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Engaging Students in a Knowledge Society

Imagine a network of networks - people from scbools, univeisities, cultural institutions, service organizations, businesses- simultaneously building knowledge within their primary group while advancing the knowledge of others. We might call such a community network a knowledge-building society.

Electronically networked environments expand the possibilities for what such productive, mutually supportive communities can produce. These environments also alter the working dynamics of these communities. We are creating a miniature version of a knowledge-budding society, using Computer Supported Intentional Learning Environment (CSILETM)software (see p. 8).

We are carrying out this work as part of the Canada-wide TeleLearning Network of Centres of Excellence.Our project is distinctive from the many devoted to educational uses of network technology, however. Our own aim is to enhance knowledge building and understanding in all sectors simultaneously, with particular emphasis on K-12 education.

Linking "Society" Members

The network we are creating in Toronto brings together a diverse group of participants. It includes elementary and high school students and their parents, and postsecondary teacher education and medical school students, all of whom can be doing coursework; museum staff, who are planning exhibits; engineering firm staff, who are tackling design problems; and staff from a science center and an art gallery. Also participating will be project researchers and software developers, who will be interpreting what is happening throughout the network and improving the technological infrastructure to support increasingly effective interactions.

Each of these groups carries out its own work. The work takes the form of entries stored in CSILE databases. Parts of this multimedia database can be closed off as private; but as much as possible, each database is open to people in other parts of the Knowledge Society network. The different open databases are listed, and can be visited, much as one visits web sites on the Internet.

Students and other network members can do more than merely visit various databases, however. They can become actively involved, entering text and graphic notes or comments in all content areas. They also may use information they see to create links between notes on different databases, pointing out discrepant information or contributing new information or ideas. (Notification systems inform participants of activity related to the ideas they have contributed.)

A group of 5th and 6th graders, for instance, might be working on the problem "How does electricity work?" At the same time, curators in a science museum might be planning an exhibit on electricity. By visiting the students' databases, the curators will gain an understanding of students' conceptions (and misconceptions) of electricity, and the students will have input to the design of the exhibit.

CSILE also supports other forms of interaction. Participants can perform keyword searches and extend them across databases. Thus, if a student searches by the keyword *electron,* the search would bring together the work of all participants who had assigned this keyword to any note they created. The student could then study, cull, or link the new collection of electron notes, or use it as a basis for forming a new study group. The student could also search by "views," and see that electrons are viewed quite differently by different groups.

It is also possible to organize crosssector interaction, so that, for example, a medical school class might work with elementary school classes on health related topics. Other kinds of engagement will be fortuitous, but everyone joining the network is expected to take an interest in, and, where appropriate, make contributions to the work of people in other sectors.

Through a variety of linking, searching, commenting, and visiting activities, the network encourages the formation of new groups and the consideration of ideas from different perspectives. The aim is to enable participants to gain knowledge and understanding and also form important new working relationships, but without being overwhelmed by long lists of notes requiring responses.

Contrasting Models

To put our Knowledge Society model in perspective, consider two other models for an educational network. In all such models there is a concern for *scalabilitv* (Can small-scale trials go Systemwide?) and *sustainability* (Can the model survive without heroic efforts?). Two further issues are whether the model supports a *constructivist approach* to knowledge and whether it brings about *involvement* of students in the work of the larger society.

Model 1. Ask the expert

> *Volunteer scientists at a petrochemical company agree to answer students' questions about chemical pollutants and additives. Stidents (or, indirectly, the teacher) submit questions by e- mail. They then share the information they've obtained in class discussions or reports.*

This person-to-person approach sometimes works very well. As a model for network use, however, it has three

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CSILE Software: Passport to the Knowledge Society

CSILETM (Computer Supported Intentional Learning Environment) has been under development since 1986 by a team of cognitive research and computer scientists in Toronto, and teachers across North America. It is the first network system to provide general support for collaborative learning and inquiry in school environments. As such, it is the beacon technology for the K-12 sector of Canada's TeleLearning Research Network. CSILE has been used successfully at all educational levels from the 1st grade to university, in all areas of the curriculum, and with many different kinds of student populations.

At the system's core is a community database, constructed by the users. Items in CSILE's shared work space are called notes. Notes may include text, graphics, and links to other media. All notes can be read by all users, but edited only according to set rules. Users create notes or comment on another note, in which case the original author is notified and can immediately view the comments and respond to them. Participants can link notes to any organizational framework created with the CSILE graphics program, thus producing high-level visualizations of work on a particular problem or issue. They can also create special-purpose discussions or conference notes.

Users access CSILE on locally networked or remotely connected computers. (WebCSILE uses a web browser in lieu of client software.) The typical school installation consists of eight computers in each classroom, attached via a local area network to a CSILE server, which maintains the shared workspace.

As links among notes emerge, participants begin to recognize higher- order concepts and view the accumulating knowledge and ways of synthesizing it. In the business world, Lotus Notes is the prime example of such an approach, and is being widely adopted by businesses setting out to become "learning organizations." In the education world, CSILE is the prime example, antedating Lotus Notes by several years.1

The CSILE network system is based on a decade of basic and applied cognitive research. Controlled studies show that students who use CSILE excel in a number of areas. They do better on standardized language and reading tests and are better able to comprehend difficult informative texts. They demonstrate advantages in the quality of the questions they ask, their portfolio commentaries and general depth of explanation, and their facility with graphics. They even demonstrate more mature beliefs about learning. The studies show, too, that students at the high and low ends of ability spectrums are equally engaged, and typical gender biases have not appeared.1

For further information, visit the CSILE web site at http://www.csile.oise.on.ca.

1 M. Scardamalia, C. Bereiter, R. S. McLean, J. Swallow, and E. Woodruff, (1989), "Computer-Supported Intentional Learning Environments," Journal of *Educational Computing Research* 5: 51-68.

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important drawbacks. First, it isn't *scalable.* That is, it may work for a few classrooms, but there aren't enough expert resources to make it work systemwide. Second, it often is not *sustainable.* Typically the relationship is increasingly burdensome for the volunteers. And their initial enthusiasm wanes as they find themselves responding repeatedly to the same questions, or to questions so basic that the students Should be able to find answers themselves. (In one case, students became impatient waiting for an e-mail response and so telephoned ,in expert at work to find out whether a milliliter was a hundredth of a liter or a thousandth!)

Third, this approach goes against *constructivist* principles. It tells students that knowledge is out there in the heads of specialists, not that it is something to be constructed through their own efforts. Finally, although scientists are *involved* in the work of the schools, students are not involved in the work of the scientists. Thus schools continue to be isolated from the workings of a Knowledge Society.

Model 2. Cross-school research projects

Scbools in a wide area collaborate on a research project. Designed by the participating teachers or a central organization, the project calls for students to collect data locally, then put what tbey've found togetber and draw inferences.

Successful projects of this kind have involved climate, dialect differences, and even the design of a space colony. Unlike Model 1, this model has the virtue of supporting *constructivist* principles. When well organized, such projects have proved to be *sustainable*- typically lasting for three to nine weeks. They are, however, significantly limited in their *scalability.* Only certain topics lend themselves readily to this approach, and they often require considerable advance organization in order to succeed.

Thus, Model 2 is likely to remain a model for special purposes, not for achieving the core objectives of a subject-matter curriculum. Finally, although cross-school research projects do much to break down the barriers among schools, they maintain the isolation of schools from other sectors of a Knowledge Society, and thus fail the *involvement* criterion.

Engaging the Larger Society

Our new Knowledge Society model allows for the person-to-person relationships of Model 1 and the distributed projects of Model 2, but it is not limited to them. It is *constructivist* in a deeper sense: it involves people in the actual work of a society engaged in constructing, using, and improving knowledge. Indeed, this *involvement is* our network's outstanding virtue: Students can do more than merely contact people outside the school; they gain entry into their working worlds.

We cannot be sure how *sustainable t*he model will be or how much energy will go into sustaining it. But we believe that, because responsibilities are so widely distributed and participants have so many opportunities to organize their knowledge, our model will not be as vulnerable as others that depend on key players.

As for technical requirements, the Knowledge Society model is best served by network databases that students and other participants build and contribute to, instead of communicating through point-to-point messages. As centers of activity and ideas emerge, participants gain new perspectives on the information. This contrasts with Model 1, which requires only e-mail. Model 2 has worked with e- mail, but Web-based technology offers many advantages for coordinating research inputs.

New Teachers' Give-and-Take

At best, technology can facilitate the Knowledge Society model. As in all communication, however, human efforts are the crucial elements. In our networks, preservice teachers play a pivotal role. They are involved in both a learning and teaching capacity. Through contacts with experts in many areas- science, mathematics, history- they stretch their understanding of subject matter while serving as mediators between their students and the experts. They also gain a better understanding of learning in TeleLearning environments. And they engage in virtual practice worldwide.

Preservice teachers use their growing pedagogical expertise to come up with approaches that will be particularly productive for their students. For example, a science teacher might realize that students could learn about endangered species in a more integrated way by organizing their collective notes by phylum. Accordingly, the teacher would enter a diagram of a phylogenetic tree and ask students to link their notes to this tree, as appropriate. The tree now provides a new view of the notes. Two other ways of organizing the same notes are a map organizer and a "Reasons for Endangerment" organizer that students generate. By linking their notes to several integrative frameworks, students come to see their ideas in several contexts, each view revealing a new way to discuss their work.

The scientist whose work is linked may or may not have time to join this new discussion group, but will already have played an important role by demonstrating to students that their work relates to that of a practicing scientist.

A Role for Academia

Graduate students in education seminars also have a role to play. They study conceptual change and curriculum development by visiting databases throughout tile world in which students are learning about everything from photosynthesis to medieval history. The graduate student not only studies the literature of conceptual change, but also views it in the context of society's expectations, as represented incurriculum guidelines.

For example, one graduate student in physics reviewed a unit on "How Heat Affects Matter," produced by 5th and 6th graders. He noticed a great deal of animistic thinking- that is, students said that molecules were "wanting to escape" from heat, "running to get free," and so forth. The physics student created a view of the database that highlighted the different animistic accounts of molecules, a view that could then be studied by students, teachers, science education students, or any other participants in the network who had obtained permission from the student and teacher to work with their database.

The physics student also wrote a scholarly paper on issues of curriculum development and conceptual change, an article that was available, not just to a select group of readers, but to a network of participants worldwide. As a result of this give-and-take, the graduate student said that he himself learned more about matter and molecules.

Undergraduate students provide another resource by using worldwide networks as a new form of field study. Like the graduate Student, they could, for example, provide faculty and professional development students with valuable information by constructing views of the database that help to identify misconceptions, highlight promising new directions for research bring participants from different sites into new working groups, or offer explanations that may be extremely helpful to others.

Strength in Diversity

A Knowledge Society should favor these kinds of mutually supportive efforts. There is strength in diversity as schools, businesses, and cultural institutions share a common medium. This is true, too, of other kinds of connections. Secondary schools have a stake in the outcomes of elementary education. So why not have the contributions of younger children flow to secondary or postsecondary students, and from there to teachers and teachers in training, and from any of these contributors to those who formulate curriculum guidelines and standards?

Some might consider this Knowledge Society model impractical. But we must overcome the obstacles for three main reasons. First, the model is inevitable. Ideas and inventions, not labor and manufacturing, are already beginning to rule world economies.

Second, the skills and technology for a Knowledge Society are here, and school networks that run counter to it are likely to be short lived. These wide-ranging networks cost no more than more limited networks, so there is little reason for schools to confine themselves within more limited technologies or networks of participants.

Finally, this is a model of mutually reinforced high achievement, in which students encounter directly the excitement of working with ideas and advancing knowledge over a lifetime, and feel a part of it. •

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[1] For further information, visit http://www.telelearn.ca/telelearn.

[2] Examples are from D.R. Ward and E.L. Tiessen, (1994), "(Re)modelling Uses of Multimedia and Hypermedia in Education." Paper presented at the World Conference on Educational Multimedia and Hypermedia (ED-MEDIA94) (Vancouver, British Columbia: Association for the Advancement of Computers in Education).

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