

Education Letter

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has reached few classrooms
beyond those actively
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scientists. For latter-day
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"activity method" Wave 2
is the limit."*

INFORMATION AND COMMUNICATION TECHNOLOGY

Catching the Third ICT Wave

Information and communication technology (ICT) has not trickled gradually into the schools but has come in waves. The general character of these waves is obvious to most observers, but interpretations differ.

CARL BEREITER AND MARLENE SCARDAMALIA, *Institute for Knowledge Innovation and Technology, University of Toronto*

The following is our interpretation:

Wave 1

Technology as an imperative. The reigning belief was that schools must become computerized and networked in order to prepare students for the Information Age (also in order to satisfy parental demands and to avoid seeming out-of-date). Governments drew up ambitious technology plans; vast sums were spent on hardware for the schools; ubiquitous training programs aimed to overcome teachers' anxieties and resistances. Larry Cuban's *Oversold and Underused* (2001) aptly described Wave 1 as it crested in the wealthy nations, while just starting to roll up the beaches in many poorer ones.

Wave 2

"It isn't the computers; it's how you use them." The imperative is not just to adopt ICT but to use it in educationally appropriate ways. The method of choice, promoted through books, workshops, and web sites, is "projects"—preferably, projects that make conspicuous use of multimedia and Worldwide Web resources. In Wave 2, the curriculum regains importance, but ICT is like the unexpected important guest at a dinner party, for whom a place must be found.

Wave 3

ICT as affordances. Educational ideas are primary; secondarily, various ICT affordances may serve in realizing a particular idea. We use the term "affordances" here in Norman's (1999) sense of *perceived action possibilities*. Experienced Wave 3 educators never ask, "How can I integrate ICT into this activity?" Instead, they think about how the cognitive and social dynamics of their classroom could be improved, how the class could evolve into a more successful knowledge building community. They are sufficiently aware of the affordances and limitations of the ICT at their disposal that it figures naturally into their planning and problem solving. They will be on the look-out for technology whose affordances are more closely aligned with their educational aspirations.

Wave 1 was almost entirely an initiative of bureaucrats, administrators, and vendors. Its effect at the classroom level was epitomized by the teacher who said she kept her computer running because it provided just the right

...continues on page 3



Message from the Editors

The proliferation of virtual learning environments in every sphere of education, the impact of artificial intelligence, and the worldwide imperative to integrate ICT in teaching and learning processes motivated us to invite distinguished international experts to share their work in technology and education. The uniqueness of this issue resides in the dialogue between technological developers, educational researchers, and educators, all of whom have had their own interest in the transformative role of ICT in its relationship with the learner.

As Carl Bereiter and Marlene Scardamalia note, we are experiencing the third wave in technological developments in education. This development moves the field beyond producing objects that transmit information to ICT mediation in knowledge creation. Eunika Mercier-Laurent's insights into artificial intelligence and her understanding of the computer as an intelligent assistant to human beings bring a different and futuristic light to the learning process. Geoff Roulet's experimentation with ICT environments as spaces to generate "constructivist learning environments" in the teaching of mathematics encourages teachers to explore concrete possibilities in their classrooms. Jonassen opens an avenue that views intentional learning as model-building with mind-tools that both model and support domain knowledge. And William J. Egnatoff places an ICT integration project carried out here at the Faculty of Education in the context of the articles in this issue. Another important component of this Letter is Thérèse Laferrière's review of global issues as detailed by researchers associated with the International Society for Technology in Education and with the International Association for the Evaluation of Educational Achievement. The photographs and art included in every issue, this time in relation to new technologies, add artistry and an aesthetic sense in this technological era.

Rosa Bruno-Jofré, *Professor and Dean
Faculty of Education
Queen's University*

Romulo Magsino, *Dean Emeritus
Faculty of Education
University of Manitoba*

Next Issue

Family Literacy: Guest Editor; Elizabeth Lee, *Faculty of Education,
Queen's University*

...continued from page 1 temperature for her pot of African violets. Wave 2, however, which is only beginning to abate, has been focused directly on classroom activity, and teachers have been under considerable pressure, both official and informal, to “integrate ICT into the curriculum.” Where resources permit, computers have been moved from computer laboratories into the classrooms, thus making integration into the curriculum a more realistic possibility, while discouraging the sort of “computers for the sake of computers” activities designed for scheduled visits to a computer lab.

Wave 3, it would appear, has reached few classrooms beyond those actively involved with learning scientists. For latter-day practitioners of the “activity method” Wave 2 is the limit. For them a positive response to ICT consists of replacing some traditional learning activities with different ones or enriching traditional activities through the resources of ICT.

A common Wave 2 phenomenon is updating the traditional school “project” by incorporating ICT. Here we are not referring to “project-based science” (Marx, Blumenfeld, Krajcik, & Soloway, 1997), where there is serious, question-driven knowledge development. Rather, we

As Bransford and Schwartz (1999) have suggested, the main value of school learning is the facilitation of further learning.

refer to what has typically been treated as a language arts activity, in which students, working individually or in small groups, identify topics, gather relevant information, organize it, and present it – traditionally in the form of a hand-written report illustrated with magazine clippings. Updating the traditional project may include retrieving information from the Web or from reference sources available on CD ROM, downloading graphics from similar sources or incorporating digital photos, and composing the report using a word processor or presentation software (Moss, 2000).

Instead of using ICT to produce objects for display of information, students in Wave 3 classrooms use ICT to create knowledge (Scardamalia & Bereiter, 2003). They produce theories, models, proofs, problem formulations, interpretations, histories, critiques, and the like. These function for them as conceptual tools that they use in making sense of the world. As Bransford and Schwartz (1999) have suggested, the main value of school learning is the facilitation of further learning. Wave 3, we believe, is about this dynamic. ICT is relevant because of the roles it can play in supporting a process of sustained knowledge advancement.

Most educators are philosophically favourable to Wave 3. It is associated with a number of generally “good words”: inquiry, constructivism, collaboration, curiosity, higher-level thinking skills, and so on. Why, then, is it so slow in making its way into practice? In our experience, the three most commonly encountered barriers are these: first, the test-driven curriculum, which tends to drive all those “good words” to the sidelines; second, a tendency of adults to be so impressed with young people’s ICT skills that they enshrine projects that enable students to show off those skills; third (and most deeply engrained) a lack of belief that children really can function as active members of a worldwide knowledge-creating culture. Proving that they can do so has been the major educational mission of our Institute for Knowledge Innovation and Technology (www.ikit.org).

Resources of Interest

Ben Schneiderman (2003)

Leonardo’s Laptop: Human Needs and the New Computing Technologies. MIT Press.

Queen’s Faculty of Education IT and Teaching blog

<http://itandteaching.org/index.html>

John Olson, *Information technology in schools: Should the product be marked hazardous.* Volume 1, Issue 2, 2005. <http://seminar.net>

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ARTIFICIAL INTELLIGENCE AND EDUCATION

Computer-Human Learning

Artificial intelligence can be defined as the science and engineering of making intelligent machines (AI). For over 50 years now AI researchers and practitioners have been working on methods and tools for knowledge acquisition, representation, and processing by computers.

EUNIKA MERCIER-LAURENT, *EML Conseil – Knowledge & Innovation Management Dept. Groupe MODEME IAE, Lyon 3 University*

Education and training systems were among the first AI applications. With the use of cognitive science techniques, models of experts who are engaged in solving problems in a knowledge domain were devised to serve as tutors promoting student learning in that domain. The explanatory ability of the systems resulted in their effective use in training and in classroom situations. The experience of successful use, as well as progress in AI, has led to a deeper understanding of how to represent knowledge and reasoning methods, how to describe procedural and contextual knowledge, and how to program computers that learn more effectively in interaction with users. Progress in cognitive science has led to a deeper understanding of how people think, solve problems, and learn.

Intuitive software with more human-like abilities and friendly interfaces can help students to learn when and what they want to learn. Smart tutoring systems can transform our concept of online learning. These systems act as coaches, guiding students in the problem-solving process to help them find the right answers through reasoning. As students solve problems the software adapts to provide feedback that is appropriate to their problem-solving and learning styles. Such systems are able to adapt to the user's level. Trained to evaluate and guide students as they work through problems, AI

applications are programmed to use models, whether in relation to the intellectual behaviour of a student working on a math problem or a range of pre-scored essays to evaluate. Systems applications can be used as well for individual or collective work. They make available different types of reasoning: analogy, rules-following, and over a hundred reasoning models.

In my vision, humans or "knowledge cultivators" work in perfect synergy with machines such as computers, robots, personal knowledge assistants (PKAs) including a cell phone...They learn from each other...

Eunika Mercier-Laurent

is able to "translate" the chicken scratch of graffiti into readable form. This same technology enables a computer to "understand" images and the text.

A web-based system lets students draft and submit their work online. The system can offer students roughly a dozen different essay prompts during the school year to help them prepare for the end of the year exam. With instant feedback, kids can refine their writing and practice new essay strategies without the pressure of a one-shot final exam.

Using the "semantic web" techniques, such as natural *...continues on page 5*

An intelligent FAQ system can be built to provide an immediate answer to a student's question, if this question/answer is already known to the computer. If not, an expert can answer the question, and the system can be automatically updated.

Voice and character-recognition technology, as well as natural language programming, helps students learn to read and write and to learn languages. Recognition intelligence dealing with script writing

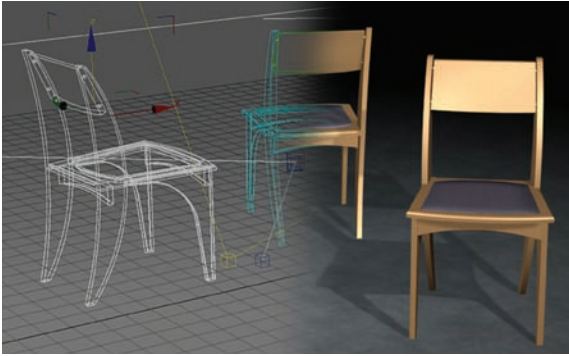
Resource of Interest

EML Conseil

<http://emlconseil.free.fr>

E-learning "knowledgeboard"

http://www.knowledgeboard.com/open_groups/e-learning/



Eric Nickerson, Sheridan College

Multimedia, simulation, computer-mediated communication networks, and distance learning have all become part of the educational toolkit. The next major technology to change the face of education will be based on the widespread use of artificial intelligence (AI).

*Smart Machines in Education,
by Kenneth D. Forbus and Paul J. Feltovich, 2001, The MIT Press*

...continued from page 4 language processing, ontology, and multi-system agents, computers are more effective in searching on the web. Constraint programming is able to make an optimized timetable in few seconds and to reschedule it, taking into account specific constraints in the real-time.

Games and virtual reality applications have become so much a part of our daily lives and are excellent tools to learn. Beyond these impressive applications, there are the artificial intelligence-based technologies. Simulations have long been recognized as the best practice when it comes to teaching critical skills that cannot be learned by trial and error. Pilots, doctors, and the like have used simulation to teach those types of skills. The corporate world recognizes the benefit of simulations and scenarios when it comes to

matching training with a live job environment. Games, however, have not been embraced to the same degree. There is some usage, and it is growing, but the really *big* user of games for the purpose of training is the US military. They are the world's biggest spenders and users of digital game-based learning tools. They use games for everything, from training officers in the tactics of joint forces operations to simulators that teach operators how to control aircraft, tanks, and submarines. We hope that more of these techniques will be used for civil learning, especially on cell phones and other smart machines.

All the approaches and techniques mentioned above play the major role in transforming the computer into an intelligent assistant to human beings.

...continues on page 6

The Other IT: Imagination Technology

Presented by Dr. Eunika Mercier-Laurent

Queen's Faculty of Education
Homecoming Dinner
Friday, 15 September 2006

Further information is available on-line: www.educ.queensu.ca/alumni

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...continued from page 5

Interactive Learning Environments

An interactive learning environment is mediated by an electronic system that facilitates the learner's ability to navigate, select information, respond to queries, and interact with other users in the same medium. This method of interaction supports the constructivist theories of learning in contrast to the behaviourist style, which would guide a learner through a series of lessons on a predetermined path. For example, the human body can be explored part by part successively or in its global systemic view in interaction with users. The electronic system can serve

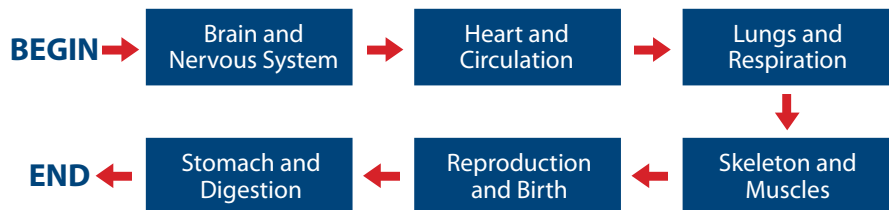
as a tool to think with, to invent, and to create on a more holistic and systematic level, as shown in the chart below.

Computer as a tool to think with, to invent and create on more holistic and systemic level.

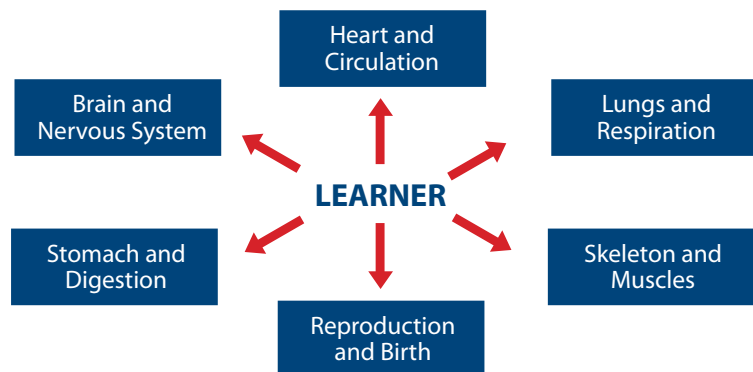
Can computers replace teachers? I do not think so. We still need a human contact. The challenge for computers remains how to be able to know and understand the user to really help him/her. This is the same challenge for teachers, and both have to develop their imagination.

PASSIVE INTERACTION

LEARNER




ACTIVE INTERACTION



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www.aaai.org/AITopics/html/education.html
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www.knowledgeboard.com/item/1379/23/5/3
International Journal of Artificial Intelligence in Education
Encyclopaedia of Artificial Intelligence, Shapiro, Stuart C., editor. 1992. 2nd ed. New York: John Wiley & Sons. Volume 1

I showed my masterpiece to the grown-ups, and asked them whether the drawing frightened them.  But they answered: "Frighten? Why should any one be frightened by a hat?" My drawing was not a picture of a hat. It was a picture of a boa constrictor digesting an elephant.
<http://www.spiritual.com.au/articles/prince/PrinceCh2.htm>

Model-Building with Mindtools

Learning is most meaningful when it is intentional. All human behavior is goal directed (Schank, 1994). That is, everything that we do is intended to fulfill some goal. When learners are actively and willfully trying to achieve a cognitive goal, they think and learn more because they are fulfilling an intention.

DAVID JONASSEN, *School of Information Science and Learning Technologies, University of Missouri*

The most intentional way of using technology to learn, I believe, is to build models of the phenomena that students are studying. Why? Because the models are representative of the theories that students are constructing about the world around them. Those theories are also known as mental models, so technology-based computational models reflect students' mental models as they are being constructed.

It is quite common in mathematics, science, and engineering for students to use models in their learning. Most science textbooks present a model of some phenomenon for students to comprehend. They follow up the model with well-structured problems related to those models for learners to solve. This form of model-based reasoning cannot be as effective as model-building because the students are not building the models. Modeling-building refers to student construction, manipulation, or testing of models of the phenomena they are studying.

Model-building can focus on different kinds of learning outcomes. They can be used by learners to model domain knowledge, such as databases of cell types in the human body, semantic networks of concepts in economics, and microworlds for supporting construction of geometry theorems. Models can also represent different kinds of problems, such as systems modes chemistry problems, expert systems of troubleshooting problems, or spreadsheets of electrical engineering

problems. Students can also build models of systems, such as the respiratory system, ecosystems, or classification of species. Tools such as databases and semantic networking tools are useful for building models of the semantic structure of knowledge domains. Finally, students can build models of the thinking processes that are required to perform some task, otherwise known as cognitive simulations. Expert systems can be used to represent the thinking required in different decision-making activities or systems models of strategies for organizing ideas.

Mindtools are software programs that provide multiple formalisms for representing knowledge. They engage different kinds of critical, creative, and complex thinking.

The tools used to construct these models are otherwise known as cognitive tools, or the commercial "Mindtools" that I have been developing for several years. Mindtools are software programs that provide multiple formalisms for representing knowledge. They engage different kinds of critical, creative, and complex thinking. Mindtools include semantic organization tools (databases, semantic networks), dynamic modeling tools (spreadsheets, expert systems, systems modeling tools, and microworlds), information interpretation tools and visualization tools, knowledge construction tools (multimedia production, hypermedia construction and linking, Web site production), and conversation tools (synchronous communication environments, asynchronous information tools, scaffolded computer conferences).

Mindtools can be used to construct models of domain knowledge studied in courses, problems being solved, systems that comprise domains, stories from practitioners, and reflections on how to learn. Each type of model reflects understanding in a different way, and each type of Mindtool requires that learners think about ideas in different ways.

When Mindtools are used to build student models of understanding, those models can be used for student assessment, and as collaborative learning activities, planning and analysis tools, follow-ups to situated activity, and as conversation media. Mindtools for model building are effective because learners are designers engaged in constructing personal meaning that makes the learners intellectual partners with the technology. Mindtools use inexpensive, commonly available technologies; they can be applied to virtually any content domain; and they are readily learned.

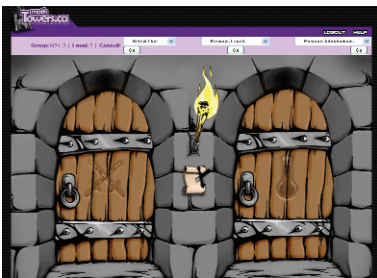
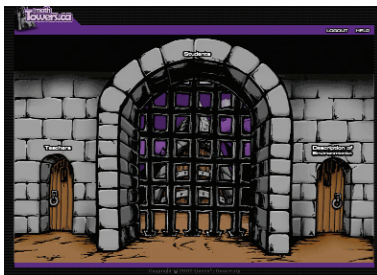
Collaborative Knowledge Construction Using ICT

Constructivism, in its epistemological, psychological, and pedagogical forms, has assumed a dominant place in education thinking and practice (Matthews, 2000).

GEOFFREY ROULET, *Faculty of Education, Queen's University*

Resources of Interest

TERC Mathematics and science education research, curriculum, technology development, and implementation support in the form of professional development and assistance to districts and schools. www.terc.edu



Math Towers www.math-towers.ca

This view, that knowledge is not a body of information and facts to be absorbed by learners, but rather something that is actively constructed by individuals and groups (Phillips, 2000), holds implications for how we might employ information and communication technology (ICT) within education. Computer-assisted instruction (CAI) packages that present pupils with direct instruction on facts and procedures have lost favour and are being replaced by “empty technologies” (Zuchermaglio, 1993), that is, ICT environments that do not hold and deliver information, but rather provide spaces for student exploration and expression. Although constructivist pedagogy is not precisely defined, there is general agreement on some basic principles. For example, Richardson (2003) pointed out, there is general consensus that an optimal approach includes engagement in tasks that encourage students to challenge existing beliefs and develop new hypotheses about their world, and the provision of opportunities for sharing and collaboratively exploring these emerging understandings. At the Faculty of Education we have been conducting design research and developing ICT supported “constructivist learning environments” (Wilson, 1996), which embody these two core processes. Through analysis of student discourse and products we are studying pupils’ construction of knowledge within such spaces.

In Math-Towers¹ (www.math-towers.ca), a website designed for Grades 7 and 8, students are presented with challenges that can be

investigated and solved by using mathematics. For each challenge, tower visitors are provided with a laboratory containing applets (small interactive programs) that support investigation and places to record their observations and conjectures. In addition, in the tower hall beside the laboratory door, each participant has a scroll where they may publish their ideas for sharing with the class and through which they can discuss their understanding of the problem. Student work is saved so that participants may visit the tower multiple times,

*Within this environment
students can construct
and manipulate geometric
objects and share their
observations and findings
with classmates...*

climbing up the floors as they solve aspects of the problem, and finally emerging on the tower ramparts to be invited to now try the initial challenge. Research (i.e., Taylor, 2005), which analyses the recordings of class work and video tapes of student pairs as they explored the towers, shows that visitors do in fact build expanded understanding of the mathematics involved. We have also found that students’ computer gaming experience spills over into the Math-Towers environment, and unfortunately discourages collaboration as participants compete to be the first to solve the problem. Parts of the Math-Towers site are presently being re-written to present the problems as challenges to the whole class rather than individual visitors and to encourage the desired use of the scrolls for sharing and communication.

The new Ontario mathematics curriculum (Ontario Ministry of Education, 2000, 2005a, 2005b) calls for the use of dynamic geometry software; to support

...continues on page 9



Math Towers presents challenges to grade 7 and 8 students that can be investigated and solved using mathematics. Financial support for the development of Math-Towers was provided by the Imperial Oil Foundation.

...continued from page 8 this the Ministry of Education has purchased a province-wide licence for The Geometer's Sketchpad (Key Curriculum Press, 2001). Recent research (i.e., Roulet, Mackrell, Taylor & Farahani, 2004) has combined this tool with Elluminate Live! (Elluminate Inc., 2004), a web-based software that supports sharing between computers. Within this environment students can construct and manipulate geometric objects and share their observations and findings with classmates by projecting the images on their computer onto the screens of other participants. In addition, control of the originating computer may be passed to anyone in the network, allowing class members to interact with each other's constructions as they share ideas concerning an assigned task. Sharing of data and conjectures within this environment, while exploring a complex senior mathematics geometry problem,

reveals to a class that there are differing plausible answers emerging. Now the development of a proof becomes a student-initiated activity rather than a teacher-or textbook-assigned task.

Teaching and learning experiments with Elluminate Live! have expanded beyond the classroom and have used its support for Web-based audio communication and application sharing to provide the senior geometry class with a virtual field trip to work with a university-based mathematician. This software is now being employed to support distance study in one of the Faculty's graduate courses and has allowed us to host a half-day international (Europe, North America, East Asia) conference exploring the use of dynamic geometry in the high school curriculum. ICT tools are rapidly increasing the possibilities for collaborative construction of knowledge within classrooms and over distance via the web.

...sharing to provide the senior geometry class with a virtual field trip to work with a university-based mathematician.

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1 Financial Support for the development of Math-Towers was provided by the Imperial Oil Foundation

INTEGRATING INFORMATION TECHNOLOGY AT THE FACULTY OF EDUCATION

From Imperative to Affordance

WILLIAM J. EGNATOFF, *Faculty of Education, Queen's University*

Resource of Interest

**Southeast Initiatives Regional
Technology in Education
Consortium**

www.serve.org/seir-tec/publications/lessons.html

*Increasingly, integration
is focused on the
"mindful" use of
computers to support
working with ideas...*

Shortly after micro-computers appeared in the mid-seventies, educators and policy makers began to attend in new ways to the information revolution and the emergence of the knowledge age. Doug Penny, the Assistant Deputy Minister of Education in charge of the newly-formed "Educational Technology Development Division" justified this attention by arguing that: using computers entails working with new symbols through new processes that condition cognition in ways still unknown; information technology could yield breakthroughs in attaining educational goals (individualization, mastery, efficiency, breadth and depth of learning, system productivity); it could bring changes in the roles of teachers and institutions and in delivery modes; and, it has the disturbing potential to leap-frog transmission of cultural values and national identity and to bring profound social change. The Faculty of Education, as part of the public educational system, felt compelled to respond to these conditions and this potential. Bereiter and Scardamalia (this volume) label this response the First Wave, or information technology as imperative.

Taking up the imperative over the past two decades, the Faculty created a new faculty position, added specialized courses in its pre-service and M.Ed. programs, set up fixed and mobile computer labs, and gradually but substantially expanded its support staff. Recently it engaged in strategic planning, the establishment of incentive grants, expansion of online teaching, and major upgrading of facilities. Early in this period the Faculty caught the Second Wave of *integration*. Penny's division funded major longitudinal classroom studies in the early 1980s that documented how the computer could be employed to support a creative and dynamic approach to learning in a wide range of subject areas, provided that teachers received adequate training and support. The Faculty now expects its beginning teachers to have their students use computers to find, organize, and present information. The Faculty also encourages specialized applications such as working in Geography or Social Studies with large sets of real data from Statistics Canada, dynamical construction and manipulation in geometrical, hypertextual writing, website development, and computer programming. Increasingly, integration is focused on the "mindful" use of computers to support working with ideas as

...continues on page 12



Principal Karen Hitchcock and Dean Rosa Bruno-Jofré formally launch the Akwe:kon Room at the Faculty of Education, Queen's University. The room is equipped with advanced technical equipment creating new opportunities for faculty and area junior and high school teachers and students to experiment with technology in the learning environment.

ICT BOOK REVIEW

Technology, Innovation and Educational Change: A Global Perspective, A Report of the Second Information Technology in Education Study, Module 2.

By Robert B. Kozma, (Ed.) (2003). Eugene, OR: *International Society for Technology in Education (ISTE)*, *International Association for the Evaluation of Educational Achievement (IEA)*. 301p. ISBN 1-56484-230-4.

REVIEWED BY THÉRÈSE LAFERRIÈRE, *Dep. d'études sur l'enseignement et l'apprentissage, Faculté des sciences de l'éducation, Université Laval*

Robert Kozma, who debated Richard Clark in 1994 on the effects of the media on student learning, edited this report on the second module of the Second Information Technology in Education Study (SITES) sponsored by the International Association for the Evaluation of Educational Achievement (IEA). This study grew out of the understanding that an economic evolution towards an interconnected, knowledge-based, global marketplace is underway, and that more students need to demonstrate proficiency in using their higher-order cognitive, affective, and social skills. Such skills are vital in



Eric Nickerson, Sheridan College

a knowledge-based economy, as pointed out by Drucker (1994). The 28 countries that participated in this study are engaged in capacity-building when it comes to the use of ICTs in teaching and learning (see Breuleux et al., 2003). Researchers from each of these countries collected data, using the same methods and instruments, and wrote a total of 174 case reports. The Council of Ministers (Canada) coordinated the study in Canada. Exemplary implementation sites were selected by national panels in all countries. For Canada, the lead researcher was Ron Owston from York University. Kozma's edited volume is meant as a resource for practitioners (teachers, school administrators, policy makers, and researchers) who believe that students need to be prepared for tomorrow's world of work and citizenship and who see the role of schools as critical to this end.

Practitioners working in classrooms get an inside look at teachers from around the world who are leading the way in integrating ICTs into formal learning environments. Project-based learning is highlighted as it had been by the Progressive Movement that interpreted Dewey's scholarly work and by the *Éducation Nouvelle* movement in France following Freinet's exemplary

work using the print machine in the classroom in the forties and fifties. What is different today is the very notion of the knowledge-based economy, and its emphasis on knowledge as both the engine and the product of economic growth (see Kozma, p. 1). Quantitative/qualitative analyses in this volume led to the identification of teaching-learning models. In the Student Collaboration Model, "teachers structured students' activities, guided their students' work, and monitored their progress, while students collaborated with others in their classes and used ICT to search for information"

(p. 228). Kozma and collaborators recognize that this model is a good beginning for ICT-based classroom practice, and they point to the Product Model and the Student Research Model as more complex ways of using ICT. The creation of products on the web may be time consuming but product-oriented projects tend to motivate students. Teachers who engage their students in collaborative problem-based inquiry and knowledge-building may be the most responsive to the new economic demand in society. The book will provide them with insights on the selection of innovative practices.

Policy makers are offered a realistic understanding of the conditions necessary for successful integration of ICTs into teaching and learning. Access to networked computers is necessary, but a coordinated policy is critical. The report stresses that "coordinated policy is more important than having a high level of technology access." Sustained support is also critical: "There is nothing in our findings that would encourage a policy maker to believe in the 'ripple effect'" (p. 234). As a recent OECD study (2005) indicated, Canadian students are rather well-connected at home and at school, but their use of ICT is rather average in

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Resources of Interest

North Central Regional Educational Library
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www.ncrel.org/sdrs/areas/te0cont.htm

Virginia Centre for Digital History
Promotes the teaching and learning of history using digital technologies.
www.vcdh.virginia.edu

the classroom. Policy makers in all Canadian provinces and territories have much coordination to do.

Finally, researchers, who can be highly instrumental when it comes to innovative teaching and learning practices, are provided with substantial information to design ICT-related research on professional development and student outcomes. In this book they will find plenty of evidence concerning the complexity of the transformation underway as the teaching profession faces the knowledge demand and retools.

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...continued from page 10 advocated by Jonassen (this volume) and illustrated in the work of Roulet (this volume).

Meanwhile, youth are inventing new forms of social interaction mediated by hybrids of the Internet, cell phones, MP3 players, and cameras. These Third Wave media are *affordances* for activities that range from the extremes of cyberbullying to international projects that promote peace, goodwill, well-being, respect for nature, and mutual understanding. This wave is hardest for educators to catch because change is too rapid to follow, let alone to comprehend. Our "hypermodern" era is increasingly unpredictable: our appetites for digital novelty seem insatiable, and the time to obsolescence of new devices or software is short compared with the time needed to develop good craft in using them. Ironically, surveillance of all sorts and production-oriented forms of accountability in school and at work are pervasive limiters of innovation.

Using information technology as *affordance* in support of the collaborative creation of publicly useful knowledge is a major challenge. The Faculty has taken several recent steps in this direction. A year-long Information Technology Integration Symposium Series, supported by Dean Rosa Bruno-Jofré, has afforded opportunity for faculty to share examples of their work. The culminating event, with the leadership of Carl Bereiter, is an experiment in constructing a Third Wave trajectory of innovation from elementary school through to the workplace and public sphere. Participants are experimenting with ways of documenting and extending the knowledge they generate in forms that are useful in Faculty programs and to its partners. The challenge remains to develop a coherent Information Technology Commons with strong support for collaborative generation of professional knowledge by faculty and students.

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