The STIN in the tale: a socio-technical interaction perspective on networked learning

Steve Walker[1] & Linda Creanor[2]

[1] Faculty of Mathematics, Computing and Society, The Open University // s.walker@open.ac.uk

[2] The Caledonian Academy, Glasgow Caledonian University // l.creanor@gcal.ac.uk

ABSTRACT

In this paper, we go beyond what have been described as 'mechanistic' accounts of e-learning to explore the complexity of relationships between people and technology as encountered in cases of networked learning. We introduce from the social informatics literature the concept of sociotechnical interaction networks which focus on the interplay between participants, technology, learning artefacts and practices. We apply this concept to case material drawn from transnational trade union education to identify and to analyse three aspects of networked learning: the local sociotechnical networks of learners; the construction of an overarching, global sociotechnical network for learning; and the evolution of such networks over time. Finally we identify issues for further research highlighted by these models.

Keywords

Networked learning, Social informatics, Social action, Web 2.0

INTRODUCTION

The learning landscape is becoming increasingly complex. In part this is due to technological developments such as Web 2.0, virtual worlds and social networking practices, alongside other factors such as widespread national and international policy changes, changing workplace skill requirements and growing learner demand for flexible learning arrangements. To understand this complexity, educators in diverse contexts require models and concepts which can help to make sense of, and to capitalise on, the interplay between people, technology, learning artefacts and learning processes. Networked learning provides a useful framework which encompasses not only pedagogy, but also the broader social, technical and cultural forces at play (Jones, 2004). The network metaphor which Jones describes as, "… *a unifying concept allowing us to bring together apparently disparate elements of the field"* (p81) remains compelling. It underpins our thinking as we explore models of networked learning which extend beyond the traditional confines of the formal tertiary education sector.

Designing and participating in effective networked learning are significant accomplishments in which educators and educational technologists ‘orchestrate’ groups of people using technology, tailored learning activities and a range of learning resources to enable learning (e.g. Barab et al, 2004; Walker & Creanor, 2005). Educators frequently need to integrate practices associated with networked learning alongside those of face-to-face learning, creating a ‘blended’ environment. Learners participate in individual and collaborative activities through which they can develop new meanings, skills and knowledge. In doing so they may use technologies which are new to them or, increasingly, they may be integrating their e-learning activities into an ‘underworld’ of communication through personal social and mobile technologies, of which tutors may be unaware. (Creanor et al, 2008). In this paper we draw on the social informatics and sociotechnical traditions of research into information and communications technologies (ICT) to highlight the complexity of interactions between people and technology in networked learning situations, and the consequent potential sensitivity to apparently trivial difficulties. Our primary contribution is to demonstrate how a particular approach from these traditions, the sociotechnical interaction network or STIN (Kling et al, 2003; Scacchi, 2005; Meyer, 2006) can be used to think about these complex interactions.

Sociotechnical studies have established that technology design and use are complex outcomes of multiple, interacting influences operating at different levels. At the micro-level for example, organisational and social influences include incentive structures and local working or learning cultures (e.g. Orlikowski, 1993; Kling, 2000). Simultaneously at macro-level, influencing factors identified by, among others, Agre (1998) and Williams (2000), include social (e.g. in the way particular communities of practice are embedded within institutions), political (e.g. how technologies may be promoted or regulated) and economic (e.g. the various cost factors associated with particular types of transaction). Studies of networked learning in these traditions (e.g. Hara & Kling, 1999; Kling & Courtright, 2004; Dutton et al, 2004) offer an alternative approach to understanding the evolving relationship of learning and technology to those which comprise what Diana Laurillard has referred to as a historically dominant ‘mechanistic’ account of change (Nash et al, 2004; Laurillard, 2005). The weaknesses of mechanistic models can be seen in discrepancies between claims made about learning technologies and the reality of their use. These have been demonstrated both at the micro-level of student responses to technology enhanced learning (e.g. Hara & Kling, 1999; Sharpe et al, 2005; Creanor et al, 2008) and at wider institutional and political levels (Selwyn, 2007).

Sociotechnical studies have generated a rich collection of methods, concepts and findings about how technology is implemented and used. In the following sections we use and develop one of these, the concept of the STIN, originally proposed by Kling *et al* (2003), to analyse the complexity of three aspects of networked learning. Drawing on case material from a transnational trade union education initiative, we distinguish the concepts of 'ego-STIN' (a network viewed from a particular individual perspective) and 'whole-network STIN' (an overarching network which encompasses a number of 'ego-STINs'). In the subsequent discussion we conclude that while the STIN concept offers a potentially fruitful approach to considering the complexity of real-life networked learning, further work is needed, in particular to follow changes in the configurations of STINs over time.

Framework: sociotechnical interaction networks

Network models have been widely used to capture the complexity of relationships between people and technology at multiple levels of analysis from the macro levels of social forces (e.g. Law and Callon, 1992) to the micro level of particular technologies (e.g. Kling & Courtright, 2004). In these models, technology supported networks are viewed as collections of artefacts and people linked in multiple ways by practices, protocols and understandings. These models reflect the complexity of introducing new artefacts into existing networks, where outcomes are frequently unpredictable and may propagate through wider networks to have effects often far removed from the original intentions.

The sociotechnical interaction network (STIN) is one such networked model, in which the technological is seen as co-constitutive with the social. Kling (2000) refers to such a network as '*highly intertwined'*, in that the technological elements cannot sensibly be discussed independently of the social aspects. This view does not, however, '*…insist that this intertwining of technical and social elements is universal. Rather, it is commonplace, and a good heuristic for inquiry, especially with complex technologies*' (Kling, 2000a:220).

Behaviour is thus 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 networks. Kling *et al* (2003) illustrate this approach through an example of online academic communication in which they distinguish several conceptual differences from what they call the 'standard model' of technology use. Firstly, their 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 (see also Lamb & Kling, 2003) who have multiple roles and relationships which can affect behaviour in a STIN under analysis by linking that STIN to other relevant STINs in multiple ways. Thirdly, technology is viewed as open to local adaptation and social influence ('configurational'), rather than simply offering a limited set of functions. Kling *et al* (2003) argue that this approach is better able to capture the complex interaction between the digital systems and the 'real world' institutions and practices of academic life.

In using the STIN approach the scope and appropriate level of detail to be included in the network are determined by the researcher, relative to the issue under analysis: different levels of resolution will be appropriate to different analyses. STINs are recursively embedded within each other such that it is always, in principle, possible to break down individual elements of STINs further, to reveal the networks within them. STINs, then, offer rich models of complex social, political, economic and in the cases discussed here, pedagogic, interactions and can be used at multiple levels of analysis

In developing our analysis of the relationship between technology and learning, we have chosen to concentrate on a micro-level analysis of specific arrangements of people, technologies and practices. We use diagrams of STINs to visualise and illustrate the important social and technical nodes and diverse links between them. Comparing the configuration of these networks then allows us to illustrate commonalities and differences between the heterogeneous configurations of actors within them. It is in this metaphoric mode that we use the concept of STINs to describe and analyse three aspects of networked learning: the relationships within 'local' configurations; between 'local' and 'global' configurations'; and as a way of modelling the way these configurations may change over time. Below we reconceptualise these three issues in related literatures as sociotechnical interaction network terms before testing these models against case study materials.

Local configurations

Participants in networked learning commonly come from a diverse range of backgrounds where they are embedded in a range of occupational, domestic or other sociotechnical networks and practices. These have important implications for how they gain access to the resources they need to participate in networked learning. Representing participants' local situations as STINs allows us to identify important elements in a particular setting, and the relationships and interactions between them

Our case material is drawn from examples of e-learning in a trade union setting, where learning events are conducted largely outside formal educational institutions, and in which informal and peer elements of learning and access to resources play a significant role. Sawchuk (2003) has demonstrated how resources are mobilised through social networks to enable learning about technology in working class communities in Canada. These informal 'working class computer learning networks' are central to the development of their members' knowledge about computers. Sawchuk's identification of these networks suggests that participation in networked learning may similarly rely on available social capital, understood as the ability to mobilise a variety of resources (including information) through social networks.

We can use STINs to illustrate these local circumstances, using them in ways analogous to the 'ego' network of social network analysis (Wasserman & Faust, 1994:41) which traces the network links to and from an individual person. Ego network studies have been widely used in disciplines such as social anthropology and clinical psychology to examine the sources of support available to individuals or families. While in a STIN, these 'ego' networks will be heterogeneous, made up of the social and technical practices associated with each learner, they allow us to identify the support available to participants, and barriers to participation in wider sociotechnical networks. We develop this argument in the first case study below.

Networked learning as the relationship of local and global configurations

If, as in the previous discussion, we conceive of participants' local contexts as STINs, then we can think of the design of networked learning as linking together these local STINs to enable learning; a networked learning event becomes a 'network of networks'. The design of such an event becomes an exercise in 'heterogeneous engineering', bringing together people and technologies organised through pedagogic practices and artefacts.

When we think of a networked learning event as a STIN, we are interested in the totality of interactions between the people and artefacts involved, and the subsequent outcomes for learning. Rather than placing an individual at the centre of the network, as in the local 'ego' STIN, we are interested in the structure and properties of the whole network; Kling et al

(2003) work at a whole-network level of analysis in their study of scholarly communication. The social network analysis literature (e.g. Wasserman & Faust, 1994) suggests a rich range of concepts which can help us to think about properties of such STINs. These include, for example, network centrality, structural equivalence, and weak ties. In the networked learning literature, discontinuities between participants' local STINs can be thought of as boundaries, which, given the heterogeneous nature of STINs, can take multiple forms (e.g. participants may be using different software; they may come from different social settings; they may have different mother tongues). We have previously argued that networked learning interventions can be thought of as boundary encounters, and that depending on the nature of the intervention, boundaries may either be central opportunities for, or obstacles to, learning (Walker & Creanor, 2005). In such settings, facilitators play a particularly important role in identifying potential cross-boundary interactions and designing appropriate pedagogical artefacts and collaborative activities. We explore this further in the second case study below.

Changing configurations over time

The structures of many STINs are likely to be time sensitive. Barabasi (2002) has demonstrated that network structures vary depending on the rules governing how new nodes are joined to a network. While the nature of nodes and the links which connect them are much simpler in Barabasi's examples (e.g. networks of hyperlinks between web sites) than in the examples with which we are concerned, we may similarly find that the manner in which STINs emerge or are designed influence their structures and properties in important ways.

In our case examples, the sociotechnical configurations of networked learning may change over time at three levels. Firstly, an individual's 'ego' STIN may be reconfigured by their participation in a learning event and the consequent development of new social relations or the construction of new knowledge or skills. For example, new technology-related skills may result in the reconfiguration of some of the technical elements in the 'ego' STIN. More widely, as people's informational needs evolve through different stages of their careers, they mobilise information and learning in different ways (Penuel & Cohen, 2003), a process which may be amenable to analysis as a reconfiguration of 'ego' STINs. Secondly, within a learning event different sociotechnical configurations may be appropriate to different stages of, or activities within, a learning process. The learning design may incorporate changing activities, social relations and uses of technologies during learning intervention. Thirdly, particularly in social action settings, an explicit aim of networked learning may be to achieve some form of longer term social change. Learning interventions may be aimed either at equipping individuals to participate more effectively in wider social activities or at supporting interactions among participants beyond the life of the learning activity itself. This involves moving from learning together, to doing or working together.

Exploring networked learning therefore may contribute to the emerging understandings of how virtual communities change over time (Andriessen, 2005) and how learning, in these less formal guises, can be supported.

CASE STUDIES

Our case studies come from trade union education, where learning is frequently conducted outside formal education contexts. It is also characterised by the values informing the design and content of the learning and the intent to encourage some form of collective social change. Pedagogies are varied, but in general tend to be learner-, rather than teacher- or expert-centred, often using co-operative or collaborative methods. The collaborative dimension of the learning is a part of the process of social change, and in some cases is intended directly to encourage collaborative working beyond a particular learning intervention. The audience for trade union learning is often comprised of people without histories of engagement with educational institutions, and in some cases with active alienation from them. It can, as in the examples discussed below, involve bringing together people who are living and working in very diverse settings.

In the following section the three uses of STINs outlined above will be illustrated by drawing on case material from Dialog On, a collaborative 16-partner project supported by the European Social Fund (ESF) and led by the European Trade Union College (ETUCO). The project took a networked learning approach to building the capacity of unions to organise in rapidly changing economic circumstances. The project was organised in two strands: a computer-mediated distance learning (CMDL) strand and a 'networking' strand. In the CMDL strand, experienced trade union educators were trained by a team of educators knowledgeable about e-learning methods, with academic support, to design and deliver fourteen national and transnational blended mode courses. The transnational courses were organised as two residential workshops with intervening periods of around three months of online learning activity. The topics of the courses were varied, for example, focussing on 'Regulation of atypical employment', or 'Competencies for negotiating on issues of vocational training'. The target audiences were correspondingly varied, though the transnational courses all involved trade unionists from pairs of European Union countries.

In the networking strand trade unionists from particular industrial sectors (e.g. the graphical industries, or higher education) participated in eight learning networks organised by European sectoral trade union federations to exchange information and generate knowledge about developments in their sector. The networking activities were similarly organised as combinations of residential workshops and facilitated online activities. Pairs of 'animateurs' were trained for each network, one of whom specialised in operational and pedagogic aspects of the network, and the other in organisational aspects. Most of the networks were intended to become self-sustaining, beyond the life of the project. Both strands were supported by centrally-produced materials and a common communication infrastructure (the First Class conferencing system). A total of 27 CMDL strand tutors and animateurs were trained in online learning and network facilitation methods before embarking on their own courses or networks. Over the two years of the project, tutors delivered 32 distance learning courses to 471 trade union learners, while the 8 online industrial sector networks attracted over 300 participants. The data used below were derived primarily from the project evaluation activities.

Each transnational course was treated as an exploratory case study of a real world event (Yin, 2003) seeking to identify constraints and benefits of transnational e-learning in trade union education. Each case combined quantitative and qualitative data. Course participants completed an initial self-profile questionnaire covering age, gender, knowledge of languages (spoken and written), union position and responsibilities, prior experience of transnational union collaboration, and prior experience of both trade union and distance education. At the end of each course, participants were asked to complete an evaluative questionnaire, covering their views on the course, materials, expectations of technology, their experiences of online collaboration and their expectations of their ability to apply their learning, all on 5-point Likert-type scales. The questionnaire also included open-ended questions asking for more detailed views of what they had liked about the course and any suggestions for improvement. The online activities were analysed quantitatively, with information collected on distribution of conference contributions temporally, by participant and within sub-conferences (usually corresponding either to particular sub-tasks or work allocated to sub-groups in the design of the courses). Course tutors were asked to complete an evaluation questionnaire, presented their experiences at an end-of-project conference and discussed issues raised at an evaluation workshop designed and attended by the authors.

The data were assembled into narratives summarising the conduct of each course – in particular patterns of online conference usage, the relationship to the learning programmes (as designed by the course tutors and network animateurs), and both tutor and participant comments on the courses, the achievements, and the difficulties encountered. In the examples below we have used the construct of the sociotechnical interaction network to consider instances of difficulties encountered by tutors and/or participants. These failures, we suggest, highlight aspects of sociotechnical interaction networks which otherwise remain unremarked, or even unnoticed.

Local sociotechnical interaction networks

Dialog On was concerned with enabling participation in networked learning by trade union members living and working in very different situations. Some elements of these situations were common across groups or sub-groups of participants but some were unique to an individual.

Participation in networked learning events requires access to a communication infrastructure. Access, however, is embedded in a range of organisational and domestic circumstances. Some of these relationships come to the fore clearly in the case of trade union education, where participants may, for example, be full-time union employees participating as part of their paid employment, workplace representatives with an office and technology access provided by agreement with (or legal requirement on) the employer, or activists with no access in the workplace but with access from home. Domestic and office settings have differing enabling and constraining implications for access. Below, we present these differing situations as micro-level sociotechnical interaction networks. We use the example of firewall restrictions on access to the project conferencing server. This was the most widely reported technical problem in the project, occurring frequently in participant course evaluations and interviews with network animateurs and course tutors.

The project conference system could be accessed either via a web interface or by a dedicated software client downloaded to the user's PC and which communicated with the server using a proprietary protocol. Most participants were trained in the use of the conference system in project workshops. The training emphasised the client rather than the web interface, partly because some functionality was only available via the client and partly because, once learned, the client interface was thought to be easier to use. However, a widely reported problem across the project was that of using the client to access the server through organisational firewalls, a problem which derived from the client's use of seldom-used Internet connection settings. For example:

> *"Some problem with "firewalls" obliges me to go through the Internet... and it is slower..."* –Participant evaluation questionnaire

> *"Technical problems (mainly firewalls) which were solved by contacts with national web masters. It was difficult when participants wanted to install First Class on their professional computer at the university because the protection systems refused."* – Network workshop evaluation report.

A more complex picture emerged during discussions by network animateurs at a mid-project evaluation event. For security reasons, many network managers set firewalls to block all connection settings except those explicitly permitted, for example to support applications such as web access or email. A frequently reported experience, following the training, was of participants returning to their organisations and finding that, having installed the client software as instructed, they were unable to connect to the server. Participants were advised to discuss their problem with whomever was responsible for network security in their organisation. While many network managers were responsive to the problem and 'opened' the firewall to client traffic, others were not. In such cases, despite the training, participants were forced to use the web interface. However, the problem recurred on several occasions even where the firewall had been opened: in instances where network managers opened the port informally, the new settings were lost when a firewall was upgraded. From a user perspective the firewall appeared arbitrarily to deny access once more. For these participants, achieving and maintaining access to the server was a personal and organisational accomplishment as much as a technological one (Figure 1).

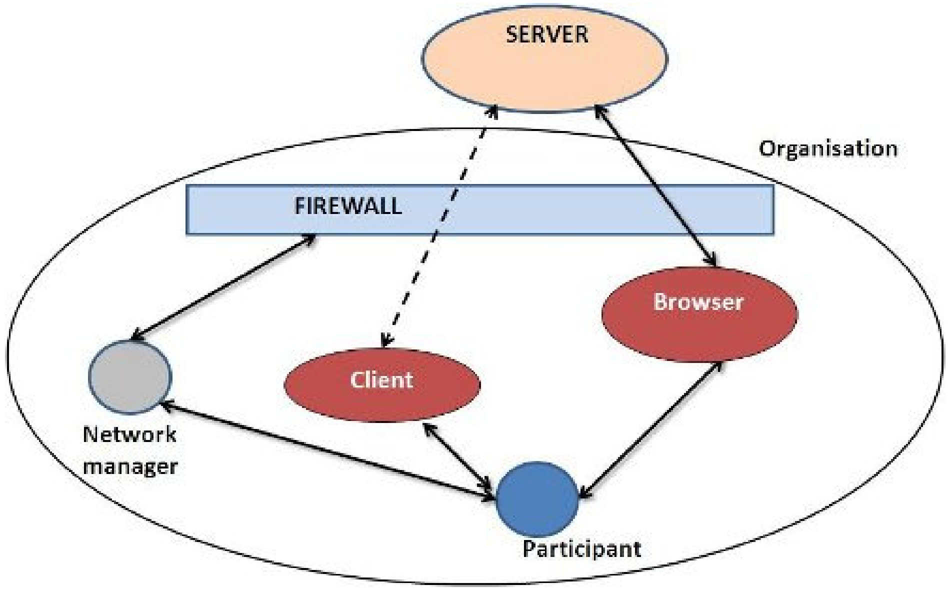

Figure 1: Accessing external conference server from within an organisation: stylised example of an 'ego STIN'

For those participants who accessed the project server from the home, a rather simpler 'ego STIN' (Figure 2) illustrates the organisationally simpler environment.

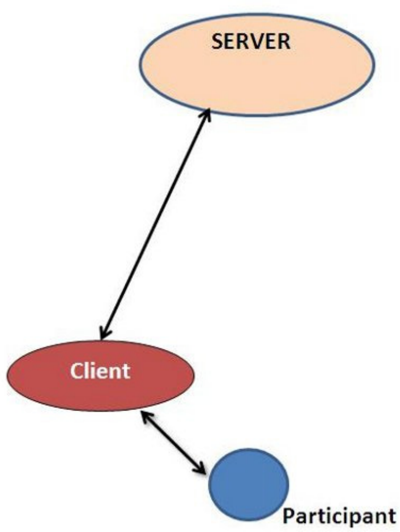

Figure 2: Accessing external conference server from home: stylised example

Given the difficulties in accessing the course infrastructure, there was an immediate danger of a negative impact on participants' motivation and their subsequent level of participation in the course. Learner motivation can be affected by many factors (e.g. Warren, 2000), but for networked learning in particular, ease of access is fundamental. By capturing aspects of social and organisational arrangements, the STINs help us to consider what is frequently conceived of as a simple issue of technical access as something rather more complex.

Networked learning events as 'global' networks

The CMDL courses were designed to bring together trade unionists from pairs of countries to study some aspect of industrial change, thus encouraging the development of a wider European perspective. Conceived of as sociotechnical interaction networks, they formed a network of local STINs for the duration of the course. One of the aims of the courses was to enable learning from collaborating with trade unionists from other countries. This is a particular challenge for European trade unionists, where industrial relations systems, trade union organisation and ways of working vary radically from country to country. As some aspects of workplace regulation are now agreed at the level of the European Union and with progressively more transnationally integrated work methods, trade unionists need increasingly to work with others in very different situations.

The course considered here brought together 16 experienced French and Spanish trade unionists in a blended mode course of two residential workshops and an intervening period of 18 weeks of online small-group collaborative learning activities. These online activities involved four working groups (two of Spanish participants, two of French participants) preparing presentations on topics identified at the first workshop for discussion at the second. As well as collaborating in their own small groups, participants were also encouraged by tutors to share their progress with the other working groups. The online part of the course relied on the First Class conferencing system, configured to support the planned working patterns for the learning tasks. The course can be thought of as an attempt to create a global sociotechnical interaction network which brought together participants operating in their own diverse local STINs.

The communication practices during the course reveal the importance of these local sociotechnical networks. In this case, the problems with building bridges between the local networks during the distance phase demonstrate the difficulties encountered in establishing an effective ‘network of networks’. Participants from each country shared linguistic, organisational and, to some extent, geographic, commonalities. Linguistic commonalities were reflected in the design of the online tasks: the four working groups were each monolingual – two working in Spanish and two in French. In practice, however, the working patterns of the two language groups diverged significantly, with almost no interaction between them. According to an interview with project staff the French participants did not use the conference server as their primary communications medium, but reverted to more familiar email systems for their group work, effectively rendering it invisible to tutors and the Spanish participants. Part of the reason for this was that the technical training planned for the first residential workshop did not happen due to unforeseen contingencies. In contrast, the Spanish participants who were already familiar with the conferencing system from its use in their own confederations, used it in a way closer to the tutors’ original expectations. Additionally, many of the Spanish participants were based in Madrid and organised their own informal face to face meetings. Consequently, levels of electronic communications, as seen in usage of the conference server, were modest, despite encouraging support by one of the tutors. As described above, the Spanish group augmented their online working with local face to face meetings, while the French group used a completely different (and to the Spanish, invisible) communications medium. Figure 3 represents the observed interactions qualitatively as a STIN to highlight the discontinuities in communications between national groups, and the alternative communication channels which emerged.

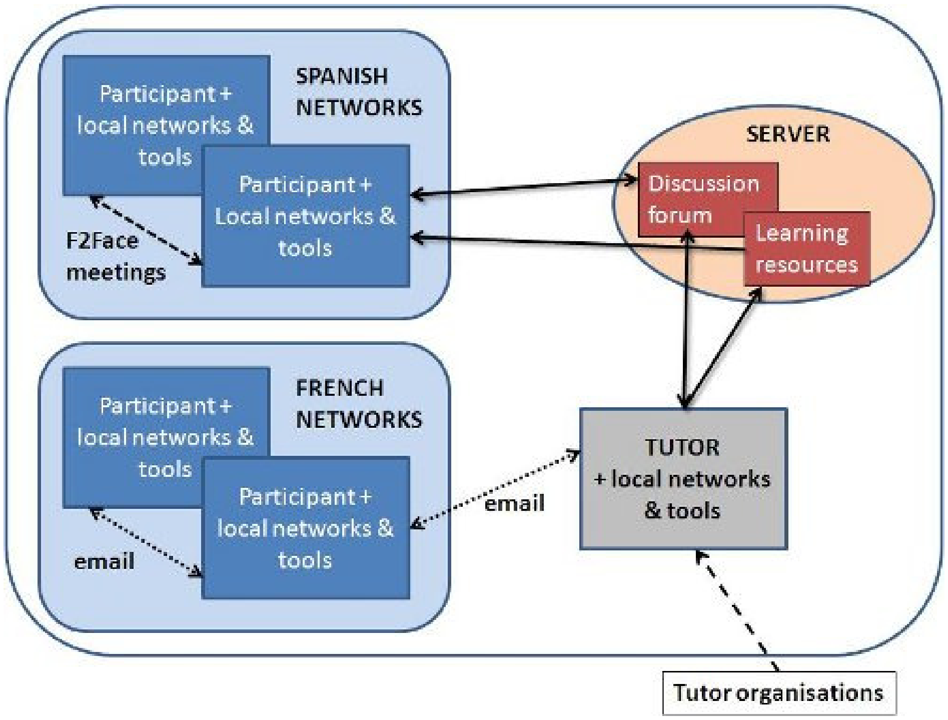

Figure 3 Sociotechnical interaction network diagram of distance learning case study

Changing configurations of sociotechnical interactions over time

We expect many sociotechnical configurations to change over time. In Dialog On, participation in networked learning was aimed either directly or indirectly at improving the collective capacity of trade unions to respond to, and contribute to, shaping social change. In the CMDL strand this was largely indirect, through individual trade unionists developing knowledge and skills that would be of use to their trade union work. In the networking strand, the initial training interventions aimed to establish durable computer-mediated networks that were stable over time. The following case study highlights some of the challenges encountered. .

The transnational network aimed initially to improve information collection on the state of collective bargaining in European countries in a traditionally well-unionised industrial sector. It was established by the relevant European sectoral federation and its affiliated national trade unions. Previously, this information had been gathered via an annual paper survey which, while effective, had required a great deal of administration. It also only gathered information 'after the event' of the various national and company level negotiations. By creating an online forum, it was expected that information could be shared more readily and that consequently network members would become 'closer together' and 'more linked', emerging as a durable learning and organisational network monitoring trends and developing the capacity to intervene. If successful, the network might also provide a model for other parts of the federation.

The network was prepared at a residential workshop. Representatives from affiliated unions were to provide bargaining information using online questionnaires through a single central forum. Ten of the thirteen initial network members were employees of national unions, the remainder being workplace representatives. The network conferences were implemented against a background of informal, ad hoc email links among some of the participants, some of whom also met from time to time at meetings of the federation. The network was co-ordinated by a facilitator or 'animateur' as part of their responsibility working for the European Federation. The collation of collective bargaining information was initially handled by an academic with close links to the federation.

In the week immediately after the workshop, 27 messages were posted online indicating enthusiasm and engagement with the topic. Subsequently, this fell rapidly before growing again modestly. The animateur reorganised the network conference in week 18, creating a collection of six conferences with additional sub-conferences. In the five weeks before the reorganisation, a modest but consistent average of 7.5 messages were posted each week, demonstrating an ongoing interaction among network members. Afterwards, the average use (summed across all conferences) fell to less than two messages per week. Encouraged by early signs of growth, the animateur had tried to extend the range of the network, in part to encourage new participants to join. However, contributions became fragmented across locations, usage rapidly fell away, and the network 'died'. The reorganisation, at best, appears to have been premature. The 'before' and 'after' states of the network are illustrated in Figures 4 and 5.

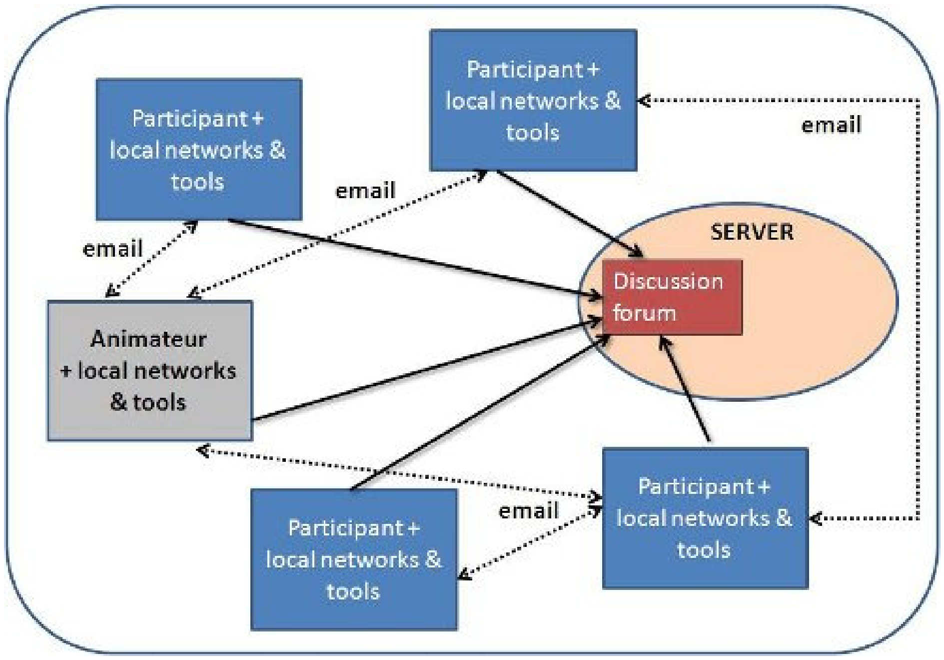

Fig 4: Collective bargaining information network initial configuration

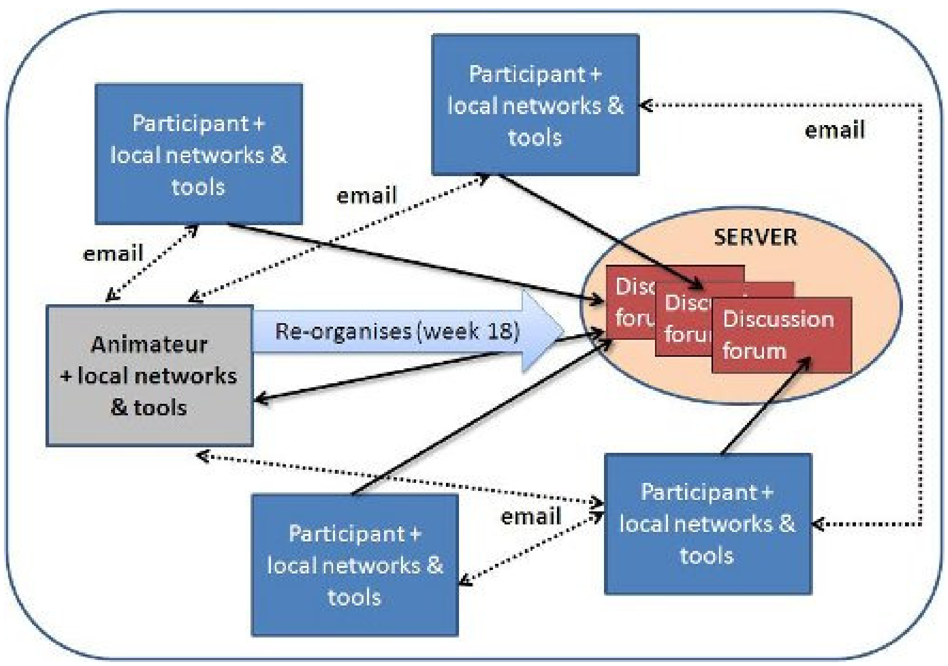

Fig 5: Collective bargaining information network – after re-organisation

DISCUSSION

We have argued that sociotechnical interaction networks are a fruitful way to conceive of networked learning interventions, and have used STINs illustratively to explore three elements of networked learning in social action settings. These case studies are suggestive of issues for further research in the rapidly changing networked learning environment, most particularly in relation to web 2.0 technologies. We then review some of the difficulties of using the STIN as an analytic device.

Networked learning and web 2.0

This fieldwork was conducted before the recent widespread uptake of web applications such as blogs, wikis, tagging, social networking, photo and video sharing, widely referred to as ‘web 2.0’. This growth has triggered extensive interest among educators both because of the changing expectations of technology use among learners, and the potential for new ways of organising learning episodes.

There is growing evidence (e.g. Prensky, 2006) that learners are approaching networked learning with complex computer-mediated communicational and informational networks already in place: they may be sharing photos and videos publicly and with friends and family, maintaining blogs, and developing a presence on social networking sites. These applications are prime examples of Kling’s ‘highly intertwined’ technologies, co-constituted by the technical and the social. Sites such as Wikipedia or Facebook by themselves do very little; it is the network of people, pages and practices which creates something of interest. For example, elaborate protocols and social structures have become established around Wikipedia to mediate contributors’ varying levels of interest, involvement and intent (e.g. Kittur & Kraut, 2008). Also, different social groups may be attracted to competing sites of the same general type: use of particular social networking sites appears to be influenced by factors such as ethnicity and family education (Hargittai, 2008). The technologies do not, alone, dictate who uses a site, how they relate to it, or, we may surmise, the meanings people attach to that use. Individual patterns of use of the same, or similar technologies, may vary radically. This may be more true than with previous online technologies, as sites and practices evolve differently over time. The variability of people’s use and understanding of technology may make it harder for designers of networked learning to make assumptions about learners’ attitudes towards and skills in the use of these technologies and their potential value for learning.

The STIN approach outlined in this paper offers a way of thinking about learners' patterns of technology use in a way that can take explicit account of values, practices and motivations beyond concerns with skills or access. Considering users' diverse local contexts as ego STINs allows the designer of networked learning interventions simultaneously to recognise the social and technical constituents of a learner's participation. In turn, this has implications for the design of the wider (sociotechnical interaction) network of (sociotechnical interaction) networks that constitute a networked learning intervention. For want of a more elegant term, we will refer to this as an 'interSTIN'. For example, rather than trying to encourage learners to interact with a central technical infrastructure which may fit more or less well into learners' existing ego-STINs, we might take as an alternative starting point the question 'what do we need to do to link up diverse ego-STINs in ways which encourage learning?'. This might mean, for example, at a technical level creating access points to our 'interSTINs' through multiple social networking sites. It might also mean relinquishing tutor control and granting the learner a higher level of autonomy over a more personalised learning environment. It should also help us to guard against over-generalising what we think we know about how different groups of people use social technologies. We can be guided in these considerations by previous research in fields such as social informatics, computer mediated communications (CMC) and computer-supported collaborative working (CSCW) which have increasingly emphasised the important of understanding the relationships of the social and the technical. For example, longstanding findings on the significance of factors such as duplication of effort and status (Grudin, 1994) or critical mass (Markus, 1987), or more recent findings on performance in social networking sites (Liu, 2008) offer insights into the way the social and the technological interact in learners' increasingly complex digital 'ecologies'.

Sociotechnical interaction networks

While interest in the STIN approach appears to be growing, it remains at a rather undeveloped state of theoretical development. At this stage it is perhaps best thought of as an analytic strategy rather than a body of theory (Meyer, 2006). We argue that used in such a way, sociotechnical interactions have been useful tools for thinking about several aspects of networked learning. Our identification of the significance of ego-STINs and interSTINs may be a contribution to the development of a wider theory of sociotechnical interaction networks.

However, there are some weaknesses in the current state of the art. Firstly, the diagrams here are rather metaphoric, derived largely from the observations of difficulties encountered in networked learning events rather than successes; presenting other case studies in this way may allow us to recognise patterns associated with successful and unsuccessful interventions. One of our anonymous reviewers specifically questioned the need for diagrams at all, since the concepts were clear from the text. For us, however, the visual representations have been important tools in developing our analysis; while we have included them as part of our analytic strategy there is evident uncertainty about their value as a communication device. There may, though, be value in considering such sociotechnical networks more formally with network analysis tools, identifying more precisely the nature and relationships of nodes and the interactions between them. Kling *et al* (2003) assert that some STINs cannot be represented as directed graphs (a precondition for applying more formal methods); while there may be formidable practical difficulties in doing so, it is unclear to us why it is not possible in principle. Secondly, and more particularly, we have found that network diagrams of the type we have used here do not adequately capture key elements of the temporal dimension of networked learning interventions without becoming overly complex. By building on more formal representations of STINs, it may be possible to capture the temporal dimension more usefully.

CONCLUSIONS

Our first foray into the use of sociotechnical interaction networks to help us to think about networked learning in social action settings has, we argue, been a useful way of conceiving of difficulties, and may help in designing alternative approaches to the organisation of such learning. We suspect that it will prove to be a powerful approach to analysing networked learning in the increasingly complex sociotechnical interaction networks of web 2.0 and social network technologies. Learners will be integrating planned e-learning activities into their complex individual information ecologies (JISC, 2007). There have been plenty of misleading predictions about how new technologies will render particular learning practices redundant. However the expectations of new generations of digitally literate learners may mean that there are new complexities to be incorporated into how we design our learning interventions.

We have also identified significant weaknesses in the practical use of STINs. In particular, the complexity of representations of changing configurations can make it difficult to identify and highlight the most significant changes. As with social network analysis, for STINs to be useful in dynamic settings, it may be necessary to simplify their representation through measurement of key features. It is, for us, an open question whether, given the heterogeneous collection of nodes and links they represent, STINs may usefully be open to more formal analysis using methods developed in, or analogous to, the analysis of other types of network (e.g. Barabas, 2002; Wasserman & Faust, 1994).

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