Networked Knowledge: Challenges for Teacher Education

Since 1990, the invention and popularization of the World Wide Web has caused an inversion in the information economy of education. Twenty years ago, when learners were set a task that required them to locate information about any but the most common topics, the challenge was most often to find relevant current information in the limited books and other resources available in the school, home or local community. Recorded information mostly moved in physical form and the best way to ensure that it was available when needed was to commit it to memory or keep a personal copy in some convenient form. The principal information challenge was one of access.

Now, when most classrooms have networked computers with Internet access, the information challenge has become one of selection rather than access. No one knows exactly how many pages are available on the Web and various estimates abound. Boutell.com (2007) quotes the Netcraft Secure Server Survey's (2007) finding that as of February, 2007, there were almost 109 million separate Web sites on the Web. They used this figure to project the number of separate pages currently on the Web, which they estimate as 29.7 billion. Rather than locating scarce information from a limited set of sources, a research task is today more likely to resolve into narrowing an Internet search to identify the most promising sources and select those considered most reliable and appropriate for the intended purpose. As mobile connected devices such as cell phones and PDAs (personal digital assistants) become commonplace, there is less need to commit information to memory or other local records in order to be able to access it when it is needed.

Where a traditional view of education had characterized teachers as dispensers of knowledge, which existed beyond the individual, the second half of the twentieth century witnessed a shift towards widespread acceptance of constructivism as an alternative paradigm (Jonassen, 1991) in which knowledge is viewed as constructed by the learner from personal and shared experience. This shift towards constructivism in education coincided with a rapid increase in the rate at which new knowledge was being developed and published. An emphasis on building personal understanding and problem solving capacity rather than rote learning of codified knowledge can be viewed as a logical response to the increasing volume of knowledge which makes it impossible to learn all that might be needed in most fields, or even within narrower specialties within such fields.

In recent years there has been increasing discussion of alternative views of knowledge, such as connectivism (Siemens, 2005). In this view, rather than learning being viewed as the construction of knowledge from experience, it can be seen as "primarily a network forming process" (Siemens, 2006, p. 15). Connection to the network allows a person access to the aggregated knowledge of the network and it is possible for the network as a whole to possess knowledge beyond that of any individual. On this theme, Downes (2006) has commented that, although no single person knows how to build a jet aircraft and fly it from one continent to another, international air travel is a daily event. The necessary knowledge exists and can be applied only because of the connections among members of a network.

Similar ideas, described using terms such as "knowledge webs" and "distributed learning" (Dede, 1996), have been discussed for more than a decade, but it has taken time for the underlying technologies to become sufficiently powerful, easy to use and widely available to have the potential to affect the daily lives of ordinary people. Related challenges and

opportunities for teacher education have been identified (Dede, 2004) but there remains much work to be done to grasp the opportunities and face the challenges.

The shift from objectivism to constructivism as an epistemological basis for educational practice challenges teachers, learners and members of their communities. That change has been described as moving from the 'sage on the stage' to the 'guide on the side' (King, 1993). For teachers accustomed to acting as the source of knowledge, the shift challenges professional identity. For policy makers at all levels, many of whom continue to believe that the mark of an educated individual is the number of facts that can be recalled, the new approach seems illogical and irresponsible. For learners accustomed to receiving content rather than constructing knowledge and understanding the additional effort is not always welcome. For communities, the apparent reduction in focus on basic skills is disconcerting.

Conscious and unconscious teacher beliefs, especially those about what counts as knowledge and how it should be imparted, are powerful influences on teaching (Ertmer, 2005). Research has found constructivist beliefs to be associated with higher levels of computer use by teachers (Becker, 2000; Hadley & Sheingold, 1993; Rakes, Fields, & Cox, 2006; Sandholtz, Ringstaff, & Dwyer, 1994) but it is not clear that the connection is causal or, if it is, in which direction causality operates (Becker & Ravitz, 1999; Dexter, Anderson, & Becker, 1999). More recently, a study combining direct observation of teacher practice with self-report data about beliefs found that although most teachers professed constructivist beliefs, their practice did not match (Judson, 2006).

The shift from viewing knowledge as transmitted from one generation to the next to seeing it as constructed from personal and shared experience had a profound impact on the work of teachers in their classrooms during the latter part of the twentieth century. It seems likely that the evolution of a view of knowledge as a property of a network rather than any individual will have an equally profound impact on the work of teachers in the twenty-first century. What are the challenges and how do we address them?

In an information-rich environment, education is likely to be less about accumulating information, whether transmitted from others or constructed, and more about transforming it in ways that make it more useful. This is the intent of a recent initiative by Tim Berners-Lee and the World Wide Consortium, which has published the rationale and specifications for the Semantic Web (W3C, 2007). The W3C defines the Semantic Web as "A common framework that allows data to be shared and reused across application, enterprise, and community boundaries." (An example of an application of the Semantic Web can be seen at the BigBlogZoo [http://www.bigblogzoo.com/], which features a collection of nearly 70,000 categorized newsfeeds and blogs.)

Developments such as the Semantic Web mean that information to be transformed will increasingly be found by students and others on the network rather than in personal memory or local records. Hence, facility with locating and evaluating information on the network becomes a critical outcome of education, both as a tool for learning and as capability for the future. It is important that teacher education graduates not only possess the relevant abilities but be able to engender them in the learners in their own classrooms.

As information continues to increase and become more and more instantly accessible, many new educational issues will emerge and some old ones will become even more critical.

Students and teachers will need to focus on dealing appropriately with networked knowledge. This calls for nothing short of building new, appropriate norms.

Although the evolution of a networked knowledge economy may eventually require responses in many aspects of education, at least three areas are already beckoning for attention. These are questions of knowledge as property attaching to concepts such as copyright and plagiarism, development of processes and skills for effective collaboration, and the problem of assessment of student learning if it is accepted that knowledge may exist in the network rather than the individual.

Scanlon (2006) argues that, although "the notion that Internet-assisted student plagiarism is on the rise has become part of the conventional wisdom about education in the 21st century", the evidence from empirical studies is less clear and the problem may not be as extensive as feared. Nevertheless, the experience of many educators confirms that at least some students are as much genuinely confused about the appropriate standards for dealing with material found on the Web as deliberately dishonest. One of us dealt with a recent case in which graduate student A in a course was identified by student B as presenting a paper comprising mostly text copied from a wiki entry created by student B and another student in a previous course taken by all three students. Student A's defense was that the wiki was badged with a Creative Commons [http://creativecommons.org/] license that allowed reuse and that, in any case, the material he had used was largely derived from specifications published on a commercial site. Student A conveniently missed the attribution requirement common to the license and general academic practice. Sorting out appropriate practice in the minds of all who use networked knowledge will present significant challenges for educators at all levels. Scanlon (2006) raises doubts about the efficacy of technological solutions, such as Turnitin (http://www.turnitin.com/), to what is essentially an ethical issue. Somewhat paradoxically, Hunt (2002) has argued that Internet plagiarism may be beneficial. His fourth, most powerful, argument for his contrarian thesis is that "by facing this challenge we will be forced to help our students learn what [he] believe[s] to be the most important thing they can learn at university: just how the intellectual enterprise of scholarship and research really works". Adopting this view may not reduce the size of the challenge facing us but may recast it in a positive light.

If knowledge is networked, then it seems reasonable to expect that learning, or at least some aspects of it, will be similarly networked. That is, we should anticipate a continuing increase in the uptake of online education and a concomitant need to conduct research to answer questions about how it might be most effectively deployed (Maddux, Sprague, Ferdig & Albion, 2007). Sharing knowledge in a network implies levels of engagement greater than those required for simple deposit and withdrawal of information. Effective dialogue towards shared understanding will be required. Recent research has highlighted the challenges involved in moving student interaction on learning tasks beyond the 'divide and conquer' approach of cooperation towards the dialogue required for collaboration (Paulus, 2005). Teacher education will need to address these issues, both in its own use of networked learning and in developing the skills that teachers will need to exercise in their own professional practice.

Networked knowledge presents new challenges for assessment of student learning. Traditionally assessment has sought to measure the knowledge held by an individual learner or the ability of the learner to apply knowledge that is available in memory or other sources. If knowledge is in the network, what might it mean to attempt a measure of the knowledge

held by an individual in isolation from the network? Equally, if application of knowledge typically occurs through collaboration among individuals through the network, what might it mean to attempt a measure of the ability of an individual to apply networked knowledge? Already the case has been made that "the closed book, invigilated final examination has become an anachronism" (Williams, 2006). The alternative is more authentic assessment in which problems are solved using the full spectrum of available tools including the network. Once again, teacher education will need to take a leading role in developing and applying assessments that respond to these challenges and model approaches that may be transferred into the professional practice of graduates.

While not necessarily directly addressing the issues of the networked knowledge economy, each of the papers in this issue has the potential to contribute to our thinking about and responding to the challenges identified in this editorial.

In writing about technology integration by social studies teachers, Zhao reports categories of activities ranging from teacher-centered to student-centered and observes that in moving from one to another "it is noticeable that the teacher's role as a dispenser of knowledge is gradually weakened while the students' roles as active learners and inquirers are strengthened". Alongside this shift there are changes in curricular focus from retention of information to development of higher order thinking skills, from teacher use of technology to present information to student use for conducting and presenting research, and from individual to collaborative work. These are the types of changes that can be anticipated as educators respond to the emergence of the networked knowledge economy.

Teachers' epistemological beliefs inevitably affect their teaching as they contend with decisions about what knowledge is most valuable and how it is best addressed in the classroom. Yadav and Koehler report that preservice teachers selected video cases about literary instruction consistent with their epistemological beliefs and interpreted them in ways that confirmed those beliefs. This apparent inertia in preservice teachers' beliefs about knowledge suggests that teacher education will need to explicitly address preservice teachers' epistemological beliefs for working with networked knowledge.

DiPerna and Derham report on a study that investigated the reliability and validity of scores from a digital portfolio. Portfolios are receiving significant attention as assessment tools in teacher education and other fields. Their capacity to bring together a variety of artifacts and relate them to relevant standards shows promise for the more authentic assessment approaches that will be needed to deal with the challenges arising from networked knowledge. Understanding how to interpret portfolio assessments reliably and validly will be important to their successful use.

In a study of an online graduate seminar, Ikpeze found that peer-led group discussions facilitated effective learning under certain conditions. Participation and group processing behavior were found to be the most important factors, which were, in turn, influenced by leadership structures and student characteristics. Better understanding of such group processes will be important for developing the collaboration required for working more extensively with networked knowledge.

In the final paper for this issue, Kafai, Nixon and Burnam discuss how pre-service teachers reason about students' use of computers and the Internet. Their reasoning was tied to local rules rather than universal considerations and they failed to understand the reasoning of their

students about similar issues. These findings point to the need for systematic preparation of teachers for dealing with the intellectual property and other issues that will accompany more extensive work with networked knowledge.

The emergence of a networked knowledge economy presents both opportunities and challenges for teacher education. Used effectively, knowledge networks present opportunities for better informed and supported practice by education professionals and more authentic learning by students. The challenges include those identified above and, while much more research and development will be required to answer them, the papers published in this issue represent useful starting points.

References

Becker, H. J. (2000, July). Findings from the teaching, learning, and computing survey: Is Larry Cuban right?   Retrieved March 13, 2007, from http://www.crito.uci.edu/tlc/findings/ccsso.pdf

Becker, H. J., & Ravitz, J. (1999). The influence of computer and Internet use on teachers' pedagogical practices and perceptions. *Journal of Research on Computing in Education, 31*(4), 356-384.

Boutell.com. (2007). WWW FAQs: How many Web sites are there?   Retrieved March 12, 2007, from http://www.boutell.com/newfaq/misc/sizeofweb.html

Dede, C. (1996). Emerging technologies and distributed learning. *The American Journal of Distance Education, 10*(2), 4-36.

Dede, C. (2004). Distributed-Learning Communities as a Model for Educating Teachers. In C. Crawford, D. A. Willis, R. Carlsen, I. Gibson, K. McFerrin, J. Price & R. Weber (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2004* (pp. 3-12). Chesapeake, VA: AACE.

Dexter, S. L., Anderson, R. E., & Becker, H. J. (1999). Teachers' views of computers as catalysts for changes in their teaching practice. *Journal of Research on Computing in Education, 31*(3), 221-239.

Downes, S. (2006). Learning networks and connective knowledge [Electronic Version]. *Instructional Technology Forum*. Retrieved March 13, 2007 from http://it.coe.uga.edu/itforum/paper92/paper92.html.

Ertmer, P. A. (2005). Teacher Pedagogical Beliefs: The Final Frontier in Our Quest for Technology Integration? *Educational Technology Research & Development, 53*(4), 25-39.

Hadley, M., & Sheingold, K. (1993). Commonalities and distinctive patterns in teachers' integration of computers. *American Journal of Education, 101*(May), 261-315.

Hunt, R. (2002). Four reasons to be happy about Internet plagiarism [Electronic Version]. *Teaching Perspectives*, 5, 1-5. Retrieved March 13, 2007 from http://www.stu.ca/~hunt/4reasons.htm.

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research & Development, 39*(3), 5-14.

Judson, E. (2006). How Teachers Integrate Technology and Their Beliefs About Learning: Is There a Connection? *Journal of Technology and Teacher Education, 14*(3), 581-597.

King, A. (1993). From sage on the stage to guide on the side. *College Teaching, 41*(1), 30-35.

Maddux, C., Sprague, D., Ferdig, R., & Albion, P. (2007). Online education: Issues and research questions. *Journal of Technology and Teacher Education, 15*(2), 157-166.

Netcraft Secure Server Survey. (2007). March 2007 Web Server Survey.   Retrieved March 12, 2007, from http://news.netcraft.com/archives/web_server_survey.html

Paulus, T. M. (2005). Collaborative and cooperative approaches to online group work: The impact of task type. *Distance Education, 26*(1), 111-125.

Rakes, G. C., Fields, V. S., & Cox, K. E. (2006). The Influence of Teachers' Technology Use on Instructional Practices. *Journal of Research on Technology in Education, 38*(4), 409-424.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1994). *Student engagement revisited: Views from technology-rich clasrooms* (ACOT Research Report No. 12). Cupertino, CA: Apple Computer Inc.

Scanlon, P. (2006). Solving the Problem of Internet Plagiarism? The Technological Expediency of Online Plagiarism-Checkers. *Teachers College Record* Retrieved December 7, 2006, from http://www.tcrecord.org/PrintContent.asp?ContentID=12797

Siemens, G. (2005). Connectivism: a learning theory for the digital age [Electronic Version]. *International Journal of Instructional Technology & Distance Learning*, 2. Retrieved March 13, 2007 from http://www.itdl.org/Journal/Jan_05/article01.htm

Siemens, G. (2006). *Knowing Knowledge*. Retrieved March 13, 2006, from http://knowingknowledge.com/book.php.

W3C. (2007). W3C Semantic Web Activity. Retrieved March 12, 2007, from http://www.w3.org/2001/sw/

Williams, J. (2006). The place of the closed book, invigilated final examination in a knowledge economy. *Educational Media International, 43*(2), 107-119.