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► **To cite this version:**

Christopher Jones. The conditions of learning in networks. Kaleidoscope CSCL SIG First Symposium, October 7th - 9th 2004, 2004, Lausanne, Switzerland. 13 p. hal-00190649

HAL Id: hal-00190649

<https://telearn.archives-ouvertes.fr/hal-00190649>

Submitted on 23 Nov 2007

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The conditions of learning in networks

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Abstract: This paper discusses the metaphor of networks in relation to networked learning and how the conditions that apply in networked environments might affect networked learning. The paper considers recent advances in the study of networks and how insights from this work might affect the understanding of networked learning. It focuses in particular on two aspects of networks, the strength of weak links and the place of non-human elements in the network. In terms of networked learning it examines the relationship of network analysis to Communities of Practice, taken as an example of relationships emphasizing strong links, and the relationship of learners to their learning resources when they are distributed in networks.

Introduction

A broad question that has perplexed social science for many years is the relationship of technology to social forms. Within social studies of science and technology despite there being a number of contending factions with serious academic and practical differences there has grown up a broad consensus around the idea that technology in both its form and content are socially shaped (MacKenzie and Wajcman 1999; Hutchby 2001). This paper takes has a relationship to this broad debate but locates itself specifically with the relationship of learning to the conditions that arise with the introduction of network technologies. The introduction points to some recent debates about the wider issues of the relationships between technology and social forms and takes up two particular ideas from these debates to explore in relation to networked learning. These ideas are those of technology seen in terms of affordances, the idea of technology as text and the related idea of design consequences summed up in the phrase 'configuring the user'.

a) Technology and affordance

The idea of affordance has been applied to technology in the sense that:

"technologies possess different affordances, and these affordances constrain the ways that they can possibly be 'written' or 'read'." (Hutchby 2001 p447)

Affordance used in this way allows for the possibility of technologies having effects and the idea that particular technologies can constrain users in definite ways. The idea has its origins in the work of Gibson who was interested in the psychology of perception. Affordances in this view might vary in relation to the nature of the user but they were not freely variable, the affordances of a rock differ from those of a stream, even though different animals might see the affordances of each differently.

b) Technology as text

Grint and Woolgar (1997) take a contrasting view of technology. They suggest that technologies should be treated as 'text' in that they are 'written' by the designers, developers and producers and they then have to be 'read' by the people who make use of the technology. They describe this view as post-essentialist and argue that while there may be preferred readings of a technological artefact it is only through an open and negotiated process that the technology becomes defined.

c) Configuring the user

Steve Woolgar (1997) argued that there is a reflexive tie between machines and their users. He goes on from the suggestion that machines make their purpose available to a user in the way that a text makes a reading available to a reader. He can be read as suggesting that designs for courses and the technologies deployed incline users to some certain uses rather than others. This is not to suggest that these certain uses are inevitable, rather it suggests some uses are more likely than others. This view would seem to imply that the conditions of productive learning are not simply out there in the world, a fixed set of characteristics waiting to be found. Rather the productive learning is constituted in relation to course design and the affordances of technology. In this sense affordances are taken to be

relational, aspects of a technology that are mobilized in a particular setting rather than attributes of the technology as such. Designers are not simply designing for certain user groups they are actively designing the user group itself. The designs that experienced practitioners develop already contain within them implicit definitions of how teachers and students will or ought to be, but these definitions have to be read and mobilized in any particular setting.

Networks, networked learning and networked society

The growth of the Internet and more recently the Web has led to an explosion of access to a variety of knowledge resources and information. The development of new social forms has given rise to claims that we live in an Information Society, a knowledge economy or a networked society. In education a parallel labelling has given rise to such descriptive terms as Virtual Universities, e-Learning and networked learning. Alongside this the idea of open and distance learning has spread from specialist institutions to the mainstream of academic discourse. The Minerva action of the European Commission's Socrates programme focuses on Open and Distance Learning. At the European level policy places a stress on digital literacy, lifelong learning and developing the skills required for what is described as the information society (Hodgson 2002). Even though online models of open and distance learning have moved away from what have been called transmissive models towards more socio-cultural or constructivist models of education they still rely on specified learning resources and content. The interactive and communicative aspects of the new technologies displace but do not replace the need for quality assured resources.

Castells has written about the way in which the possibilities and limits of the Internet play out in relation to social forms, in particular community (Castells 2001). He claims that the Internet is especially effective at maintaining weak ties (p129) as well as strong ties at a distance. More generally the form of networked society in which networked learning takes place has been described by Castells as one of 'networked individualism' (1996, 2001) not one of close community. Castells also makes the point that on-line communities may emerge but they rely on networks built out of an interaction between off-line and on-line sociability. Castells' work is descriptive of modern society but it suggests a relationship between dominant technological forms, the Internet and the Web and the form of society.

The Centre for Studies of Advanced Learning Technology (CSALT) group at Lancaster University has been associated with the following definition of networked learning.

Networked learning is 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.

The key element of this definition is the term connections. The notion of learning emphasized in this definition is a relational view in which learning takes place in relation to others and also in relation to an array of learning resources. Networked learning doesn't privilege any particular types of relationships between people or between people and resources and in this it differs from two of the most popular approaches to the use of computers and networks in an educational setting CSCL and Communities of Practice. For CSCL, however defined, the relationship between people is one of cooperation or collaboration and in terms of Communities of Practice the relationship is one that implies both the closeness of community and a certain unity of purpose. Though both approaches include learning resources neither CSCL nor Communities of Practice draw particular attention to them. The idea of networked learning has been explored from this perspective drawing on recent developments in network analysis (Jones 2004, Jones and Esnault 2004).

Network analysis

The claim made in this paper is that network analysis and the study of networks more generally have the potential to provide an interdisciplinary framework for understanding a wide range of phenomena. This could have the benefit of linking research in networked learning with research in other domains and of linking different aspects of research within the domain of learning. John Law has noted that the ubiquitous nature of the metaphor may be related to a potentially conservative process in which we "uncritically reproduce some kind of dominant ideology" (Law 2003 Paragraph 1). Indeed it is possible that in conducting a network analysis we are reproducing a preferred representation of the present ordering of the world. Networked learning could become part of a hegemonic discourse and John Law notes that when we write as network analysts we may be buying into and adding strength to a managerialist agenda. I am drawing attention to this point as a corrective to any suggestion that might arise in what follows that networks can be adopted uncritically as a purely technical term that helps in solving a number of practical problems. Network analysis implies a latent politics that shouldn't be ignored, even by those in favour of using the metaphor.

Network analysis concerns itself with the description of phenomena in terms of nodes and the links or arcs between them. A simple analytic technique is to focus on the ways in which transfers can take place across a network, for example to examine whether the network is traversable or not. One important aspect of this field of study is that it holds out the prospect of developing mathematical *laws* of networks that may prove to be robust in describing a broad range of phenomena. A recent example of using the mathematical descriptions in relation to networked learning can be found in Ravid and Rafaeli (2004). In this article the authors take the mathematical descriptions of scale free networks and small world phenomena and examine whether these network forms can be found in discussion groups that were an integral part of the distance learning apparatus of a single university. More generally texts aimed at lay readers have begun to examine a wide range of phenomena in network terms including topics in social and biological domains (Barabasi 2002, Buchanan 2002). Because network analysis examines systems through the links between nodes in a web like structures some critics of this approach have suggested that networks suggest simple planer structures (Ingraham 2004). This has been a problem in relation to random networks but one of the attractions of the work by Barabasi (2002), is precisely that it moves away from this two-dimensional view of networks. I would recommend readers to examine some of the structures that emerge as representations of networks from the scale-free approach taken by Barabasi and his colleagues. Scale-free networks suggest an historical process of development in which scale-free networks develop in an ordered way over time in ways that are highly structured. In particular they form clusters, small numbers of nodes forming many links whereas a majority of nodes have few links, the development of such clusters implies the development of power relations. In short scale-free networks are not two dimensional or even three dimensional as they incorporate at least a fourth dimension with the inclusion of time.

Work reported by Barabasi has argued that advances in the characterisation of complex networks that focuses on scale-free and hierarchical architectures demonstrate that a wide range of complex networks including the Web and Internet share these properties (2002). These networks differ from random networks in which nodes are connected without any organising principle. Scale-free networks show a degree of organisation; in particular they display a power-law distribution. Those nodes with only a few links are numerous, but a few nodes have a very large number of links. An example of a power law distribution can be seen below in Figure 1.

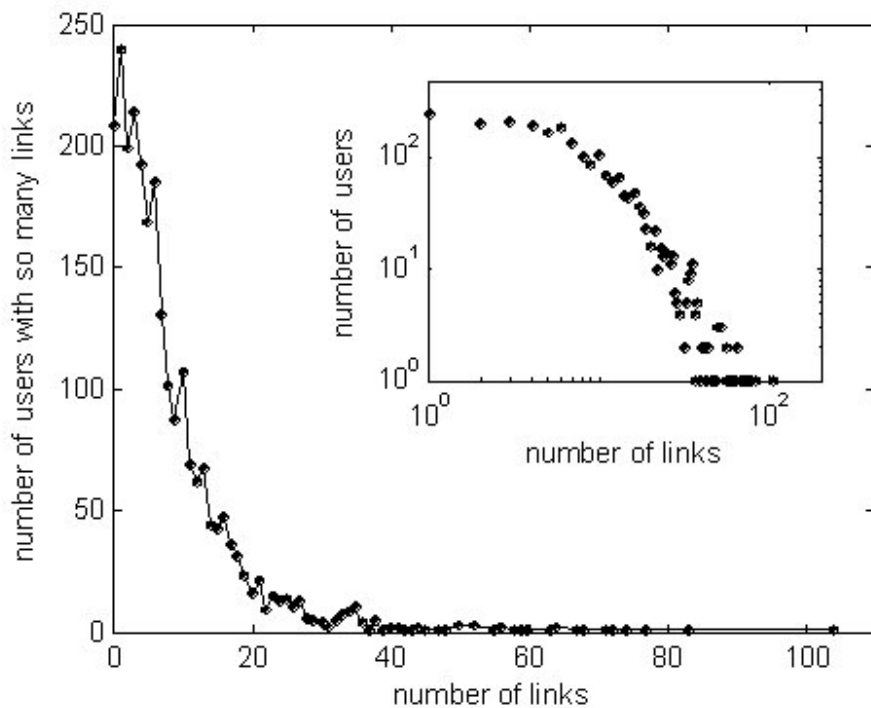


Figure 1 An example of a power law distribution from Adamic, Buyukkokten and Adar 2003. This shows the number of buddies individual users have on their buddy lists.

The rationale behind this kind of distribution rests on some simple propositions. Firstly networks grow through the addition of new nodes and these new nodes link to pre-existing nodes. Secondly there are preferential attachments within the network such that the probability of linking to a pre-existing node is higher if it already has a large number of attachments.

As well as being scale-free most networks also display a high degree of clustering. This clustering is consistent with the predictions of the scale-free description of networks with a power law distribution if a hierarchical organisation is introduced into the network model. The presence of the hierarchical structure helps to re-interpret the role of hubs in complex networks. The theory predicts a modular topology with self-nesting groups of nodes in clusters with dense interconnections. The overall suggestion is that networks are far from random and evolve following robust self-organising principles and evolutionary laws that cross discipline boundaries (Barabasi 2002). The interesting nature of these networks retains some of the advantages of random networks, few steps between any two nodes, with the features of organisation.

Mark Buchanan in his recent book *Nexus* (2002) concentrates on recent developments in a well known set of mathematical problems known as small world phenomena. The most popularised form of this problem is in the idea of six-degrees of separation that any one person is likely to be connected to any other through only six degrees of separation. Small Worlds and the idea of 'six degrees of separation' first became famous through the work of Stanley Milgram (Ravid and Rafaeli 2004). Milgram investigated the number of people a message would need to traverse for it to reach a specified complete stranger. The number of links taken to traverse from one node to the other was an average of only six. A key element in the description of the networking structures and patterns that lie behind small-world phenomena is the idea of the strength of weak ties. Strong links, for example between close family members, do not reach out very far. It is often through weaker links that we can bridge between quite different clusters in networked worlds. The small world phenomena draw attention to the need for weak links and bridging contacts to the organisation of networks. These links are central to the dissemination and propagation of ideas and are of particular interest in education. Together the idea of networks as having a self-nested topology and the idea of small worlds begins to map networks as self-organising structures that lie somewhere between order and chaos. This positioning of networks on the border of order and chaos offers a tantalising link with theories that have suggested chaos and complexity theory as potentially rich sources of ideas for analysing education (e.g. Barnett 2000).

The combination of scale free networks and small world phenomena has been observed in discussion groups set up for educational purposes. It seems that naturally occurring systems in education show the characteristic patterns of these kinds of network.

“As we have seen, the collection of responses to messages in the discussion groups in a specific academic institute over four years fits the model of both Small World and Scale Free models.” (Ravid and Rafaeli 2004)

It might be expected that the clustering found in such groups would be a result of the formal and informal status of the tutor. In fact students in the network formed the majority of hubs.

“From the network’s structure perspective it is clear that the instructor is located in a functional center of the group... However, instructors are not the only form of a hub. In fact, they are not even the most common hubs. When we investigated the 10 most influential people in the network we found that only two (20 percent) of them are instructors. The large majority of hubs were "regular" students. They "earned" their designation as hubs through participation, not through holding a formal position.” (Ravid and Rafaeli 2004)

This brief example indicates a way in which network analysis might suggest topics for further research. In this case a topic might be to determine what conditions were necessary for students to develop influential roles within such networks and to examine the influence they had, both positive and negative, on particular cohorts of students.

Networks and Communities of Practice

The idea of Communities of Practice rests on the apprenticeship model that Lave and Wenger (1991) that is generalized in terms of learning as legitimate peripheral participation. Communities of Practice involve a process of

relatively close engagement in a community with the distinguishing feature being the sharing of practice. Shared practice in turn requires members to have the time and space to collaborate (Lave and Wenger 1991; Wenger 1998). The translation of the idea of Communities of Practice into digital and networked environments raises a series of questions.

Fox (2002) has noted such communities only exist in the “interstices” of modern organizations. Communities of Practice of the type identified by Lave and Wenger are in many ways marginal, inhabiting the informal regions that survive outside of and often in spite of mainstream relationships. Communities of Practice have become a corrective, identifying self-activating units within large organizations that are capable of significant self-management. Just as we noted earlier in relation to networks Communities of Practice are not a neutral description of aspects of modern societies they are mobilized by modern business organizations to reduce the administrative load on formal structures and reposition responsibility on informal structures and organization. In a similar way the educational use of Communities of Practice puts additional responsibilities upon students who are required to develop, monitor and control their own groups and relieve the burden from the formal teaching structure that can adopt a more facilitative or moderating role. Community is also a term that is loaded, as are the terms cooperation and collaboration, with a preference for strong or close ties. Networks in contrast make no claims about the type and character of the links between nodes. Networks can be composed of strong ties but they also allow for weak links understood as less intense or occasional flows between nodes.

Networks are not necessarily in opposition to the ideas of Communities of Practice and both Wenger (1998) and Brown and Duguid (2001) have noted that there are relationships between certain types of network and Communities of Practice. Wenger suggests that a network with strong links resembles a community (Wenger 1998 p283). Wenger goes on to identify the following features as points that distinguish networks from Communities of Practice.

- Networks deal with relationships and flows Communities of Practice focus on the practice created in the process rather than on flow of information or relationship. (Wenger p287)
- Communities of Practice are concerned with ‘what is shared and learned and becomes a source of cohesion’. Networks do not carry the same sense of cohesion. (Wenger 1998 p283)
- Communities of Practice are concerned with a history around which impersonal network ties are organized. (Wenger p298)

The key divergence for Wenger between networks and Communities of Practice lies in the emphasis placed on structural properties and process. Wenger emphasizes process elements and suggests that the key distinguishing element of Communities of Practice when viewed from a more structural point of view is that they are cohesive, sharing historical processes that are composed of strong ties.

A significant question arising from Wenger’s comments for the network metaphor is whether it is able to deal with networks as a process, a dynamic and developmental series of relationships rather than a kind of reified structure or topology. If we take a simple network structure, just two nodes related by a single link, we might ask what the network represents. The link between nodes could be sustained by heavy traffic, a more or less constant flow. On the other hand it could be a weak link one that represented either a latent relationship or a link that was only used for occasional communication. A graphical representation of a network could include some minimal depiction of such features, for example by colour coding links to represent variations in type or differences in level of flow between nodes. There is nonetheless a fundamental difference between viewing networks as processes and reifying the process such that representations of process in topologies are taken to be the network itself. I am interested in topologies of networks and I am interested in mathematical ‘laws’ that may be useful in describing network forms, but I think of these as simplified and abstracted representations of process, indices of activity, rather than as the phenomena itself.

An example of how network analysis can be applied to learning can be found in Aviv, Erlich, Ravid, and Giva (2003). This research used a combination of methods including social network analysis and content analysis to evaluate two three month courses. They found that the patterns of interaction were affected by design and that: the structured design was associated with a high degree of cohesion, encoded by a dense inter-linked set of cliques. Maintaining such a dense network of cliques requires effort on the part of the participants, and yet the students felt that the effort was worthwhile. Note that cohesion could have both a beneficial or debilitating influence on discourse and reflection. Too cohesive a group could stifle criticism and, therefore, open

discourse. What is the optimal degree of cohesion? How should the cohesion be “tuned”?

This example shows how interesting research questions can flow from such an approach and this research also illustrates some limitations of a structural approach. The structural analysis of the network and content analysis of the transcript relied on a common sense understanding of the process of networking. As an example a simple exchange of messages was not thought to be enough to establish a meaningful link so response messages were set as a condition for having an established relationship. This analysis assumed rather than established what a link might be composed of. The quality of an exchange was not considered and ‘lurking’ or ‘vicarious learning’ that did not fulfil the criteria of responsiveness would be excluded.

Network theory would suggest that the strong notions of community contained in Communities of Practice might ignore the importance of the 'strength of weak links'. The idea of weak ties has recently been applied in relation to Communities of Practice (Rosson 2003). Rosson argues that the social nature of Internet use by people who act as weak links, in her terms ‘bridges’, suggests that they use the Internet for maintaining relations and increasing face-to-face interaction. Weak ties are in this view an enabling factor in social activism and the building of ‘social capital’. The educational focus in networked learning has often been on strong links and the emphasis on community may have made less visible the many necessary but weak connections that make the network idea so powerful. The nature of networked learning is such that whether the network is used for distance or largely place based learning the participants do not have to be co-present. The student cohort in a networked course may well have weaker ties with each other and with the tutor than might be expected in terms of a community of practice. Student cohorts often do not have a history and may never become cohesive units. For these reasons we argue that a network analysis might be more appropriate.

A further weakness in this example of social network analysis was that the nodes were defined as ‘actors’. This restriction of network nodes to people limited the study to network connections between people. This would exclude the relationship that is possible between a learner and learning resources. These could take the form of digitised artefacts, including books, journal articles, simulations game etc. This restrictive approach to what might constitute a node on the network is out of tune with other network approaches. Actor Network Theory for example allow for non human agency within a network in the term ‘actants’ (Latour 1991). Osterlund and Carlisle (2003) have considered the issue of knowledge sharing in relation to ‘social objects’. They claim that a relational thinking lies at the heart of social practice theories and that subjects or social groups only develop their properties in relation to other subjects or social groups. In particular:

“social objects derive their significance from the relations that link them rather than from the intrinsic features of individual elements.” (Osterlund and Carlisle 2003 p3)

This relational view borders on a network description that privileges the links rather than the properties of individual nodes. The authors go on to claim that what they call practice theory goes beyond other theories by not only looking at the:

“recursive dynamics of a given relation but places everyday practice as the locus of the production and reproduction of relations.” (ibid p3).

The issue of knowledge sharing is developed further in relation to learning resources below.

Constellations and networks of practice

Etienne Wenger has noted that the intensity of interaction between people distinguishes between a community of practice and a personal network (Wenger 1998 p126). He goes on to note that

Some configurations are too far removed from the scope of engagement of participants, too broad, too diverse, or too diffuse to be usefully treated as a single community of practice. (Wenger 1998 p126)

Wenger notes this limitation is not one solely of scale, affecting both large and small configurations. To describe this type of broad and diffuse configuration Wenger uses the term constellation, specifically drawing attention to the use of the term grouping stellar objects even though they may not be close to each other. Constellations of practice are intimately connected with the negotiation of boundaries and interactions among practices. They are engaged in

the 'export' of practice, allowing detachment from any specific enterprise. The exported styles and discourses whilst not practices themselves provide resources that can be used in the context of practice.

A related development has been popularised by Brown and Duguid (2001) as networks of practice. Brown and Duguid note that that Communities of Practice can seem indifferent to other forms of social alignment; in particular they can seem a "social monad – a fundamental building block" (Brown and Duguid 2001 p203). This atomic view of Communities of Practice can obscure the socially heterogeneous nature of Communities of Practice and could be thought of as 'communities of Communities of Practice'. For Brown and Duguid a particular reason for the importance of this issue is that it touches on the question of 'disembedding' and 'reembedding', and that new technologies allowing communication across time and space. This issue echoes Wenger's concern with the export of repertoires and styles.

Central to both accounts is the need for conditions at both ends of an exchange to allow for a flow of information and knowledge and the disembedding or export and reembedding or import of discourses and repertoires originating in one practice to be incorporated in another. This issue, in another tradition referred to as transfer, is central to education and networked learning. It is the difficulty of dealing with this in the classic articulation of Communities of Practice that suggest the adoption of the metaphor of networks. Brown and Duguid use the term networks to indicate loose epistemic groups and note that most people in such a network will never know, know of, or come across one another. The argument of this paper is that the term should have a more general currency, that networks should cover not only very distant relationships but also relationships that have varying degrees of proximity but do not have the degree of cohesion required for a community. The use of the term network allows for scalability in analysis as networks can have a nested character. Each node in a network can itself be a network; the atomic nature of the community metaphor can be replaced by a fractal geometry allowing for an infinite repetition of similar but not exact forms in various scales. Finally the network metaphor does not privilege any one particular view of relationships, and this may be especially important for learning.

Applications of networked learning

This section of the paper draws out some implications from two recent examples of how network analysis can illuminate the structure and processes of networked learning. The first example examines a course taught online that uses the idea of networked learning to organise its structure and presentation. In particular this example is written in relation to the idea of weak links. The second example first example draws on a broad evaluation of a UK wide initiative to provide digital resources to staff and students in tertiary education (EDNER <http://www.cerlim.ac.uk/edner/>). This example examines the place of digital learning resources in a networked learning environment.

Weak links

The course used in this example is an MSc in Advanced Learning Technology which is designed primarily for part-time study. Research for a case study of this programme has been undertaken as part of the Kaleidoscope network in the JEIRP Conditions of Productive Learning. Currently the course is running with between 20 and 30 students at any one time (<http://csalt.lancs.ac.uk/alt>). The course is organised in six core modules and assessment of the programme is by coursework and a final project report. Each module is assessed independently by a piece of coursework that is equivalent to either a 6,000 word assignment (18 M level credits) or a 12,000 word assignment (36 M level credits). The final project is equivalent to 18,000 words maximum. The modules for the ALT programme are organized in a timetable over a two-year period and students may join the programme at the start of any module. Before students can commence work on a further module they must have submitted the assignment for any prior modules they have completed. Course members are expected to participate in online discussion of assignment ideas, draft assignments and associated activities. To complete the MSc 180 M level credits are needed, comprised of a pass for each module and the Final Project.

Assignments topics are 'negotiated' with tutors and generally have a strong relationship to the work setting of the participants. The ALT programme aims to support continuing professional development for busy working professionals. The programme is a mix of distant/independent study, supported by ICT and non-compulsory short intensive residential periods.

“The ALT programme is seen as a place in which participant’s work-related interests come together with our research-based knowledge. The goal of the programme is to find fruitful ways of combining these two.” (ALT course validation documentation 1999)

The course explicitly builds on the idea that participants bring to the course valuable prior experience. The social process of the course is about an engagement with participants’ experiences and resources brought to the modules by active research staff. Recruitment has been primarily from staff working in post-compulsory education, corporate training in a business environment and in consultancy.

The course design is explicitly set to enable participants to study in a flexible way in terms of time and by limiting face-to-face contact. It is supported by largely asynchronous bulletin board like technology based on Lotus Notes/Domino. Each module has a discussion space that is used to post materials and for discussion. There is also a synchronous discussion tool which is available for use in all modules and is integrated in some modules or activated by student demand. Students have also been introduced to Sametime, a Lotus Notes based environment allowing audio and video conferencing, shared documents and whiteboard. This tool has not been integrated in any module and has only been used for demonstration purposes. The programme is supported by the library and in the last year digitised texts (book chapters and online journal articles) have been provided online from the course pages and journals and digital books are available through the library catalogue using a separate library supplied log-in.

The features of this course do not match either a standard CSCL environment or one based on the idea of a Community of practice. At any one point students on the course are in an uneven mix of novices and experienced participants but they are not in a developmental relationship though there is peripheral participation by new students who can model themselves on more experienced participants. There is no fixed cohort and there is a limited chance of community development within the module or programme. Interaction between students is uneven, some participants are regular contributors in the online discussion but others are only occasional contributors. The structure of the course is task driven and each module falls into three sequential phases. During the first phase students are asked to work on several short tasks individually and to post their responses into the discussion space. The design at this stage is task oriented and individual, the coordinated activity of posting contributions only takes on any collaborative aspect later when students are asked to reflect on each other’s postings. Prior to the second phase there is a short two day residential. Students who attend are involved in intensive face-to-face activities and develop a strong group sense. On return from the residential it is noticeable that the energy from the residential students often contrasts sharply with the students who did not attend the residential. In the second phase of activities students are told by the course tutors to expect greater online activity and the tasks assume online discussion and in some modules expect some group collaboration. It is nonetheless possible to complete this phase in a relatively individual way. The third phase involve students in negotiating with the tutors a topic for their assignment. The agreed topic and an outline are posted to the online space at the close of the second phase and students largely work alone to produce their assignments in the third phase.

How can this programme best be described? This appears to be a system of weak links forming a network in which the students and tutors are engaged with each other, the course documentation and the learning resources. The MSc ALT programme has been successfully running since the late 1980s. It has had some major revisions but has been in its current form for over 5 years. The programme has had good outcomes and was explicitly mentioned in the teaching quality assessment audit of the department which obtained a maximum 24 score in the review. The programme is cooperative in the sense that the tutors and students work together to accomplish the sequence of activities during each presentation. This clearly involves students and tutors in extensive negotiation of meaning about what the module contents are and how they can be understood. It also involves making sense of the module documentation and what the tutors’ intentions might be in organising the activities in the way that they do. However even from this brief outline I think it is apparent that the course has a focus on flexibility and the needs of individuals in relation to their learning. The first phase asks individuals students to make sense of some of the key ideas in the module. They are asked to reflect on their prior experiences to do this and during the course of the module they are encouraged to reflect on these using the literature supplied as resources for the module. This is a largely individual set of tasks in which the students interact largely with course texts and only post their responses online. The relationships amongst students and between tutors and students can best be thought of as weak links. Participants on the course remain largely in their work place communities and they are explicitly encouraged to elaborate this experience in relation to course materials and activities. The levels of day-to-day interaction are relatively low and the intensity of the interaction is also relatively low. On some modules some of the students try to

organize groups to engage more fully, for example using the synchronous tool built into the environment. Occasionally these initiatives work and groups form at regular times and days each week, however in other modules students have been highly resistant to higher levels of engagement.

Digital resources

The Information Environment (IE), which was originally known as the Distributed National Electronic Resource (DNER) was an initiative funded by the Joint Information Systems Committee (JISC), that followed on from a series of interventions that aimed to develop what might be termed primary courseware (Jones and Brophy 2002, Goodyear and Jones 2003). The DNER was:

‘a managed environment for accessing quality assured information resources on the Internet which are available from many sources. These resources include scholarly journals, monographs, textbooks, abstracts, manuscripts, maps, music scores, still images, geospatial images and other kinds of vector and numeric data, as well as moving picture and sound collections’ (DNER, 2001)

The DNER followed on from a number of earlier initiatives that included the aim of the creation of primary resources. A conclusion from evaluation studies of the products of one of these was that:

" significant barriers to wider uptake of C&IT into learning and teaching still exist. Technical infrastructure is now less important to most staff than the need for pedagogical support " (Anderson et al 1999 Executive Summary)

The implicit pedagogical beliefs of the courseware production teams were embedded in the courseware and this was amongst other factors implicated in the limited use made of the courseware by staff whose pedagogical beliefs and practices may not have been compatible with those of the courseware producers. The DNER aimed to produce and/or improve access to primary resources and it did so with what appeared to be a much more open sense of what might be possible pedagogical usages (Goodyear and Jones 2003).

The significance of this project in terms of networked learning is the attention it draws to the place of learning resources in learning environments in a network setting. A significant question for the IE was how teachers and learners would take up the designs and the plans of project teams that were embedded in project outputs. The evaluation team engaged with projects throughout the lifetime of the projects and attempted to surface the implicit notions of change within the project teams and to discuss with projects how the outputs and outcomes of the projects could be taken up to achieve anticipated benefits for learning and teaching (Goodyear and Jones 2003, Zenios Goodyear and Jones 2004). The key elements of this research in terms of networked learning were:

- a) The ways in which project teams embedded theories of change and pedagogic notions within project outputs
- b) The ways in which projects envisaged and began to develop their relationships with the potential audiences of users for the project outputs
- c) The ways in which teaching staff and students related to project outputs when they were actually used

Learning resources in this view are not raw materials but artefacts that are the outcomes of complex processes of design and deployment. In actor network terms these artefacts are actants within the network and have a similar status to utterances or text in that they cannot constrain any one particular understanding but they can incline or disincline users to some particular understandings rather than others.

The most common understanding by projects of their educational and pedagogical task was that they were to enable access. In a programme which did not have strong pedagogical direction, it emerged that project teams tended to assume (a) that better access to electronic information resources will lead to better learning and (b) that other people can be relied upon to bridge the gap between project outcomes and the delivery of tangible educational benefits. The majority of the project staff restricted their comments to the description of project outcomes that were concerned with improving students' access to electronic information resources and/or enriching such resources. Some of the projects did talk about ways in which students might use electronic information resources in their learning. They gave some kind of description of possible learning activities. Only one fifth of the projects fall into this category, in 80% there was no description of intended or envisaged student learning activity. Another way of 'going beyond access' would be if project staff mentioned that their goals included providing learner and/or teacher support materials to help with the integration of an electronic information resource into the curriculum. 25% of the project responses did this. The third and final category that went 'beyond access' included all of those projects that mentioned that they had been working with teachers in developing their electronic information resources. 7% of the

responses mentioned they had been working with teachers (or intended to do so). For a fuller description of this work see Goodyear and Jones (2003).

The above assessment took place in relation to all the IE projects involved in developing materials and services for teaching and learning. The evaluation had further continuous contact with 11 of the 35 projects. In this work we found that most of the projects examined had thought about possible integration of their products with learning activities. Although eight of the project teams had some views about the ways in which teachers in higher education could seek to connect information resources with the rest of their wider learning environment, insufficient attention was being paid to the relationship between learning activity and information resource. The project teams often relied on the mediation of external bodies to shape the nature of learning activities and their outcomes even though these bodies are not directly involved in the design of the resources. Out of the 11 projects, only three appeared to have a pedagogical rationale (see Table 1). Among the remaining eight projects there was an assumption that the use of networked technologies would lead to definite educational outcomes and lead to changes in practice in higher education simply by making resources available to students. Two projects in particular are committed to research on technical developments without seeking to bridge the gap between technology and pedagogy (Zenios. *et al* 2004)

Project	Assumptions about pedagogical purpose
Case study 1	There is a need to create a learning object database used by students, to the improvement of their information skills.
Case study 2	Better language learning outcomes are achieved because of greater exposure to spoken language and use of resources with fellow students enabled through the use of technology.
Case study 3	There exists a set of museum resources that are being digitised, enhanced through parallel development of teaching tools and finally integrated within specific courses and thus leading to increased use of museum resources in teaching.
Case study 4	Student performance is increased through providing seamless access to information resources (e.g. library-mediated and broader resources from within VLEs).
Case study 5	A knowledge base in use of video streaming resources, frameworks and tools needs to be developed if we are to make appropriate pedagogical decisions.
Case study 6	Seamless access and improved web-based interfaces for data extraction/visualisation are needed to increase the Census user base and enhance student project work.
Case study 7	The provision of a learning technology portal with resource submission, access and discovery facilities has the potential to engage staff and students in learning technology.
Case study 8	There exists a set of data, which are expected to be used more frequently and effectively, thus enhancing learning after the development of related web-based tutorial packs.
Case study 9	A package of online resources (graphics, images, text) is being made available to enhance interdisciplinary student access to and use of specialised collections.
Case study 10	Optimised access to customised materials and resources assist in the advancement of knowledge.
Case study 11	Visibility and accessibility of resources focusing on machine-to-machine interchange increase user base.

Table 1: Assumptions about pedagogical purpose

Of the eleven projects we had a closer engagement with we only managed to follow six to the point when they were engaged with real users beyond a test phase. It should be made clear that the points that follow are distillations from our overall engagement. We concluded several factors had affected the projects ultimate ability to involve users in the intended settings including the following.

- 1) The development of specific and targeted relationships between projects and some well-defined segments of their target user group.
 - a. For projects with a narrow target the development of definite contacts outside of the project area with the aim of transferring and generalising project outputs

- b. For projects with broad or generic aims work with smaller and well specified target groups during development rather than relying on an immediate connection to a wider community
- A good example of this process is provided in the following excerpt from a project report:

“ In the previous biannual report we discussed the issue of piloting of materials being a problem for some sites. This continues to be the case, and regardless of our outreach work to the community we have received few offers to pilot the materials. However, this issue was also addressed at the all project meeting in June, with the result that *all partners responsible for piloting materials have been working on recruiting two or three sites with whom they can work closely over the next academic semester* in order to pilot materials. The feedback from this work will be incorporated into the materials, which will subsequently be promoted to a wider teaching audience.” (Project 2 Report to JISC covering 2/02 – 7/02, Italics added)

Overall the process of developing digital resources for teaching and learning suggests a process similar to that suggested by Woolgar (1997) as configuring the user. The more successful projects cultivated a long-term relationship with selected users and encouraged an interaction over time in which there was a mutual development in which the project understood the potential users more fully and the potential users came to understand the ideas and intentions of the project team that were being embedded in the final outputs of the project.

Conclusions

This paper has examined the possible use of the metaphor of networks in relation to the conditions of networked learning. The paper has drawn on the wider debates about the relationship between technology and social form and suggests that the use of the network metaphor may help develop research in a number of areas. Firstly the paper draws attention to the ways in which network analysis might relate to the ideas of Communities of Practice. It suggests that networks be understood as the more general case and that Communities of Practice might be understood as a special case of those networks with strong ties and a strong degree of coherence. In terms of the example of networked learning the paper suggests that the current practice of educational activities, successfully engaged with networked technologies, are not well described in terms of close relationships and that weak links might provide a better description of the type of relationships found on these courses. This example is also a case that would benefit from an analysis of the quality of the relationships that can be described as weak links. It is clear that the simple fact that a link has been made and that there is some sort of traffic to maintain that link does not adequately describe the link. We know from experience that family or strong friendships can make links that can lie dormant for considerable lengths of time and yet these same ‘weak’ links can be mobilized rapidly and be sustained over significant distances. Network analysis of the links and relationships found in networked learning environments needs to move from simply mapping the structures of networks to go on to supplement mapping with a qualitative analysis of the nature of these links.

The use of digital resources raises serious questions for current metaphors used to help understand learning in networked environments. Investigation of a large scale national initiative to provide digital resources for teaching and learning shows how the nature of these resources is negotiated in a complex process of design and development in which the user is configured in an ongoing relationship rather than designers designing for the user conceived of as a general category. The network of connections between designers and users is only one aspect of this relationship. Metaphors of learning in a society saturated with digital resources can conceive of learning environments as being constituted by people and things. Theories of collaboration, cooperation and Communities of Practice have emphasised human-to-human contact, yet one of the most commented on features of networked environments is the explosion of available information and the relationship between humans and the resources accessible through networks. In this world resources used for learning, human artefacts, can appear simply as things. The example of the Information Environment shows how learning resources are temporary or provisional stabilities that relies upon a relationship between the designer and the user whether that relationship is recognised or not. The human-human interaction emphasised by current metaphors can be expanded to include a fuller understanding of the ways in which artefacts can embody human activity and come to be reintegrated into human activities away from their original source.

Acknowledgements

I would like to thank my colleagues at Lancaster University for the work reported here deriving from the EDNER evaluation and also Vanessa Watts for her assistance in relation to the ALT case study. I would also like to thank Laura Zurita for her helpful comments and reviews made during the writing of this paper. Any errors and defects are however my own responsibility.

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