

Learning as knowledge networking: conceptual foundations for revised uses of the Internet in higher education

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Abstract—this paper argues that the inherent characteristics of knowledge work, when combined with the operation of the Internet in contemporary society, produce a change in the dominant paradigm of what constitutes knowledge work. Since learning is a form of knowledge work, therefore this change will affect university education. The paper further argues that, because of the way in which online learning initially developed in universities, in most cases, the current approach to the Internet and higher education does not account for the changed conditions of knowledge in a network society. It concludes that new directions are needed which will allow us to make technology and pedagogy choices for future education better suited to a network society.

Index Terms— Online learning, knowledge networking, web 2.0, e-learning.

I. INTRODUCTION

This paper presents a new way of considering the Internet in higher education. It argues for a new conceptual basis on which to adapt the Internet to education, reflecting changes in society as a whole, rather than seeing the Internet as an educational technology. This basis is the shift in society towards knowledge networking, interweaving the Internet and its knowledge functions into everyday life – especially for many younger people likely to become university students. Knowledge work becomes ‘net-working’ when it is largely practised through, computer-mediated information and communications systems. The utility of the concept of knowledge networking for higher education is that learning, while capable of many definitions, is a special form of knowledge work. Thus, if knowledge work changes its character, therefore approaches to learning must change.¹

A new approach, recognizing knowledge networking as everyday behavior outside education, will enable educators to

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¹ This paper presents conceptual work that forms part of the Learning in Networks of Knowledge project: <http://altc-link.wikidot.com>

design curriculum, choose online tools, and have teaching approaches that connect online learning with the other kinds of knowledge work now being done online. A knowledge networking approach is needed to re-align university education with the development and use of the Internet in society. While there was a relatively close alignment in the 1990s, standard ‘online learning’ approaches no longer have a close relationship to the overall way the Internet is used and understood in society. This misalignment has become particularly evident since the mid-2000s with the growing popular recognition of ‘Web 2.0’ [1], [2].

We begin with a history of the development of online learning at universities, demonstrating the growing contrast between it and the general, everyday and everywhere uses which now predominate outside of the academy. This history provides evidence that there is a misalignment which inhibits effective innovation. The paper then offers a multi-faceted definition of knowledge work and argues that there are some broad changes in the way knowledge work is now done, because of the Internet. As noted, because learning *is* a form of knowledge work, these changes therefore constitute a motivation to think again about approaching learning using the Internet. The paper concludes by offering key directions for universities and the Internet to ensure online education remains relevant to the experiences, expectations and needs of contemporary students.

II. WHY CURRENT NORMS OF ONLINE LEARNING ARE OUT OF STEP WITH THE INTERNET IN SOCIETY

The use of the Internet in university learning has been common for at least a decade now. However its origin dates to at least the late 1970s, when early experiments were conducted by Turoff and Hiltz at the New Jersey Institute of Technology [3], [4] and, thereafter, at other institutions. From around the early 1980s until the emergence of the World Wide Web (and the start of widespread adoption of the Internet in society), researchers and pundits generally proposed that networked information and communications systems, could provide a useful or even essential component for student learning. There were two broad approaches proposed in this early period of development. First, in the coming era of computer networks was thought to enable a replication of the on-campus experience, at distance. In this approach, the focus was on the transmission of lectures, and the holding of seminars of a traditional kind. It was assumed that

broadband communications links would soon emerge which would enable distant education in a manner like face-to-face classes. There was less thought of creative pedagogy, and more interest in access to the university unchanged [5]. Second, and more commonly, innovative educators wanted to explore some more unusual affordances granted by computer-mediated communications. They were focused mainly on the interactive nature of the medium, especially the different rhythms of asynchronous communication, and the different engagements of text-based conversation, and the chance to use computing to support collaborative, shared work [6], [7]. Until the late 1990s, however, much of the development was largely theoretical or experimental. Not only was network access relatively limited, but the tools needed to use the Internet for online learning often had to be built from scratch; there was a general lack of embedded knowledge among teachers and students as well.

By the end of the 1990s, in contrast, many universities had a much more systemic approach to online learning. In the rapid expansion in understanding about the Internet and its capacity in the late 1990s, many had developed their own in-house approaches; many more – especially those coming later to the task – had implemented learning management systems such as WebCT and Blackboard. By the new century, most universities had settled on one or other commercial package (or a variant of it from open sources) – decommissioning many of the purpose-built systems unique to their institution [8].

This development was particularly important for universities – like many in Australia – that offered significant distance-based learning programs, primarily for students unable to attend campus in person. The technologies dramatically changed the capability of students to interact with teaching staff and, more importantly, with each other. Distance education became – largely – ‘online education’ which, even if it still involved paper-based materials, was a qualitatively different experience because of the way students could discuss their studies, share ideas, and converse in either synchronous or, more usually, asynchronous formats, with each other and teaching staff [9]. Even campuses with a more traditional classroom-based approach soon became comfortable with the use of learning management systems to provide a modest degree of flexibility in the way learning might occur, providing ready access for both students and staff to a repository of lecture notes, additional discussion opportunities and so on [8].

From this time emerged a relatively common set of assumptions and expectations about how the Internet might be used to enable, enhance or make more efficient, the conduct of university learning [10]. First, distance education was revolutionized, so long as students had access to computing and networks [11]. The assumption was, now, that non-classroom learning that did not involve the Internet was lacking. Second, on-campus learning – even though it had been the source of the original ideas about learning because only on-campus students could reliably access networked computers until the late 1990s – was thought to be largely unaffected, except insofar as students might turn to the Internet for supplementary or

remediation materials. The assumption was that the classroom remained the primary site of learning for students attending a campus [12]. Third, it was assumed that the principal benefit of the online learning deployments common around the turn of the century was their capacity to build constructivist learning environments in which students’ discussions of their learning, sharing of ideas, and informal collaborations would promote far more effective learning than transmission models associated with face-to-face delivery [13]. Of course, in relation to this third assumption, it is fair to conclude that many on-campus, face to face settings were equally (or more) effective in implementing constructivist approaches. Similarly, many online learning implementations often ended up being transmission oriented and probably worse than the classroom approaches upon which they were meant to improve [14]. Finally, it was clear that the predicted explosion in ‘tele-present’ education – live lectures and seminars involving video presentation – was not yet, or likely to be, systemically viable. Lack of bandwidth, costs far in excess of value, and the general dominance of the constructivist approach relegated such approaches to a much less important place than had been imagined in the 1980s.

The salient lesson from this brief historical review is that, for much of the first decade or so of online learning development, there was a broad expectation that the Internet’s availability in society was *not* especially widespread, that innate abilities to use it for knowledge work were unlikely, and that it was not fully integrated into people’s lives such that ‘studying’ and ‘using the Internet’ were synonymous. In almost all cases, online learning was systematically implemented (aside from occasional experiments and variations) for students unable to attend a classroom, or somehow held back from learning in class as much as they might. Only in the hands of some pioneers did it seem that Internet-based learning might take on a form that attempted to shift the primary locus of learning from the classroom to cyberspace, regardless of whether students were isolated from one another and distant from the university, *or* collocated and at the university.

And, at this time, institutional pressures to expand the use of online learning to include more and more units of study, for more and more students, began to grow. In the 2000s, these pressures came to militate against the widespread adoption of innovation. They cultivated, instead, a mediocrity in the use of the Internet for learning, aimed at broadening its use across more faculty and staff, while reducing the actual difference that it would make. Fundamentally, there emerged a ‘deficit’ model [e.g. 15] to drive widespread adoption of the Internet for higher education. The Internet became seen as making up for some lack – either the ‘lack’ of attendance and co-presence; or the ‘lack’ of ability to achieve without some assistance available to on-campus students if they chose to use it. This institutional deprecation of innovation also reflected significant disinterest from the majority of academics in radically revising their established practices to account for the Internet.

So, the summary history of the development of the Internet in higher education can be seen thus. Experiments were conducted

in the 1980s, with almost no impact on higher education as a whole. These experiments became a critical base for operational innovations in the 1990s, which pointed the way for universities as a whole, even while mainly the change was limited to individual teachers and their students. However, in the early 2000s, as more academics and universities deployed 'online learning', they largely did so by stepping back from some of the more innovative approaches of earlier times [16].

Critical to this 'scaling-up' of online learning, and the consequent scaling back of innovation, was the state of the Internet in society which had led to the widespread development of learning management systems in the first place. Essentially, approaches to online learning and the technologies used systemically to implement them had developed during a time when the Internet was not intimately bound up in the lives of most people in society. Indeed, the Internet was often seen as an educational technology – not so much an everyday part of life, but a specific tool to be deployed how and when educators needed it [17].

As a result, when the Internet did start to become part of the everyday, and when new approaches and understandings developed in society about its utility and power, learning management systems and their associated affordances for particular kinds of education remained the same. Essentially, the success of wide-scale deployment of learning management systems created a duality between the Internet as experienced by people through such applications as MSN, Facebook, Google, Wikipedia and so on; and the Internet as utilized by university students through WebCT, Blackboard and the like. Most critically, while the interfaces and basic technologies were not that different – indeed learning management systems were designed to package basic net applications into an easy-to-access and manage suite of tools that mimicked other functions, the underlying experiences of 'using the Internet' and 'using the Internet through formal learning systems' began to diverge more and more, especially from the mid-part of this decade when Web 2.0 started to dominate a new round of web development.

Nothing sums up this differentiation more than the terminology for the software applications which, by 2000, seemed to dominate university online learning. These applications were either: virtual learning environments [i.e. 18]; or learning or course management systems [see 8]. The reference to environments echoed the older times of the Internet in which online activity was seen as different from, separate to and 'other' than offline life. To enter an 'environment' was much like going to a distinctive physical space – a classroom – in which education took place, with the difference being its virtual state. The reference to systems reflected a more transactional approach, in which students conducted their learning by becoming part of a system, more or less delivered via the Internet, but was *distinct* from it.

In both cases a particular conceptual model of education was at play: from the perspective of the teacher, it was about, more or less, the creation of a shared, private community – a 'class' in

which – when it worked – constructivist learning would occur through student interaction based on content; or, at least, it was an attempt to promote this approach even if the learning was less collaborative than hoped. From the perspective of the institution, such online learning 'systematized' the interactions of students, limiting, in various ways, the array of transactions and activities in much the same way that database systems for finance, human resources and so on constrain business processes so as to ensure regularity, reliability and common outcomes.

As we approach the end of the first decade of the twenty-first century, the Internet outside of such university systems and environments has developed in new directions. More importantly, the social use and cultural understanding of the Internet has changed dramatically. These changes expose the mismatch between universities' 1990s approaches (even though they continue to be effective within their own, limited terms of reference) and the growing, everyday and everywhere culture of the Internet. This cultural shift is often associated with Web 2.0 [for example 19], and is often linked to generational change. In fact it is as much a consequence of the very ordinary ways in which many people, regardless of age, and whether using Web 2.0 or not, rely on the Internet for all kinds of knowledge-based actions, exploiting the particular utility of a distributed, interactive information and communications network that is woven seamlessly through their lives. The increasing availability of the Internet through mobile devices, wireless networks, and – because of broadband – at more effective speeds and in 'always-on' mode, also play a major role in building this interdependence.

While not every student who attends university has this experience, and while no student's experience is identical to others – we must avoid the easy generalities of 'digital natives' [20] and remember the various dimensions of the digital divide, both in access and literacy – more and more the overall culture of the Internet in society is now very different to that which we invoke through our current modes of organized online learning.

III. UNDERSTANDING KNOWLEDGE WORK AND KNOWLEDGE NETWORKING

How can we approach this new situation? If we begin with tools, or applications – as many do – we may be moderately successful; however what is needed is, first, an analysis of the ways in which the Internet works to array and produce new modes of knowledge work, since learning is itself knowledge work (of a special kind). In other words, we need to think of how knowledge is now performed in a society that is relentlessly connected, through numerous technologies which aid in, extend, or remodel our cognitive facilities as humans. On this basis we can then reshape our approach to learning in such a manner that university-based uses of the Internet better match the way people are using the Internet outside of universities far more extensively than when first educators approached the question of how to we get people to learn online, and then built systems

which at first facilitated this outcome, but now constrain it.

To achieve this analysis requires a conception of what knowledge work is, as well as discussion and analysis of the kinds of different attributes that such work has when undertaken within networks of both human and technological actors.

Knowledge work is best understood as the development (and ongoing redevelopment) of mental constructs that internally represent for an individual the world to be 'known'. Such constructs consist of claims about the world, both what is and what ought to be, and the associations between these claims to form consistent and plausible relational structures. The mental constructs knowledge work produces enable knowledgeable action in and for a world which is represented to an individual as knowledge. So, this potential to act in the world is intimately linked to the work of understanding the world, such that knowledge always has the potential (and often the actual state) of serving as an intermediary between thought and action.

And, with reference to 'thought', knowledge work is cognition, but it is not just internal mental processes such as memorizing, structuring and so on. Knowledge work, if we arbitrarily separate out constituent components, proceeds from intent or purpose, through a variety of activities exploring or fulfilling that purpose, towards completion and reflection upon that process. At all stages, knowledge work involves acquiring, arranging and expressing information-as-knowledge.²

Put simply, knowledge work is about inputs, processes and outputs. But this is not a simplistic model drawn uncritically from information science and earlier versions of cognitive psychology [e.g. 21]. It is made complex, and more accurate, by the fact that every input is someone else's output; that one's outputs are others' inputs; and, most importantly, that processing does not neatly occur between the acquisition and expression of knowledge but is a continuous, diverse process which only artificially can be differentiated as involving flows of information in or out of a knowledgeable system [22].

This definition of knowledge work draws on the following understanding of knowledge, which attempts to combine, rather than oppose, four different approaches. First, knowledge is as *object* [e.g. 23], which we can discern as a distinct and transmissible thing, existing in forms which can and do regularly externalise knowledge (if only temporarily) from knowledgeable humans and make it distinct from their social and other organizational contexts. Second, at the same time, but perceived differently, knowledge is *conversation* [e.g. 24], such that knowledge only emerges from and through the communications between people, such that knowledge is more than just the sum of each individual contribution to the conversation

Yet, equally, knowledge is a *social process* [e.g. 25], in which – essentially – there are no distinct objects, and conversations are but evidence of a continual process by humans of 'coming to know': creating, critiquing, changing, and confirming their collective and distributed knowledge. And,

finally, knowledge is *enactment*, where knowledge is discerned through observable actions in the world, inferred from what happens by observers and, perhaps more importantly, understood by knowledgeable subjects themselves through actions, and never as abstract from the world which knowledge represents.

Based on these definitions, we would conclude that knowledge work, while having an internal quality to it, is fundamentally collaborative because of the circuits of interaction between knowledgeable subjects that are implicit in the simple recognition that inputs and outputs are merely a matter of perspective and that processing of information, the constitution of knowledge occurs continually. Moreover, the dialogic nature of language, within which claims always speak to someone (even if only our own inner ear), calling out for interpretation and association, ensures that knowledge work is communicative, quite apart from any practical tendency for people to discuss and share their constructs of the world – their knowledge – as a fundamental part of experiencing ourselves as social beings.

Knowledge work has an inherent tendency to a networked form [as evidenced by 26]. It involves communication to activate the dialogic qualities of the mental constructs at its heart; it implies collaboration, for although it has a mix of activities that appear individual and linear (input to process to output), these three components are operationalized simultaneously and among many people. And, when networked information and communications technologies become predominant in society, this potential is unleashed, and becomes the dominant quality of knowledge work. Knowledge work becomes knowledge networking.

Manuel Castells, in revising his earlier conception of the socio-economic revolution which he termed the "rise of the network society" drew a similar conclusion. Initially Castells saw the network society as a radical break with past social organization. However, by the time he had been able to observe the impact of the Internet on society, he concluded that, in fact, societies had already had the potential for a networked organization but that it was the combination of this inherent potential and the Internet, and not just one or the other, that actually produces the profound changes witnessed in the past two decades [27], [28].

Thus, we conclude, knowledge networking is the emerging dominant paradigm for knowledge work in contemporary society [2]. Within 'networking' (which of course is both a technical and human phenomenon), knowledge work is fragmented, distributed and collaborative, involving considerable separation of its distinct components – inputs, processes, and outputs – which are then shared in time and space, between human and non-human actors, in ways that de-centre 'knowledge'. In some sense, knowledge is no longer an object that is produced, circulated and received, and reinvented: it is instead a state of being, with which people are involved. One does not know, anymore: one is part of knowledge, experienced and enacted through networking. This

² The term information-as-knowledge indicates an end to the false binaries of information and knowledge as distinct components.

ideal state, of course, does not necessarily map exactly to the realities of lived experience; but it is becoming – through metaphor, norm, and practice – a much more significant component of our lives.

In particular, as suggested by Castells, the impact of the Internet has been to extend to potentials for knowledge networking very broadly in society, such that even a mundane task – arranging an overseas holiday, maintaining links with distant relatives by sharing information, planning to purchase consumer goods – becomes knowledge networking. Not only is some of the processing done ‘for’ humans by computers (think of the way airline booking systems interact with websites offering cheap fares), and not only is there a wide array of inputs available to assist in decision making (think of the professional and user reviews of products online), but the Internet now seductively encourages us, all the time, to add to the stores of knowledge, to engage in conversations in which our reflections and conclusions become the inputs into someone else’s knowledge work. A life lived, using the Internet, becomes a matter of knowledge work. Since education is all about knowledge, and we are teaching students who engage more thoroughly with knowledge work than ever before, therefore this state of affairs must necessarily lead to a re-examination of what we do as teachers and learners.

IV. CONCLUSION

This paper has characterized the history of the use of the Internet for online education at universities as moving through three stages – experimentation from the 1970s to mid-1990s; innovation from that time until the turn of the century; and then systematization and scaling from that point on. This history, of itself, is unimportant, except that it is parallel to a history of the Internet in society which suggests that universities now approach online learning from a basis dating from much earlier times, and not reflecting the unleashing of the network potential within knowledge work which has occurred in recent times.

Knowledge networking involves knowledge work that is shared, distributed and fragmented. Increasingly, students come to university education already involved in knowledge networking [29], even though their conscious understanding of this kind of work can vary significantly from naïve to sophisticated. In such circumstances, what future directions should research and development in online learning take?

First, technologies for online learning need to evolve to take account of what is popularly described as Web 2.0. This evolution does not, however, simply mean adding on blogs, wikis and similar features to existing learning management systems (even though the leading providers of such systems are hurriedly attempting to do so). Rather it means creating new kinds of educational systems that do not adopt the affordances of the Internet for knowledge work and repackage them. Instead, these new systems need to be gateways or interfaces between the educational environment and the complex, rich world of knowledge already to be found and created online. Rather than embedding content and conversation within a

simulacrum of the classroom, they need to be portals to a wider world. As just one example, systems need to prioritize the creation of identities for students at third-party sites, rather than bringing the functions of those sites within the learning system. A better interface is required between unique-to-education functions (largely, the management of assignments) and the Internet as a whole – for example, in systems which would gather online contributions by students at diverse sites and collate them in a portfolio.

Second, and soon, all learning will involve the Internet. Thus, the institutional organization of online learning needs to recognize that, while presence or absence of students changes the modalities of learning, the Internet is no longer a technology of time and place (providing students with opportunities to study off-campus or to arrange their time flexibly while on-campus): it is a technology that distributes knowledge work differently. Policies, procedures and institutional directives concerning online learning must place knowledge networking first. If early ideas about networks and learning emphasized the transmission of ‘the university’ to remote places; and if practice through the 1990s established the idea of gathering students *in* a virtual classroom; then future developments will need to explore the distribution of students through their knowledge across the Internet.

Finally, curriculum design needs to proceed on a different basis. Knowledge may be socially constructed, and learners do benefit from collaboration and conversation with others. However, the increasing sophistication and extent of knowledge work tools available through the Internet means that increased attention needs to be paid to the internal conversation a student has with themselves, based on the comparison of what they have in their heads, and what they see on a screen; and also attention must be paid to expanding the network of productive interactions beyond the students’ peers, to include judicious interactions between students and the real knowledge networks in which they are learning to be a part. In other words, Web 2.0 might appear to some to be the harbinger of a renewal of constructivism: but in fact it suggests an altogether more radical form of pedagogy which is centered on knowledge work, of which social constructivist interactions are just one part.

While similar work by Downes [30] towards a ‘connectivist’ theory of learning is important here,³ the approach we suggest requires a more thorough assessment of the interrelations between individual nodes in the network, the distribution of cognitive functions to human and computer actors, as well as a consideration of the new state of fragmented online conversation. Moreover, we argue that the knowledge networking paradigm needs to encompass more than just pedagogy but also institutional understandings of the social use of the Internet (which often lag far behind current participatory practice), and also the design of ‘mashed up’ online learning applications which are largely reliant on existing sites and services outside the university.

Web 2.0 technologies provide the apparent impetus for these

³ See <http://www.connectivism.ca/>

changes [13], [29]; they provide some of the tools necessary to implement them. However, in conclusion, we would argue that Web 2.0 is just the contingent circumstance which reveals the current limitations of universities' approaches to the Internet and learning. Innovation rests not with the technology itself, but with the way that the Internet – often imprecisely, inappropriately, or unpredictably – works as an engine for the transformation of how we 'do' knowledge work in our everyday lives. The current network society's conceptual and practical origins – Wiener's cybernetics [31], Bush's Memex [32], Licklider's Library of the Future [33], Nelson's Project Xanadu⁴, Berners-Lee's Web [34] – remind us that technologies are a language through which we articulate different visions of knowledge work. If Khan's recent collection online learning [35] is generally accurate, higher education has much to do compared to the emerging networked forms of knowledge in contemporary society.

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REFERENCES

- [1] M. Allen, "Web 2.0: An argument against convergence?" *First Monday*, Vol.3, No.3, March 2008. Available: <http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2139/1946>
- [2] M. Allen, "Education and the Internet: web 2.0 and renewed innovation in online learning," *Teaching and learning forum 2009*, Perth, January 2009. Available at: <http://www.netcrit.net/wp-content/uploads/2009/07/presentation-tlf-edantheinternet-2009.pdf>
- [3] S.R. Hiltz, "Collaborative Learning in Asynchronous Learning Networks: Building Learning Communities (Invited Address)", *WEB98 conference*, Orlando Florida November 1998. Available: http://web.njit.edu/~hiltz/collaborative_learning_in_asynch.htm.
- [4] S.R. Hiltz, *Learning without limits via computer networks*. Norwood NJ: Able, 2004.
- [5] B. Collis, *Tele-learning in a digital world: the future of distance learning*. London: International Thomson Computer Press, 1996.
- [6] L. Harasim, S.R. Hiltz, L. Teles, M. Turoff, *Learning networks: a field guide to teaching and learning online*. Cambridge, MA: MIT Press, 1995.
- [7] R.M. Palloff, K. Pratt, *Building learning communities in cyberspace: effective strategies for the online classroom*. San Francisco, CA: Josey-Bass, 1999.
- [8] A.C. Price, "Higher education's use of course management software," in *Handbook of research on computer-mediated communication*, S.Kelsey, K.St.Amant Eds. Hershey, PA: Information Science Publishing, 2008, pp. 63-72.
- [9] M. Allen, "From classes to communities: Internet-based learning and relations of individual learners to one another," *Proceedings of SSGRR-2001 conference on advanced Internet for business and education*, June 2001, L'Aquila, Italy: SSGRR.
- [10] M.K. Tallent-Runnels et al., "Teaching courses online: a review of research," *Review of Educational Research* Vol. 76, No.1, 2006, pp.93-135.
- [11] S. Wheeler, "Web-based learning and transactional distance," in *Toward the virtual university: international online perspectives*, N. Nistor, S. English, S. Wheeler, M. Jalobeanu Eds. Greenwich, CT: Information Age Publishing, 2003, pp.87-100.
- [12] A. Littlejohn, C. Pegler, *Preparing for blended e-learning*. London: Routledge, 2007.
- [13] R. Mason, F. Rennie, *E-learning and social networking handbook: resources for higher education*. New York: Routledge, 2008.
- [14] B. Gillani, *Learning theories and the design of e-learning environments*. Lanham, MD: University Press of America, 2003.
- [15] M.L. Price, A. Lapham, "The virtual seminar," in *Virtual learning and higher education*, D.S. Preston Ed. New York: Rodopi, 2004, pp.15-28.
- [16] A.G. Picciano, "Online learning: implications for higher education pedagogy and policy," *Journal of Thought*, Vol.41, No.1, 2006, pp.75-96.
- [17] P.R.Polsani, "Network Learning". Available at: <http://www.ltc.arizona.edu/pdf/NetworkLearning.pdf>
- [18] M. Weller, *Virtual learning environments: using, choosing and developing your VLE*. London: Routledge, 2007.
- [19] M. Ebner, A. Holzinger, H. Maurer, "Web 2.0 technology: future interfaces for technology enhanced learning?," in *Universal Access in HCI, Part III*, C.Stephanidis Ed., Berlin: Springer-Verlag, 2007, pp.559-568.
- [20] G.Kennedy, "The net generation are not big users of Web 2.0 technologies: Preliminary findings", *Proceedings of the Ascilite Conference: ICTS: Providing Choices for Learners and Learning*, Singapore, December 2007. Available at: <http://www.ascilite.org.au/conferences/singapore07/procs/kennedy.pdf>
- [21] W. Huit, "The information processing approach to cognition," in *Educational psychology interactive*. Valdosta, GA: Valdosta State University, 2003.
- [22] A. Seufert, G. von Krogh, A. Bach, "Towards knowledge networking," *Journal of Knowledge Management*, Vol.3, No.3, 1999, pp.180-190.
- [23] M. Kakahara, C. Sørensen, "Exploring knowledge emergence: from chaos to organizational knowledge," *Journal of global information technology management*, Vol.5, No.3, 2002, pp. 48-66. Available at: http://www.kakahara.org/papers/Kakahara&Sorensen_JGITM.pdf
- [24] Y. Kazmi, "Teaching knowledge as conversation: A philosophical hermeneutical approach to education," *Studies in philosophy and education*, Vol.11, No.4, 1993, pp.339-357.
- [25] D.Memmi, "The social context of knowledge," in *Social information retrieval systems: emerging technologies and applications for searching the web effectively*, D.Goh, S.Foo Eds. Hershey, PA: Information Science Publishing, 2008, pp. 189- 207.
- [26] A. Bharadwaj, R. Sarkar, "Identifying and capturing knowledge from networked knowledge spaces: theoretical insights and applications," *The 2nd International OPAALS Conference on Digital Ecosystems*, Tampere, Finland, October 2008. Available at: <http://matruii.ee.tut.fi/hypermedia/events/opaals2008/article/opaals2008-article22.pdf>
- [27] M. Castells, *The rise of the network society*. Oxford: Blackwell Publishers, 2000.
- [28] M. Castells, *The Internet galaxy: reflections on the Internet, business, and society*. Oxford: Oxford University Press, 2001.
- [29] R.Fitzgerald, et al., *Digital learning communities (DLC): investigating the application of social software to support networked learning*, Sydney: Australian Learning and Teaching Council, 2009. Available at: <http://eprints.qut.edu.au/18476/1/c18476.pdf>
- [30] S. Downes, "Learning networks and connective knowledge", *IT Forum*, October 16 2006. Available at: <http://it.coe.uga.edu/itforum/paper92/paper92.html>
- [31] N. Wiener, *The human use of human beings: cybernetics and society*. London: Sphere, 1968.
- [32] V. Bush, "As we may think", *The Atlantic Monthly*, Vol. 176, No. 1, 1945, pp.101-108. Available at <http://www.theatlantic.com/unbound/flashbks/computer/bush/hfm.htm>.
- [33] J.C.R. Licklider, *Libraries of the future*. Cambridge, MA: MIT Press 1968.
- [34] T. Berners-Lee with M. Fishcetti, *Weaving the web: the original design and ultimate destiny of the World Wide Web*. San Francisco, CA: Harper, 1999.
- [35] B. Khan, Ed., *Flexible learning in an information society*. Hershey, PA: Information Science Publishing, 2007.

⁴ See www.xanadu.net/