The Knowledge Building Paradigm:
A Model of Learning for Net Generation Students

by Donald Philip

As noted by a number of contributors to the previous issue of this publication (e.g., Barnes, Marateo, and Ferris 2007; van't Hooft 2007; Thompson 2007), the Net Generation expects that technology will be an important part of their education. This is nicely illustrated by Chen (2002) in his description of an encounter with a young Net Generation student:

Recently, I met some middle school students who carry laptops in their backpacks. One boy told me how technology should not be a machine you go to, but a machine that goes with you. He said, somewhat impatiently, "It's part of my brain. Why would I want to leave it behind in a computer lab?" (xxii)

The statement that the computer is "part of my brain" should resonate with everyone involved in education today. Computers and the attendant technology can no longer be considered desirable adjuncts to education. Instead, they have to be regarded as essential—as thinking prosthetics (Johnson 2001) or mind tools (Jonassen 1996). But, like any other tool, thinking prosthetics must be used properly to be effective. In this article we briefly address the shift in learning styles associated with Net Generation students; we then introduce the Knowledge Building paradigm, a learning model particularly suited for a social environment in which cognitive prosthetics have become indispensable, as well as for the professional settings these students can expect to confront in their future careers. In doing so, we also point to corresponding transformations in business and education that will determine the future of the Net Generation learner and worker.

The Net Generation

The Net Generation (N-Gen) is defined as the population of about 90 million young people who have grown up or are growing up in constant contact with digital media (Tapscott 1998). Tapscott has, through extensive interviews, identified a number of changes in the way these students work and think, the key characteristic of which is interactivity (129–132). Tapscott has identified eight shifts caused by interactivity learning:

- from linear to hypermedia learning,
- from instruction to construction and discovery,
- from teacher-centered to learner-centered education,
- from absorbing material to learning how to navigate and how to learn,
- from schooling to lifelong learning,
- from one-size-fits-all to customized learning,
- from learning as torture to learning as fun, and
- from the teacher as transmitter to the teacher as facilitator. (142)

These developments have the potential to create a tremendous change in how schools operate. As N-Gen students' exposure to interactive media changes their perception of how education should proceed, schools will need to move from the former model of classrooms that are analogs of broadcast media to a more interactive model of learning. But what does this kind of learning look like in practice?

The Knowledge Building Paradigm: Guiding Principles

One answer is the Knowledge Building paradigm promulgated by Scardamalia and Bereiter (2003). This paradigm, which is based on the manner in which research communities work, takes a sociocultural perspective on human-computer interactions, seeks to virtualize the process of education in keeping with new trends in the technological circulation of knowledge, and privileges a less hierarchical model of learning based on flexible organizations of small teams. Each of these guiding principles is elaborated below, followed by a consideration of the practical applications of this model.

The Sociocultural Perspective

The sociocultural perspective focuses on the manner in which human intelligence is augmented by artifacts designed to facilitate cognition. Our intelligence is distributed over the tools we use (diSessa 2000; Hutchins 1995). The old saying, "To a man with a hammer, every problem looks like a nail" is very true. As Hutchins (1995) notes, "It is a truism that we cannot know what the task is until we know what the tools are" (114). Computers are a particular sort of tool known as cognitive prosthetics; they augment human intelligence, freeing humans to do what humans do well. Johnson's (2001) comments about StarLogo can be paraphrased to say that computers should do the work our perceptual and cognitive faculties cannot do on their own. Such tools often become invisible as we come to accept that they are part of our normal environment. As a result, we tend to see any intelligence in them as part of the person, not the object (Pea 1993). However, human cognition is mediated by the symbolic forms and tools we use, and the computer, a kind of omnitool, is rapidly becoming our principle cognitive mediation tool. The Net Generation is growing up in a tool-rich environment and this needs to be taken into account in designing pedagogical systems.

Virtuality

Pierre Lévy (1998) notes that one of the principal characteristics of the knowledge age, in which the Net Generation is growing up, is virtualization, a process in which "[an] event is detached from a specific time and place, becomes public, undergoes heterogenesis" (74). He outlines five characteristics of virtualization:

- deterritorialization (the prying loose of an object or event from a physical place and moving it to a non-territorial space, essentially to cyberspace);
- detachment (the prying loose of objects and events from their original context);
- sharing (the distribution of conceptual artifacts among communities interested in them);
- elevation to a problematic (the arguments, or ideas, and the problems that arise from the consideration of the logical relations among them); and
- heterogenesis (the change that occurs as one shifts from traditional media to digital media, and the personal changes that occur to individuals as their thinking is increasingly shaped by digital media). (74-75).

Much of the education of the Net Generation (formal and informal) is becoming virtualized—a profound change from traditional educational forms, a change which both promotes the use of thinking prosthetics and continues to transform student expectations of their learning environments.

Learning Organizations

Traditional, industrial-model schools are designed around the ideas of hierarchies and top-down control of the learning process, just like industrial-age factories. However, many businesses are now finding that the pace of change demanded by the global economy and facilitated by various technologies is requiring them to rethink how they are organized. Many are restructuring themselves as *learning organizations*—organizations in which new learning and innovation are the engines that drive the company. These companies have flattened layers of management and tend to work in the manner suggested by Kelly (1994), Johnson (2001),

and Gloor (2006): bottom-up, swarm-like organizations with fewer hierarchical barriers between ideas and decisions. In such organizations, goals are fluid, driven by new learning among the organization's members; goals are emergent properties of the system (Holland 1998), guided by general principles, and as such are unpredictable. In such companies, teams form around an interest in ideas for new products and services. Fisher and Fisher (1998) note, "These teams are difficult to describe to outsiders because their membership shifts from time to time, forming and reforming like rapidly splitting amoebas" (106). In this environment, Bennet (2003) notes the need for tools that support collaborative work to virtualize the knowledge of the team, distributing it onto the artifact and thus making it available to all team members.

It is worth noting that such companies really are *learning* organizations. A recent *Time* magazine article (Ignatius 2006) describes how Google expects its employees to work: "Innovation tends to bubble up from these bright young minds . . . . Every employee is meant to divide his or her time in three parts: 70% devoted to Google's core businesses, search and advertising; 20% on pursuits related to the core; and 10% on far-out ideas" (28). This means that approximately 30% of an employee's time will be spent on pursuing new learning and developing innovative ideas. In fact, Ignatius notes that co-founder Larry Page explicitly modeled Google after Stanford University (27). Google is a leader, but many organizations are undertaking similar shifts.

The educational system will have to produce individuals who can work in such organizations and who understand the processes of innovation and creativity. N-Gen students are initially prepared for this by the very process of "growing up digital" (Bereiter 2002, 220). As noted in the introduction, N-Gen students already regard computers as part of their brain; they are accustomed to distributing their knowledge across its various functions and collaborating virtually via e-mail, instant messaging, and any other available tool. In other words, N-Genners are used to working as part of a heterogeneous, distributed system. These are the same skills that learning organizations expect workers to deploy.

The Knowledge Building Classroom

Arguably the best way to develop these skills is to create a learning community in which students can practice the essential skills required by learning organizations. By an odd confluence of events, educational researchers have already been studying the construction of classes with exactly these characteristics. For over 20 years, Marlene Scardamalia and Carl Bereiter have been leading the Institute for Knowledge Innovation and Technology (IKIT), a team of researchers working on knowledge-building theory, a pedagogical approach in which students work in a computer-mediated environment in the manner of a research community (Scardamalia and Bereiter 1992; Scardamalia 2004). As Bereiter (2004) notes,

> Sustained innovation, progressive research, and idea-centered education are all basically the same knowledge building process, carried out in different contexts. Thus the skills and habits of mind acquired through classroom knowledge building are essentially the same skills and habits of mind that figure in workplace contexts of creative knowledge work. (3)

In this approach the computer-mediated learning environment—formerly designated as the Computer-Supported Intentional Learning Environment (CSILE) and currently called simply the Knowledge Forum—is designed to make advanced knowledge processes accessible to all participants, including children; to foster the creation and continual improvement of public artifacts or community knowledge; and to provide a community space for carrying out this knowledge building work collaboratively (Scardamalia 2004, 2002). In a knowledge-building classroom, learning is a by-product of the creation of new knowledge, but the focus of classroom work is the continual improvement of ideas.

How does it work? In practice, the teacher presents students with a problem of understanding relevant to the real world. It could be a question such as *What is the nature of light?* or *What makes a society a civilization?* The focus here is to make student ideas, rather than predetermined activities or units of knowledge, the

center of the classroom work. The next step is to get the students to generate ideas about the topic and write notes about their ideas in the Knowledge Forum (KF) database, an online environment with metacognitive enhancements to support the growth of the knowledge-building process. In generating these ideas, the students form work groups around similar interests and topics they wish to explore. These groups are self-organized and dynamic; the teacher does not select the members, and members can join or leave as they choose. Idea generation can take place during these group sessions, during which all students are given the chance to express their ideas, or in individual notes posted directly to the KF database. While in a typical classroom setting ideas or comments generated in discussion are usually lost, the KF database preserves these ephemeral resources so that students can return to them for comment and reflection. Students are then encouraged to read the notes of other students and soon find that there are differing schools of opinion about the problem. The teacher's job is to ensure that students remain on task and work towards the solution of the problem under study by reading each other's notes and contributing new information or theories to the database.

For example, in one IKIT class project, students in a Gr. 5/6 split class studied ancient civilizations. The unit began with a visit to a local museum, during which the students were exposed to a number of characteristics that researchers use to classify a society as a civilization. Their subsequent inquiry centered around what makes a society a civilization and what characteristics are important in determining the concept of civilization. In doing so, the students did not accept the museum presentation as the final word, but treated it as a conceptual object capable of improvement and open to critique (Exhibit 1). After the museum visit, the teacher allotted two 90-minute periods each week for twelve weeks, during which time the students engaged in knowledge-building talk sessions and used laptop computers and the Knowledge Forum software to explore their ideas regarding ancient civilizations. The students, rather than the teacher, chose the civilizations to be studied and, facilitated by the online environment, the students organized themselves into groups around the civilizations that interested them. The inquiry ranged from commonly studied civilizations such as Rome and Egypt to the Vikings and even to the skeletal 'hobbit-like' hominids discovered on Flores island. In each case, students explored whether these societies were civilizations and why. Students classified their contributions to the database using built-in metacognitive scaffolds (cognitive labels) such as "new information," "my theory," "this theory cannot explain," "I need to understand," and "putting our ideas together," and they made extensive use of both the reading and responding functions.

As the work progresses, new knowledge (at least, new to the class) and new understandings emerge, change, and grow. Students are encouraged to research their ideas by accessing a variety of authoritative sources, or by designing experiments, or by any other means that is practical and safe. They bring the fruits of their research back to the class in the form of more notes in the KF database, either supporting or invalidating their positions. Typically, one inquiry runs into another in a flow dictated by the output of the previous research, not by direction from the teacher. This process continues until the topic has been exhausted or time for study of that unit runs out. During the process, the students often far exceed curriculum expectations and develop a deep understanding of the topic under study.

Studies bear out the value of this practical scheme. Using social network analysis, Philip (2005) found flexible work groups spontaneously forming and breaking up in the live-class setting; in an analysis of note-reading patterns in the database, Zhang, Scardamalia, and Reeve (2006) found a highly complex clique structure with a large degree of overlap among cliques. Philip (2005) also found a high density of note reading (92%)—a strong indicator of teamwork in the class, and generally consistent with the extensive patterns of collaborative communication otherwise observed among students (Exhibit 2). Further observation of these sessions yielded additional information regarding the relative degree of focus and digression on the part of students as well as the need for resilient moderation skills on the part of teachers; moreover, the communal process of note reading among students suggested that actual levels of database access may be substantially higher than the levels recorded by the system itself (Exhibit 3). While the high levels of free exploration afforded by this pedagogy may require a greater degree of monitoring and discretion on behalf of teachers, the approach allows students to adopt strategies of small-team collaboration that will suit them well in their future professional careers.

Knowledge Forum is, of course, not the only online learning environment available. Others of note include FirstClass, WebCT, and Blackboard. Palloff and Pratt (2001) note that, whatever online environment is used, "attention needs to be paid to developing a sense of community in the group of participants in order for the learning process to be successful" (20). In other words, a knowledge-building community must be allowed to develop in order for the learning to succeed. For further illustration of this approach, the IKIT Web site provides virtual tours of the knowledge building process. Specifically, one set of tours contains video of a teacher talking about how he runs his knowledge-building class and video of a student talking about how collaborative science is done in a knowledge building class.

Linking this type of environment to Tapscott's (1998) ideas, the Knowledge Building approach, through its idea-centric focus, shifts the locus of classroom control from the teacher to the students, with the teacher acting as a facilitator. In this shift, the students become the directors of their own learning, catalyzing the transformation from one-size-fits-all to individualized learning; from instruction to building new knowledge; from learning as drudgery to learning as fun; and towards learning how to learn in a non-linear way geared to produce the innovative ideas our society will need in order to solve the problems of the future (Homer-Dixon 2001).

Conclusion

Industrial schools were patterned on industrial-era factories; as businesses restructure themselves as learning organizations that work like knowledge-building research groups, the next generation of education will have to help students deploy appropriate skills. N-Gen students, having grown up in the presence of interactive media that have changed both their thought patterns and their expectations, already have some of these skills. They are accustomed to distributed cognition and virtualization, which demand a new way of approaching work and learning and open new possibilities for innovative work. Online learning environments such as Knowledge Forum, which helps students create new knowledge and new understanding in a collaborative manner and through diverse media, can prepare them to work in the distributed, virtual workplaces of the future.

References

Barnes, K., R.C. Marateo, and P. Ferris. 2007. Teaching and learning with the Net Generation. *Innovate* 3 (4). http://www.innovateonline.info/index.php?view=article&id=382 (accessed May 25, 2007).

Bennet, A. 2003. The knowledge-centric organization. In *Knowledge capital*, ed. J. L. Chatzkel, 364-388. Oxford: Oxford University Press.

Bereiter, C. 2002. *Education and mind in the knowledge age*. Mahwah, NJ: Lawrence Erlbaum Associates.

Bereiter, C. 2004. Knowledge building and idea-centered education: A combination for the knowledge age. Paper presented at Institute for Knowledge Innovation and Technology Summer Institute 2004: Knowledge Building Discoveries and Innovations, Toronto, Canada, August.

Chen, M. 2002. Introduction: Edutopia—"The actual proves the possible." In *Edutopia: Success stories for learning in the digital age*, ed. M. Chen and S. Armstrong, 294. San Francisco, CA: Jossey-Bass.

DiSessa, A. 2000. *Changing minds: Computers, learning, and literacy*. Cambridge, MA: MIT Press.

Fisher, K., and M. Fisher. 1998. *The distributed mind: Achieving high performance through the collective intelligence of knowledge work teams.* New York: AMACOM (American Management Association).

Gloor, P. A. 2006. *Swarm creativity: Competitive advantage through collaborative innovation networks*. Oxford: Oxford University Press.

Holland, J. 1998. *Emergence: From chaos to order*. Reading, MA: Helix Books.

Homer-Dixon, T. 2001. *The ingenuity gap: Can we solve the problems of the future?* Mississauga, Ontario: Vintage Canada.

Hutchins, E. 1995. *Cognition in the wild*. Cambridge, MA: The MIT Press.

Ignatius, A. 2006. In search of the real Google. *Time* (Canadian Edition), February 20, 20-32.

Johnson, S. 2001. *Emergence: The connected lives of ants, brains, cities, and software*. Toronto: Scribner.

Jonassen, D. 1996. *Computers in the classroom: Mind tools for critical thinking*. New Jersey: Prentice Hall.

Kelly, K. 1994. *Out of control: The new biology of machines, social systems, and the economic world.* Cambridge, MA: Perseus Books.

Lévy, P. 1998. *Becoming virtual: Reality in the digital age*. Trans. R. Bononno. New York: Plenum Trade.

Palloff, R. M., and K. Pratt. 2001. *Lessons from the cyberspace classroom: The realities of online teaching.* The Jossey-Bass higher and adult education series. San Francisco: Jossey-Bass.

Pea, R. 1993. Practices of distributed intelligence and designs for education. In *Distributed cognitions: Psychological and educational considerations*, ed. G. Salomon, 47-87. Cambridge, UK: Cambridge University Press.

Philip, D. N. 2005. Communication patterns among students in a live-class setting. Paper presented at Institute for Knowledge Innovation and Technology Summer Institute 2005: Creating Knowledge to Drive Knowledge Creation, Toronto, Canada, August. http://fcis.oise.utoronto.ca/~dphilip/CommunicationPatterns.pdf (accessed May 25, 2007).

Scardamalia, M. 2002. Collective cognitive responsibility for the advancement of knowledge. In *Liberal education in a knowledge society*, ed. B. Smith, 76-98. Chicago: Open Court. http://ikit.org/fulltext/inpressCollectiveCog.pdf (accessed May 25, 2007).

Scardamalia, M. 2004. CSILE/Knowledge Forum. In *Education and technology: An encyclopedia*, ed. A. Kovalchik and K. Dawson, 183-192. Santa Barbara: ABC-CLIO.

Scardamalia, M., and C. Bereiter. 1992. An architecture for collaborative knowledge-building. In *Computer-based learning environments and problem solving*, ed. E. De Corte, M. Linn, H. Mandl, and L. Verschaffel, 41-46. Berlin: Springer-Verlag.

Scardamalia, M., and C. Bereiter. 2003. Knowledge building. In *Encyclopedia of education,* 2nd ed., ed. J.W. Guthrie, 1370-1373. New York: Macmillan Reference, USA.

Tapscott, D. 1998. *Growing up digital: The rise of the Net Generation.* New York: McGraw-Hill.

Thompson, J. 2007. Is education 1.0 ready for Web 2.0 students? *Innovate* 3 (4). http://www.innovateonline.info/index.php?view=article&id=393 (accessed May 25, 2007).

van 't Hooft, M. 2007. Schools, children, and digital technology: Building better relationships for a better tomorrow. *Innovate* 3 (4). http://www.innovateonline.info/index.php?view=article&id=376 (accessed May 25, 2007).

Zhang, J., M. Scardamalia, and R. Reeve. 2006. Designs for collective cognitive responsibility in knowledge building communities. Paper presented at American Educational Research Association Annual Meeting, San Francisco, CA, April.