What did the Romans ever do for us? 'Next generation' networks and hybrid learning resources

Conference or Workshop Item

What did the Romans ever do for us? 'Next generation' networks and hybrid learning resources

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Abstract

Networked learning is fundamentally concerned with the use of information and communication technologies (ICT) to link people to people and resources, to support the process of learning. This paper explores some current and forthcoming changes in ICT and some potential implications of these developments for networked learning. Whilst we aim to avoid taking a technologically determinist stance, we explore the potential for future practice and how some educational and pedagogic practices are evolving to exploit and shape the digital environment. We argue that we can change both the ways in which connections between people (learners and other learners; learners and tutors) are made and the nature of the resources that learning communities (particularly distributed communities) can engage with. In doing this we draw on two strands of work. Firstly, we draw on the 'IBZL Education' a UK Open University initiative to develop new scholarship in the context of STEM (Science, Technology, Engineering and Mathematics) through which educators are encouraged to think about technological change in the next five to ten years and ways in which we can intervene and shape these developments. We use problem-based learning as an example of a learning experience that can be difficult to implement in a networked learning environment. IBZL identified two broad strands of significant technological development. 'Superfast' broadband networks that are capable of supporting novel applications are being rolled in the UK (and elsewhere). Also, boundaries between the real and virtual worlds are becoming blurred as in the 'internet of things' where, for example, RFID tags enable information about the real world to be brought into the virtual one. We use the term 'artefact' to describe designed components, whether entirely digital, such as a computer forum, or material, such as a tablet PC. Networked 'hybrid' technologies of virtual and material components have may great potential for use in education.

Secondly, we illustrate how these changes may be beginning to happen in distance education using the example of TU100 My Digital Life, a new introductory Open University. . TU100 Students use an electronics board in their own homes to work on a programming problem in collaboration other students through a tutor-led tutorial in a web conferencing system. We also note some of the evident complexity that establishing such resources as part of wider infrastructures of networked learning would be likely to involve.

Keywords

networked learning, IBZL, TU100 *My Digital Life*, web conferencing

Introduction

Networked learning is fundamentally concerned with the use of information and communication technologies (ICT) to link people to people and resources, to support the process of learning. This paper explores some current and forthcoming changes in available ICT and some potential implications for networked learning. In doing so, we aim to avoid taking a technologically determinist stance – that new technological characteristics necessarily lead to particular changes in networked learning. Rather, we aim to explore what some of the potential for future practice might be and how some initial steps are being taken in developing educational and pedagogic practices to exploit and shape the digital environment. We suggest that changes in the wider technological 'ecology' will have implications both for connections between people (learners and other learners; learners and tutors) and the nature of the resources that learning communities (particularly distributed

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communities) can engage with. In the first case, 'next generation' or 'superfast broadband' communications will help to reduce some of the current difficulties in real-time distributed collaboration applications. In the second, we suggest that we are starting to see a blurring of the digital and material worlds, through for example, robotics, 3D printing and 3D scanning which are becoming more widespread than hitherto. This may offer the potential for entirely new kinds of networked learning resources, particularly in the context of next generation networks. We are particularly interested in how these developments may have implications for the design of distributed problem-based learning interventions.

In considering this, we draw on two strands of work. The first of these is Infinite Bandwidth, Zero Latency (IBZL) *Education futurecasting* project, part of eSTeEM, a wider UK Open University (OU) initiative to develop new scholarship in the context of STEM (Science, Technology, Engineering and Mathematics) education. Educators from a range of backgrounds were encouraged to think about technological change in the next five to ten years and ways in which we can intervene and shape these developments in education. For the second strand, we illustrate how this may be beginning to happen, drawing on the example of TU100 *My Digital Life*, a new introductory Open University computing and information technology module which can be viewed, in this context, as an early example of moving into the educational design space we are concerned with.

The paper is organised as follows: firstly, we highlight some recent developments in ICT, and consider these in the context of problem-based learning. Secondly, we introduce our two starting points as outlined above. Thirdly, we discuss some tentative observations arising from this.

Background

Emerging technologies and networked learning

Networked learning is about learning through online relationships between people, and between people and things. Goodyear et al (2004:1), characterise networked learning as using information and communication technologies (ICT) to “promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources”. Jones and Dirkinck-Holmfeld (2009) develop this view further, highlighting the significance of the design of learning environments and the roles of particular technologies in mediating human thinking and action. In particular, they highlight the complexity of relationships between the social and the material worlds, drawing on the concepts of affordance and technology-in-practice (Orlikowski, 2000), and infrastructure (Star and Ruhleder, 1994). These are important points; in what follows we are discussing the consequences of changes in the artefactual element of technologies and suggesting some possible implications. In taking a sociotechnical view of technology, we need to be careful about our terminology. By 'artefactual', we mean a designed component which may have material aspects (for example a tablet PC) or may be entirely digital (as in a computer forum). We are particularly interested in those networked artefacts in which the relative significance of the digital and material components is changing, referred to by Knutsen et al (2011) as 'hybrid' objects.

We are not trying to predict the future; that will emerge from the interplay between artefacts, the multiple actors involved in their design and use in educational settings, and the wider social and organisational context (most immediately, at the time of writing, the incipient global economic crisis). Any emergence of these artefacts as components of infrastructure in the sociotechnical sense is likely to be at least as much the outcome of organisational and social conflict as rational planning and allocation of resources (Bowker & Starr, 1999). However, we cannot write the particularities of technologies entirely out of the story. We contend that while these artefacts are open to multiple understandings and interpretations by different social groups which strongly influence both the design and subsequent use of technology. That is, they have interpretive flexibility. However, this flexibility is not unbounded; we can't, for example, drive to the moon in a car, no matter how hard we try. We suggest that educators need to be actively involved in establishing visions and interpretations of the value of these technology; the development of technologies such as the internet suggest that many other groups will be. This is a social/political/economic claim rather than a technological claim.

We identify two broad areas of change. Firstly, most developed countries are either planning, or already have, access to what (in the UK, at least) are widely termed ‘next generation’ or ‘superfast’ broadband networks with transmission capacity to support multiple high definition (even 3D) video communications channels, and with more symmetric architectures that support user generated content, rather than view them as passive recipients of content. These will have consequences for the ways in which communications between learners, and between learners and tutors, are conducted. At the very least, we are close to a world in which applications like audio-and video- web conferencing function well across reliable telecommunications networks. This is a necessary first step if they are to become sociotechnical infrastructures in the senses used by Starr & Ruhleder; that is in which knowledge of how to use them, an assumption that they actually work as described, and shared conventions for their use are widespread. It is well established in the computer mediated communication literature that context and social norms are central to the way in which particular technologies are used (e.g. Rudy, 1996).

Secondly, and perhaps more interestingly, though, the boundary between the ‘virtual’ and ‘real’ worlds is beginning to become blurred, through what is widely referred to as the ‘internet of things’. In a sense these are *hybrid* artefacts with both digital and material components. Technologies such as robots or fabrication tools display novel and distinctive combinations of material and digital characteristics. Hitherto, mainstream networked learning research and practice has been concerned primarily with text communication, through the web and through asynchronous conferencing systems. More recently this has extended to include social media like wikis, blogs, Facebook and twitter. These technologies all increasingly include images, and there is a growing use of audio and video learning resources, typically as information dissemination tools as in podcasting. We are suggesting that a new range of technical options, in which the relative significance of the material element and the digital element can be radically changed, are becoming available to the design of networked learning interventions. Where, in networked learning, we need to address issues of the physical world, this has been often been through simulation of the physical world, as for example with (for example, virtual microscopes http://www.open.ac.uk/earth-research/tindle/AGT/AGT_Home_2010/Virtual_Microscope-Scutt1.html), and similarly hybrid physical/digital simulations, as in the simulation of networking technologies and their configurations (e.g. Moss and Smith, 2010). More recently, we have started to see studies which examine the potential for networked interaction with the material world, as in the Open University’s (OU) ‘Out There and In Here’ project (Adams et al, 2011) using mobile technology and table interfaces to link students conducting fieldwork (in the material world) with students unable to get in to the field using novel interfaces. The work of Herring *et al* (2010) on mixed virtual and real worlds for children with autism illustrates how symbolic objects in the real world enabled by RFID tags and with the use of an RFID reader may be used to encourage a child to interact with a virtual teacher in a CAL package. Now we are seeing artefacts which comprise new combinations of the physical and the digital, we would expect the emergence of such technologies to be similarly enrolled in complex social and organisational developments, as we are beginning to see in other domains, such as robotics in healthcare (Barret et al, 2011). The potential for networked learner and educator interaction with such material resources offers potential new ground for networked learning research.

Establishing these emerging technologies as functioning sociotechnical networked learning infrastructures will not be a simple or predictable process. As Bowker and Star (1999) note in the context of classification infrastructures, establishing these are social, and frequently political, (certainly with a small 'p', possibly with a 'P') processes. Indeed, we would argue that this precisely why it is important for educators to engage with these developments early and to be active agents in shaping their use (or, of course, rejecting them entirely. As a first step in this direction, in this paper we consider potential relationships between these technologies and an example of distributed problem-based learning (PBL). We will start by explaining how the idea for the paper developed from the ‘Infinite Broadband Zero Latency’ Project (IBZL).

Infinite Bandwidth, Zero Latency - imagining an educational future

The ‘Infinite Bandwidth, Zero Latency’ (IBZL) project, is part of an internal STEM education initiative of the OU’s Faculties of Science, and Mathematics, Computing and Technology. IBZL is essentially a workshop-based thought experiment designed to explore potential technological futures. The workshops use a technique known as Imagine, drawing heavily on the ‘rich picture’ techniques of soft systems methodology, which encourage participants to usual visual rather than written representations of objects and ideas, (see Bell & Walker, 2011; Walker et al, 2011 for more on the ‘Imagine’ workshop method and the way it has been deployed in the IBZL ‘futurescaping’ initiative). IBZL was originally conceived as a way of exploring potential uses of ‘next generation’ network access in the context of the 2010 Digital Britain report. What might be termed ‘IBZL Education’ was the second set of workshops using these methods, aiming in particular to explore possible technological futures in educational settings. These workshops ran during 2011.

Briefly, two ‘Phase 1’ workshops each brought together around 15 educators from a diverse range of disciplines and backgrounds, including further, higher, community and trade union education. Using as a probe a vision of a world in which current network restrictions of bandwidth and latency no longer apply, participants were asked

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to work in small groups to explore potential ideas and issues of emerging technologies and educational change. Participants then ranked and clustered ideas in terms of their significance and ease of achievement in a 'system of challenges'. Clusters which might have the potential for further development (for example as research projects, prototype applications or business plans) were named and recorded. By way of illustration, a 'Capture the Loveliness' cluster of ideas (the title was chosen by the working group trying to capture the essence of their concerns in a pithy phrase) generated by one group considered whether improved communications technologies (in particular, higher bandwidth and lower latency) might allow the design of learning episodes that begin to capture some of the type of student engagement widely seen at Open University residential schools (the 'loveliness').

Participants in these workshops were subsequently invited to a 'Phase 2' workshop, with the intention of building on the ideas generated in Phase 1. The phase 2 workshop sought to explore whether there were viable ideas, and consortia with the interest and ability to pursue them post-workshop. Ten participants took part in the 'Phase 2' workshop, in September 2011. This paper reports on and develops the ideas and work of one of those groups (in which the authors participated). We chose to try to visualise what a distributed PBL scenario might look like in ten years' time, across a range of curriculum areas, and assuming the further development and widespread availability of some key technologies. These technologies might include remote robotics, 3D printing, augmented reality, and other hybrid physical/digital artefacts associated with the 'internet of things'. As it became clear how context-specific such applications might be, we developed our thinking in the hypothetical context of cross-curricular activities in which students investigating the Roman Empire might engage in, around the question "What did the Romans ever do for us?" Taking the imaginary example of found fragments of a broken pot, it was possible to envisage a number of activities which might lead to valuable learning, and perhaps even ultimately to the restoration of the original artefact. These included imaging the fragments (with a 3D scanner), making copies of these fragments (by 3D printing), building digital computer models of the pot, generating missing fragments (again using 3D printing) and reassembling the copies (or perhaps the original) using remote robotics. Such a learning activity might be designed for students who are geographically remote, and using physical resources (for example, 3D scanners and printers) which may or may not be collocated.

Technically, all of the artefactual elements for this type of activity already exist, and several seem to be on the brink of becoming widespread, even everyday, resources. So, it is reasonable to ask what issues their exploitation in this kind of way might be, and how we might evaluate their likely educational effectiveness. We can, we think, see some hints of these issues through some contemporary developments which might be viewed as initial steps in these areas, and in particular a new Open University introductory-level technology course TU100 *My Digital Life*.

Distributed problem-based learning

In the IBZL workshop, we chose to examine the possibilities that new technological scenarios might open up for problem-based learning. The potential of PBL to engage learners effectively has long been recognised. Arguably, this approach has long existed but it has achieved prominence in the context of medical and health education over the last few decades (Schmidt, 1983) where it has proved effective in areas such as diagnosis, where students use prior knowledge to arrive at increasingly certain conclusions, with or without peer discussion and tutor support. However, the wide application of PBL across other curriculum areas has not always been welcomed, and it is argued that it may be a distraction or an impediment to learning (Kirschner et al., 2006).

Against this controversial background, the introduction of networked learning is already showing the potential to shift the way that PBL is contextualised, and the development of more sophisticated and immediate technologies is likely to lend increasing complexity to these arguments over the coming years. However, there is danger that PBL means different things to different people. In the networked context, PBL often implies one of two contrasting methods: text-based discussion, or virtual reality. Arguably, neither of these is in consistent with the true spirit of PBL, which implies a constructivist approach to teaching (Savin-Baden, 2007), and requires the learner to engage with real issues or objects.

An emphasis on text-based activities can mean that the skills being practised are not the same as the skills required in the course. To choose a simple example, if a learning outcome is to design a bridge, then talking (or writing) about how to design a bridge will only get you part of the way. We argue that it may be possible, although perhaps not simple, for groups of students to practise bridge-designing skills at a distance from the lecturer and from each other. However, the design of learning around these ideas is challenging, and requires many questions to be addressed. For example, if students are to work collaboratively, what do they need to share – beyond simple words and images? What sort of time scales is involved (asynchronous, 'synchronous, or 'zero-latency')? And how might this be co-ordinated?

The limits of text-based interaction are well recognised, and there has been as particular interest in virtual worlds, such as Second Life, as a medium for developing immersive PBL experiences for learners, leading to a number of pilot projects (e.g. Burden et al., 2008). However, the costs of creating these are significant, and at least two questions remain unclear, namely how great is the benefit to learners, and how effectively these pilots might scale up to an institutional level. Moreover, there is a degree of detachment between the student and their avatar, which may negate much of the impact which could be gained from working directly with a physical object, or perhaps a patient. Treating a patient in Second Life simply does not feel like treating a patient for real. This example raises a wider question: do online technologies integrate with and enhance PBL, or are these approaches in danger of colliding, as suggested by Savin Baden (2007)? Superficially, the emphasis on active learning indicates a good fit between PBL and networked technologies, but combining these concepts raises a key question: who controls the learning experience - the learner or the teacher? The extent to which PBL is effective may ultimately be defined not by technology, but by the degree of learner engagement and control (Glud et al., 2010).

In the light of these issues, we believe that there is a case for broadening the discussion, in order to incorporate a broader range of curriculum areas, and to take into account the full range of technologies which may support PBL. In this way, it may be possible to make even a remote PBL activity into a genuinely interactive and engaging learning experience. Indeed, the skills developed in such a learning environment might increasingly correspond to authentic professional skills. For example, learning to control a robotic device on a distance geography 'field trip' may develop the kind of skills that are actually required by researchers, for example working close to volcanoes.

Networked learning, 'next generation' networks and hybrid resources

In this section we will explore ideas about networked learning and hybridising physical and digital resources, with reference to a distance learning module *My Digital Life* which blends learning materials in both printed and electronic form and also includes a piece of kit, the electronic SenseBoard.

My digital Life

Context

TU100 *My Digital Life* is the OU’s new level 1 module in information technology (IT) and computing which commenced its first presentation in October 2011. The module focuses on ubiquitous networked computing. It starts with the students themselves and their experience of the world of networked computers and works outwards to the use of mobile devices in the environment and then takes in social networking, the electronic society and more.

As Mike Richards and John Woodthorpe, the chairs of the module production team, explain:

> ‘Ubiquitous computing provided us with an opportunity to widen participation in computer science and engineering. If computers are going to be everywhere and ‘everyware’, then we should attempt to teach the subject in a manner that would appeal to as large an audience as possible.’ (Richards & Woodthorpe, 2009)

Unlike other universities, the OU does not require any previous educational attainment as an entry condition. Therefore the module assumes only a basic level of prior computer use. However, the module is intended to provide a solid foundation for students wishing to study IT and Computing at level 2 and beyond. In addition, because OU students study at a distance, the university cannot offer them the experience of working on ubiquitous devices in a laboratory. This presents quite a challenge. TU100 is designed to be delivered by distance learning and is presented in a mixture of printed and online self-study materials including resources such as audio- and video-recordings, many specially produced for the module. Various online asynchronous communication tools are available in the module, such as forums, blogs and wikis for students to communicate with their tutors, other students and the module team. An important aim of the module is to introduce computer programming concepts. Rather than use a traditional programming language (where students' first experience is often that of bafflement in trying to find the missing semicolon, rather than grasping the essential principles of writing good software), TU100 has developed Sense, a drag-and-drop programming language based on MIT's Scratch environment, which was originally intended to teach programming concepts to children. As an educational programming language Sense has a number of advantages; it has a clear programming structure in which individual program blocks can be assembled like a jigsaw puzzle, removing some of the frustration of having to use the exact syntax as in other programming languages. Although not in industrial use, Scratch can help students learn all the basic concepts of common programming languages and thus help build students' confidence in their ability to program.

A number of real-time web-conferencing tutorials have been written for the module which will be offered to students at intervals of 4 to 6 weeks. Some of these will support the teaching of Sense. The OU is currently using the 'Elluminate Live!' web conferencing system. This is a synchronous audiographic system in that it combines technologies to provide different modes of communication and supports multiple media. Not only does Elluminate provide audio conferencing but it also offers text chat, a white board for multi-media presentations and virtual artefacts using images, video and audio (de Freitas & Neumann, 2009). A tutor can demonstrate features and projects in the Sense programming environment in Elluminate using the application sharing facility. In addition, tutors can use Elluminate to set up problem-based learning programming activities, and the breakout room facility allows tutors to organise students into small groups who can then work on different aspects of a larger problem.

Blurring boundaries: ICT and the physical world

TU100 uses the SenseBoard with the Sense programming environment to illustrate the concept of small, networked devices sensing the environment and responding to changes therein. A SenseBoard is a programmable hardware device that can be connected to the student's computer using a USB connection. Based on the PicoBoard used with Scratch, the SenseBoard contains sound, light, a slider device and a button which allow Scratch to react to changes, for example so that an on-screen graphic on can be controlled by a slider. The SenseBoard includes outputs such as LED lights and other sensors, such as a thermistor and motion detector along with and outputs such as LED lights. The idea of the board is to illustrate how sensors and actuators work as in a ubicomp device. . Importantly, from our perspective, the Sense programming environment provides network support and in particular internet access (Richards & Smith, 2010). Consequently, students can use Sense to access RSS feeds from the internet and also upload their own data to a TU100 students' shared space on the internet. This creates the potential for distributed applications which bring together data from the physical world as some form of mashup (for example, real-time temperature mapping).

From the perspective of this paper, TU100 is a significant move in the direction suggested by this paper both in the way that networked physical resources are incorporated into the pedagogy and in the practices associated with 'enhanced' (the inverted commas will remain until such time as we have empirical evidence) synchronous communication technology. At the time of writing, the first cohort of students is half way though the module, so our reference to the module is illustrative rather than making claims about the effectiveness of the approaches. though we hope colleagues better placed than we are will be able to report on those in the coming period).

Discussion

During the IBZL workshop, we explored the possibilities of some of the 'design space' becoming available to educators through the convergence of 'next generation' broadband networks with technologies which increasingly blur the distinction between the digital and material worlds. The availability of these artefacts does appear to offer exciting new terrains for networked learning. Below, we reflect on some of the issues suggested by the example of TU100, putting these into the wider context of technical change. In particular, we look at those issues that appear to be obstacles to establishing such forms of networked learning as sociotechnical infrastructures in the sense used above and some of the wider issues raised by these developments.

In our example of TU100 My Digital Life, the 'artefacts' are the hybrid digital/physical SenseBoard and the entirely digital Sense development environment. Each student receives a SenseBoard and Sense software to use in their own learning space, (typically their homes). The tutor will be able to demonstrate in real time the use of Sense through the application sharing facility in Elluminate. Students will then be able to work on a particular problem in small groups in Elluminate and then try it out on their own computers in their homes. These artefacts are specific to the introductory study of ubiquitous computing. Unsurprisingly, a technology module is experimenting in this way with emerging technologies. The particular implications, opportunities and problems are likely to vary significantly across disciplines; for example, the collaborative construction of material artefacts is likely to be of particular value in design and engineering education. In environmental science, there may be greater value in the ability to collaborate on data gathered by learners (possibly in real time), and so on.

Networked communication infrastructure

The roll-out of 'next generation' telecommunications networks is accompanied by widespread claims about their value in education (alongside areas such as entertainment and healthcare). However, the complexity of establishing a viable sociotechnical infrastructure is evident. In preparing the use of web conferencing in TU100, social, technical and pedagogic issues remain to be resolved. For example, there are differences in way that people communicate online, for example, the 'sociability' (Preece *et al*, 2003) or, how the social interactions of members determine the characteristics of an online community and even the computer program a community uses influences the character of an online community. Thus a community that uses asynchronous forums will have a different 'feel' to one that uses a synchronous chat, for example. We are currently at the very early stages of developing norms and expectations about the appropriate use of audio/video conferencing in education and our students will no doubt be developing their own norms about the use of these technologies, drawing on their experiences elsewhere...

At the technical level, anecdotal evidence from tutors and others suggest that our networks often remain inadequate, with problems of signal attenuation and drop out leading to gaps in transmission which means that the person on the receiving end experiences gaps between words of other speakers. Unless users have a 'headset' with speakers and microphone, other users may experience 'feedback' from the person's speakers. The technology works better with broadband but Elluminate can be run at lower connection speeds to accommodate students with dialup modems. From a teaching and learning perspective, there may be a tendency for a session to become a lecture rather than a discussion (Kear et al, 2012). This is because the tutor usually has control of the microphone, although other participants can ask for the use of the microphone by clicking on a raised hand icon. This system poses challenges for the tutor who has to both teach and manage the web conferencing room during the session. However, a PBL approach means that students may be able to take more control over the learning experience for themselves. Perhaps more fundamentally for some models of networked learning, the need for everyone to be available at the same time to participate in the session may conflict with the aim of 'openness' and flexibility in distance learning in that distance learning should be as far as possible independent of time and place.

We are not arguing that these difficulties make the use of real time audio/video communication unviable for PBL or other learning experiences. Rather, we are pointing to the complexity of the situation, and noting that the issues involved in generating a viable learning infrastructure are far from simply technical, but include the institutional, pedagogic, social and technical.

Blurring boundaries: networked resources

If the uncertainties in the integration of audio and video conferencing in to education are complex, at least we have the experiences of integrating text-based CMC into networked learning, and some relatively early experiences of audio and video. We have rather less to guide us in understanding the situation with the incorporation of resources which change relationships between the digital and the physical. If such novel resources are to be effectively enrolled more widely in networked learning we can expect (more accurately, guess) that new interfaces (such as haptic) may be needed to control resources remotely; protocols (both social and technical) will be needed if people are to collaborate in real time using such resources. These will in turn require rather more reliable network connections than is currently often the case. Access to resources like 3D printers and laser cutters may pose problems; while some of these devices may become everyday tools in some households in the relatively near future, social infrastructures such as 'FabLabs' (see for example http://www.fablabmanchester.org/) that parallel earlier generations of 'Electronic Village Halls' (Qvortrup, 1989) might also prove to be valuable components of new educational infrastructures..

Conclusions

In this paper we have looked at some current technical developments in education and considered some of the implications for networked learning. This was stimulated by our participation in an IBZL 'futurescaping' project which invited us to look at potential technological futures. In order to try to avoid some of the risks of technical determinism that accompany many rather 'gung ho' accounts of emerging technology for education, we have looked briefly at some of the issues involved in a new Open University course which is, we think, an early pathfinder in to the design spaces that are opening up. These experiences highlight some of the hard organisational and pedagogic work that will be involved in the critical development of networked learning applications in these new spaces.

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