much networked learning and teaching (Goodyear 2009, p. viii).

Recent research has begun to recognise the social elements of technology use more explicitly with its emphasis on the learner perspective (Hardy and Bates 2009; Sharpe et al. 2010), providing an important, though incomplete, corrective to technology-centred views of the learning experience. This leads to a consideration of learning at levels beyond the individual and also opens the door to consideration of a stratified model of learning taking account for example, of learning at the group, organisational or community levels (e.g. Pawlowsky 2001).

Going further, there are traditions of studying technology generally, and information and communications technology in particular, which view its use as the outcome, rather than the instigator, of complex interactions between people and the material world (Law and Hassard 1999). These traditions include social informatics (Kling 2000), social shaping of technology (Mackenzie and Wacjman 1999), soft systems (Checkland and Holwell 1998), sociotechnical systems (Trist and Bamforth 1951) and others. They have yielded a collection of "mid-range" theories and concepts which, we suggest, have been under-utilised in studies of networked learning. Further, this lack of consideration of the interaction between social agency and learning artefacts has frequently resulted in stark discrepancies between the claims made about the potential of particular technologies and the subsequent realities of their use in a learning context (Selwyn 2007; Laurillard 2005).

A distinguishing feature of networked learning research is its focus on socio-cultural theories (Jones and Dirckinck-Holmfeld 2009), including those of Lave and Wenger (1991), Wenger (1998) and Engeström (1999), which often look beyond formal learning to informal communities of practice and learning within organisations. In this context, shared goals and the co-construction of knowledge are key aspects. Elsewhere, learning technology research has drawn primarily on educational theories of learning, which place the emphasis on the cognitive or socio-cognitive processes of developing personal knowledge and understanding (Mayes and De Freitas 2007; Jonassen and Land 2000).

In this chapter, we contend that sociotechnical approaches developed in technology studies, and in particular the study of information systems (IS) and information and communication technologies (ICT) can also provide a rich source of concepts which are under-used in the networked learning literature. We illustrate

this with a brief summary of our own use of one of these, Kling et al. (2003) "sociotechnical interaction network (STIN)." We conclude by arguing that these approaches in general, and the STIN concept in particular, are important conceptual tools in dealing with issues currently confronting contemporary networked learning 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.

Limitations in the 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 sociotechnical and environmental factors (Walker and 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. Indeed as Selwyn points out there is,

> …a growing need for the education community to account for the distinct 'digital disconnect' between the enthusiastic rhetoric and rather more mundane reality of university ICT use (2007, p. 84).

The literature reveals an uneasy relationship between pedagogy, technology and agency, with a persistent technological determinism limiting a more careful analysis of the nature of this interplay. The implementation and use of technology in education often appear resistant to repeated pleas for evidence-informed pedagogy (Laurillard 2009; Conole and Oliver 2007) and are frequently driven by political agendas and tactical funding opportunities (Hughes 2008; Conole et al. 2007; Clegg et al. 2003). Most recently, this can be seen in responses to the spread 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, p. 5) in a context where social networking is a well-established presence in the lives of many learners (Jones and Ramanau 2009; Creanor et al. 2008). Indeed we are warned of "*a crisis looming and a paradox emerging*" (Traxler 2009, p. 70) over issues of agency, ownership and control in light of the rapid evolution of these devices and applications and their adoption by learners. It can be seen too in the attention commanded by immersive 3D virtual worlds as claims about their educational potential become more widespread (Bayne 2008; Bronack et al. 2008). Here again many accounts default to technologically determinist, with rapid technological and social changes leading developments in education, often at the expense of pedagogy and theory.

It is becoming increasingly challenging for educators to keep pace with, and make sense of, the speed of technological change, while simultaneously responding to demands for learning experiences which develop the capacity for the collaborative,

as well as independent, learning skills now increasingly demanded of graduates in the workplace (e.g. Nielsen 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 and Zaparyniuk 2009; Savin-Baden 2008).

While the need for an inter-disciplinary approach to theory is recognised (Oliver et al. 2007; Jones and Steeples 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 and Bronack 2008; Parker and Chao 2007; Felix 2005). Nonetheless, it is clear that the boundaries between education systems and the wider sociotechnical environment are becoming increasingly blurred. Recognising this, research into networked learning has placed the emphasis on "*epistemic fluency*" (Goodyear 2009, p. x), invoking 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 and Larson 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, for example in a campus-based, blended learning context (e.g. Bonk and Graham 2006; Oliver and Trigwell 2005). As attention shifts increasingly towards the affordances of collaborative and social networking, however, new perspectives are relating learning technology and social practices more closely by harnessing the concepts of "the collective" (Dron and Anderson 2009) and "connectivism" (Siemens 2004). These emerging theories, while still relatively untested, claim to provide alternative lenses through which learning in the Web 2.0 world may be examined. A potential danger in this approach, however, is in tipping the balance towards social agency at the expense of individual autonomy.

The learner experience debate of recent years, again given added momentum by the availability of strategic funding and the "popularised" interest in the net generation, has helped to shift the focus from the relatively narrow confines of formal education to the wider consequences of technology use in the everyday lives of learners (Sharpe et al. 2009; De Freitas and Conole 2010). Studies of the agency of individual learners in the appropriation of social media and personal mobile devices for learning purposes have shed new light on previously hidden attitudes and behaviours (Creanor and Trinder 2010; Czerniewicz et al. 2009). Nevertheless there is a growing recognition that a focus on the individual and their personal networks often fails to take fully into account the impact of context (Jones and Healing 2010). Here, theoretical approaches have drawn on activity theory (Engeström et al. 1999) and more recently critical realism's concepts of morphogenesis/morphostatis (Archer 1995). 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 sociotechnical frameworks which can make sense of these new interactions and analyse their consequences. Although

more established traditions have been explored to some extent, particularly in the study of networked learning, there remains a limited understanding of how the increasingly connected learning context can benefit from a closer inspection of existing sociotechnical understandings of technology.

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 involved in ICT design and use; a wide range of cultural, organisational, social, political (and Political), economic, technical, gender and other processes are at play in the real-world introduction of technologies, in ways which are often contingent and indeterminate.

There is a wide range of approaches to studying technology which attempt to capture this complexity for differing purposes, in different ways and at different levels. These include sociotechnical systems (Emery and Trist 1960), soft systems (Checkland 1984), social informatics (Kling 2000), social shaping of technology (Williams and Edge 1996) and social construction of technology (Bijker and Law 1992). Perhaps the best known of these in the learning technology literature are actor network theory (Law and Hassard 1999; Latour 2005) and activity theory (Engeström 1999). We cannot introduce and consider these variously complementary and competing approaches here but merely highlight their range and note that they have generated valuable ways of thinking about the complexity of human–technology relationships. While these approaches differ quite radically from each other, a common concern is to avoid technologically determinist accounts of technology. 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 designed and used are substantively context-dependent.
- The distinction between technology design and use is frequently blurred. Indeed, the term "user" is often a problematic and inadequate term to describe relationships to technology.
- The focus of research is typically on the design/and or use of technology "in the wild" rather than on controlled laboratory-style tests.
- 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 particular sociotechnical approach to studying 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 a recent article journal paper we have used Kling et al's in our own collaborations (Creanor and Walker 2005; Walker and Creanor 2005, 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 communication technologies in ways that take into account their interaction with institutional and cultural contexts" (Kling 2000, p. 217). 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 2000, p. 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 article journal paper we have used Kling et al.'s (2003) concept of the STIN to analyse a case of cross-border networked learning in trade union education (Walker and Creanor 2009). The 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, such that the technological elements cannot sensibly be discussed independently of the social aspects. Behaviour is not simply a consequence of the affordances of a particular technology or artefact. Rather, it emerges from participants' interactions with other people, with institutions and with artefacts.

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

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. It is understood therefore, that participants will share the benefits of their shared knowledge, artefacts and expertise across the various networks to which they belong. This reconception of the user as a social actor better reflects the typical situation, in which a 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. These interactions, rather than any inherent properties of the technology, are identified by Orlikowski (2000) as the ultimate determinants of network structure. Thirdly, technology is viewed as open to local adaptation and social influence (it is "configurational"), rather than simply offering a limited set of functions.[2] The STIN traces and represents the key interactions between people and technologies, allowing us to consider the impact of these interactions on informal and formal learning

To sketch our case study very briefly (for more detail, see Walker and Creanor 2009), 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. These took place as part of a large-scale project with 16 partners, supported by the European Social Fund, which aimed to increase capacity for social dialogue across a range of European trade union organisations. In particular, the learning interventions were aimed at preparing trade unionists to respond better to the increasing workplace regulation originating at the European Union, rather than the national, level. In all, the project developed 32 courses, involving a total of 471 trade union officers and representatives along with 27 tutors and facilitators. 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 extended elements of online collaboration, using the First Class conferencing system, complementing the classroom-based seminars. Our analysis focussed on the human/technology relationships in these networked learning events which were rendered even more complex by their multicultural and multilingual aspects.

A mixed-mode methodology incorporating online observation, questionnaires, interviews and video-recording of an evaluation workshop produced a rich dataset.

[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, and they highlight interactions both within and across networks.

In order to render the data collection manageable, the various groupings of participants were conceived of as a series of case studies (Yin 2003), thus enabling an in-depth examination of their outcomes. Following are two[3] examples of how thinking in terms of STINs 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. As is common with adult part-time learners, this frequently involved complex domestic or organisational arrangements which influenced their ability to engage fully in the learning intervention. In our case study, a particular set of issues arose around the use of the conferencing system's client software which required to be downloaded to each participant's PC to allow them to access the online learning environment either from home or from their workplace. Instructions on how to do this were given at the first face-to-face session, with the offer of additional support by phone or email. Although not strictly speaking a networked learning activity, any delay in doing this would have meant a late start for participants which could have had a detrimental impact on their initial enthusiasm for learning and their ongoing motivation.

It soon became clear that what had not been fully considered were the issues participants might face in accessing the learning environment from their workplace. The client software did not use standard internet protocols, leading it to being blocked by some organisations' firewalls. While the project's own technical support could give guidance on how to configure firewalls to allow the client to access the server, the actual process for many learners centred on the negotiation with their local organisations' technical staff to open the firewall to the client. While some network managers were happy to allow access others were not, forcing participants to revert to the less flexible web interface. In other cases, firewall settings were changed informally and would be lost when the firewall was subsequently reset or upgraded. For participants in these situations, access to the learning environment disappeared in apparently arbitrary ways, rendering them disempowered as learners.

For participants from work premises, then, accessing the online learning environment required a set of social/organisational as well as technical arrangements to be established. Perhaps ironically, learners who accessed the servers from home (in many cases, precisely because they did not have organisational "support") generally experienced less difficulty; the STINs in these cases were considerably simpler. Where domestic firewalls did exist, learners who were unsure could be guided directly through the process of opening the appropriate channels by the project's support staff.

We characterised the sociotechnical networks through which individual participants gained access to the online environment as "ego-STINs" (analogous to the ego-networks of social network analysis). Elsewhere in the literature (Greene and Kirton 2003), issues such as negotiating access to a family computer in order to participate in online learning, are highlighted and might be considered to be

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

elements of these ego-STINs. Personal networks may also include the use of social media and mobile technology to connect to family, friends and work colleagues. The complexity of relationships, both social and technical, within these ego-STINs is often invisible to tutors, yet can have a significant impact on the engagement with, and outcome of, networked learning.

Secondly, and following on from our consideration of aspects of learners' local environments as STINs, we viewed the networked learning event itself as a form of STIN which was designed to knit together these diverse local networks for the purpose of enabling learning. The courses were designed to bring trade unionists from different countries together to examine the changing workplace skills required by their union members. Face-to-face sessions were conducted with simultaneous translation, but the online working was designed to be carried out by national groups linked together by (bilingual) tutors.

Illustrating this, the effectiveness of the online learning episode in a second case study 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. The course brought together two national groups of participants, each of which had distinct socio-cultural profiles in their trade union context, their approaches to learning and their familiarity with learning technologies. One national group of learners was already familiar with the system since it was the same one used by their own union, therefore they subsequently used it broadly as the tutors had planned. The other was unfamiliar with the system and instead these learners carried out their online collaboration using their normal email application. This rendered their online activities invisible both to the other group and to the tutors, and the subsequent evolution of the online phase of the learning event was very different from the way the tutors had originally envisaged it (Fig. 10.1). The tutors meanwhile, drew on their own tutor network for guidance and support. Although both groups completed the learning activities successfully and reported positive experiences despite using different technologies, the transnational element of the online course, originally a key focus, was lacking. Nevertheless, the fact that each group interpreted and implemented the learning activities correctly is testament to the validity and clarity of the pedagogical design which proved to be independent of a particular technology.

Again, it is difficult to explain these observations without noting the very close relationship between context, planned pedagogy and technology. That the planned learning outcomes were still achieved by both groups might be taken as further evidence of the capacity of "users" to work around technologies which don't address their needs. We likened the conduct online to a (sociotechnical interaction) network of (sociotechnical interaction) networks, designed to link up the ego-STINS in ways which would allow learning.

These examples illustrate the close, and in practice inseparable, relationships between the technological, the social and the pedagogical, in networked learning. The sociotechnical interaction approach to modelling a networked learning event allowed us to draw out and interpret the complexity of the processes at play in networked learning episodes which may otherwise have remained hidden. This is not unusual in

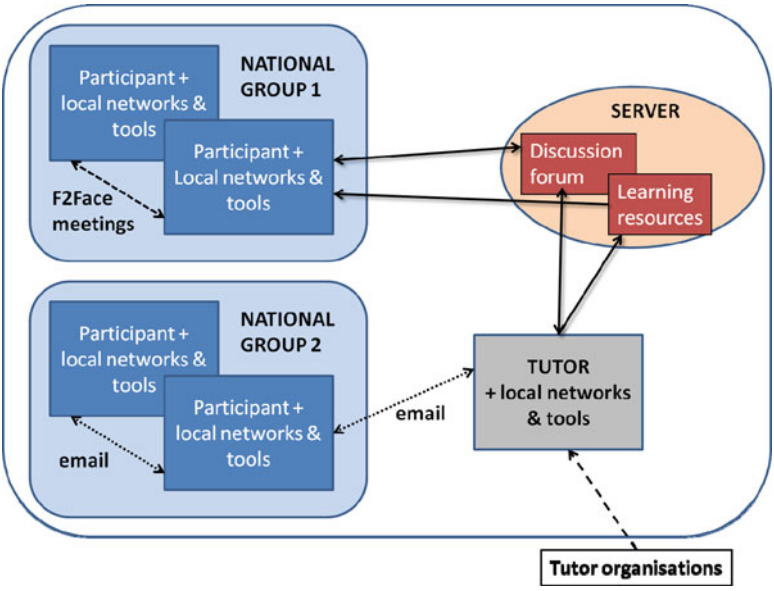

Fig. 10.1 Diagram showing the complexity of interactions during online course

social studies of technology, where a concern with actual practice draws out the way in which rather mundane issues, and responses to them, are essential to allowing technologies to function. The approach provides a framework for identifying key aspects of the context of networked learners and learning which goes beyond the obvious. 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 the former 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 other learners. Secondly, it demonstrates the path-dependence of technology use: differing groups of participants' patterns of use were heavily influenced by prior exposures to technologies once the planned training failed. There was nothing inevitable about the way learners used particular technologies. The apparently small, local contingency of a missed training event can have significant consequences for the conduct of a 3-month learning event.

Discussion: 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 current research in the learning technology field. We have illustrated this through our application of one these approaches, the STIN, to two case studies of

networked learning, demonstrating that achieving access and maintaining engagement with learning can be as much a social as technical accomplishment for learners (as well as tutors, administrators and others) who may be working in very different social and technological settings. When confronted with difficulties in using a particular technology to collaborate online, learners improvised their own way of working, drawing on their prior knowledge of communications technologies. Simply looking at technology, the learning design 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, indeed, failures). It is likely that claims made on behalf of technologies in support of networked learning would be rather more modest than is often the case currently.

Beyond these general arguments, sociotechnical approaches to learning technology in general, and the concept of the STIN in particular, have very particular value in contemporary learning technology research. Firstly, this is because many of the Web 2.0 technologies that are currently the focus of practice and research are examples of technologies which are particularly "malleable," "configurational" or "highly intertwined" with the social. The social elements of many social media technologies are particularly obvious and the technologies cannot usefully 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 it does from the underlying programmes and infrastructure of a wiki.

Secondly, these technologies are being introduced in a period when higher education is undergoing profound environmental change. There is, for example, increasing pressure to develop "work-ready" graduates who have the independent learning skills so sought after by employers (Archer and Davison 2008), leading to a greater emphasis on authentic work-related learning activities and a growing interest in sociotechnical models of learning which derive from organisational and workplace studies (e.g. Littlejohn et al. 2009). While making the final revisions to this chapter, indeed, recommendations for radically changing the entire nature of higher education funding in England from the state to the student have been proposed and appear likely to form the basis of future policy.

Thirdly, recent learner experience studies have highlighted the complex and often subversive nature of technology use among learners (i.e. the diversity and complexity of STINs with which learning technologies and practices interact). Many learners have 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 sociotechnical interaction framework to these diverse learner situations and behaviours may provide a more holistic and detailed view of both formal and informal aspects of learning which goes beyond that captured by current networked learning research.

Conclusion

In this chapter, we have highlighted the need for an inclusive and encompassing range of theoretical perspectives in networked learning research if we are to continue to interpret the complex social, pedagogical and technological landscape in which networked learning resides. We have recognised the distinct character of networked learning research where "epistemic fluency" is encouraged. We have also noted weaknesses in some aspects of learning technology research based on technologically determinist assumptions and argued that there exist bodies of research from technology studies and information systems which can help us better to conceptualise the relationship of people, technology and pedagogy in learning technology environments. We have illustrated this by developing a concept from the social informatics tradition to a case study of trade union education, and suggested how such an approach can contribute to a more grounded and detailed understanding of how learners interact with systems designed to support their learning. Research based on sociotechnical strategies will, we suggest, complement accepted socio-cultural theories in networked learning and enrich our ability to interpret the complex interactions at play.

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