AN APPROACH TO DISTRIBUTED COLLABORATIVE SCIENCE LEARNING IN A MULTICULTURAL SETTING

Jesús Vázquez-Abad, Nancy Brousseau, Guillermina Waldegg C, Mylène Vézina,
Alicia Martínez Dorado, Janet Paul de Verjovsky, Enna Carvajal, Maria Luisa Guzman

ABSTRACT
There is growing interest among educators in studying communities of learning and practice, particularly those supporting a social construction of knowledge through collaboration assisted by information technologies. We are currently investigating one such community in the context of high-school science. Researchers, graduate students and high-school teachers and their students, from schools and universities in Canada and Mexico, set out in fall 2000 to work on the general topic of integrating concepts in science school subjects. Once a "prototype" community is established, it becomes a "terrain" where different aspects can be studied: how do collaborative technologies work, what knowledge production and representation processes occur, what do the products of knowledge construction show and, very importantly, what characteristics of the community can be generalised for the establishment of other, self-sustaining (as opposed to externally supported) communities. The set up of the proposed "prototype" distributed science learning community was therefore an essential yet far from trivial first step. This was done in two stages: a pilot phase, in Winter-Spring 2001, and a full-implementation stage in the 2001-2002 year. Over 250 students are participating in the current year. The research efforts are focused on aspects of motivation toward science, scientific careers and IT; science process skills; cultural factors influencing performance on this kind of distributed collaborative approach; and teacher appropriation of the approach. This article focuses on the process of setting up the community and the lessons learned.

KEYWORDS
school science learning, collaborative technologies, multinational collaborative learning, distributed communities of learning

INTRODUCTION

Recent developments in instructional technologies and pedagogical practice are having an impact on school based science education (Hassard, 2000). Concepts and approaches from situated cognition, collaborative learning, technology enriched learning environments, dynamic learning communities and constructivist design, are among those presently found in writings involving socio-constructivist views in the application of instructional technologies to science learning (Brown, Collins, & Duguid, 1989; Jones, Rasmussen, & Moffitt, 1997; Lave & Wenger, 1991; Duffy & Jonassen, 1992)

There is particular interest in exploiting the potential of instructional technologies to put into practice the principle of students being the main actors in constructing their own knowledge (Crook, 1994; Papert, 1993). This requires the development of pedagogical situations that encourage students to act individually and collectively in significant and concrete situations (Bruner, 1996; Papert, 1986). Technologies can be catalysts for change: while it is true that if merely added to traditional practice they simply reinforce traditional models (such as learning as transmission of knowledge), as tools for searching and producing multimedia information, and for communication and exchange, they can render new models feasible. In addition to their impact on student learning, these new models bring new ways of looking at school curricula (the need to link different disciplines, the need to link school learning with extra-school reality) and at the role of the teacher (the need to become a mediator and facilitator of knowledge in an interdisciplinary context).

We are currently conducting a four-year project aimed at investigating a community of practice in which instructional technologies support collaboration (Roschelle, 1995). This community is composed of teachers, researchers and graduate students, and includes a community of learners composed of the same high-school teachers and their students. The community of practice is working on the general topic of integrating concepts in science school subjects; it is geographically distributed, with participating members in Mexico and Canada. The project is funded by the Mexican Council of science and technology, with complementary Canadian funding, for 2001-2004[1].

The motivation behind the project is to explore the potential of communities of practice that make significant use of collaborative technologies. Such communities could have an impact on many levels: improving science education, fostering skills related to a knowledge-based society, promoting aptitudes related to global and intercultural interaction, and helping the adoption, integration and internalisation of new instructional models. Once a "prototype" community is established, it becomes a "terrain" where different aspects can be studied: how do collaborative technologies work, what knowledge production and representation processes occur, how are motivation and process skills affected, what do the products of knowledge construction show and, very importantly, what characteristics of the community can be generalised for the establishment of other, self-sustaining (as opposed to externally supported) communities. The set up of the proposed "prototype" distributed science learning community was therefore a necessary first step.

This article focuses on the process of setting up the community. A pilot phase in spring 2001 tested the contents and different technologies with the high-school teachers and a sample of their students. The aims were to examine the relevance and feasibility of the collaboration model and the chosen topics and to make an inventory of problems and technical difficulties. Stage Two was the first implementation with full classrooms; it took place in the academic year 2001-2002 and involved more actively the researchers. In the 2002-2003 academic year, over 250 students are participating in a full implementation using a different platform, WebCT, for collaborative work. The aims are to assess the importance of the changes made and to test instructional management aspects.

APPROACH

Six schools are participating in the project: four Mexican (one private in Mexico City and three public in the towns of Cuernavaca, Jojutla and Pachuca) and two Canadian, both in Montreal (one private French-language and one public English-language French-immersion). Students are drawn from grade 12 (Mexico) Biology and Chemistry, grade 10 (Montreal public) Biology, and grade 11 (Montreal private) Chemistry classes. Individual students participate only once in the project.

Researchers, teachers and graduate students started by conducting an analysis of the existing conditions. The content had to be anchored to integrating concepts; thus, topics should span the scientific disciplines and require a multidisciplinary view. The topics also had to present multinational concerns in order to create motivation that could lead to cross-cultural awareness. The aspects studied should not be obvious nor readily obtained but should require an original synthesis from the students in order to achieve authenticity status. Finally, topics should not be part of the mainstream curriculum in either country, so as to avoid interference with local academic development, but they should be close or relevant to the local curricula so as to give validity to the activity.

Table 1 lists the topics and sub-topics chosen. The activity would include researching the scientific/technical aspects as well as the historical, legal, ethical and societal ones. The latter three were in-

[1] Project partially funded by CONACYT (grant no. G33909-S), Université de Montréal (Vice-rectorat à la recherche et Bureau de la coopération internationale), and the Ministère des Relations Internationales du Québec (*IXe Rencontre du Groupe de travail Québec-Mexique*).

cluded since the goals of this project include promoting an increased awareness among students of similarities and differences across North American societies and the "informal" development of skills to communicate in a second language.

Table 1

Topic	Sub-topics
Contamination	Air/Water/Soil
Waste Treatment	Domestic/Industrial-Agricultural/Hospital
Production of Drugs	Allopathic/Homeopathic/Alternative
Energy	Solar/Wind/Biomass Nuclear/Chemical/Green
Reproduction techniques	Assisted/Cloning/Prenatal Diagnosis

We looked for an instructional approach that would maximise the benefits of collaborative learning. We chose a version of the Jigsaw model for classroom collaboration (Aronson, 1978) that has been adapted to distributed collaboration (Winer, Chomienne, & Vázquez-Abad, 2000).

Since collaboration within teams was to happen between sub-teams in different countries, special attention was given to the issue of developing tools and procedures that would help set up and maintain appropriate interdependencies (Salomon, 1992). After the initial gathering of information on their sub-topics, sub-teams would share and discuss their findings producing an initial synthesis of the topic. This synthesis would be developed into a Web page uploaded onto the project site, which would then serve to gather further comments from "visitors" in an electronic poster session.

The eGroups platform was chosen for communications and document sharing. A free service (now under Yahoo), eGroups provides a "group portal" for email, chat, and exchange of documents, and allows for the recording of these activities. Initial, rough versions of procedures for student work ("protocols") were then developed.

PILOT PHASE

Ten teams were formed for the pilot phase. Each team had three sub-teams, two from different Mexican schools and one from a Montreal school. No two teams had the same composition in terms of the schools where sub-teams came from. The Mexican sub-teams had four or five students each; the Montreal sub-teams had two students each. In all, over 100 students participated in the pilot. In terms of language skills, all Montreal students were proficient in both English and French but only some spoke Spanish; only a few Mexican students spoke French. Therefore, it was ensured that at least one member of each Mexican sub-team had declared some proficiency in English. In this phase, participation in the project did not count towards the grade of the students in their different courses. Each team was assigned one of five topics in Table 1, and each one of the subtopics was assigned to a sub-team.

Work started in winter 2001 with a period of teacher familiarisation with the technologies used. Starting in February 2001 students were given two weeks to contact all members of their team and plan their work. In subsequent weeks, each sub-team gathered information about its sub-topic. Four weeks were then scheduled for information exchange, team discussion and synthesis, followed by the production of reports in the form of Web pages.

All inter-sub-team communication was done via Internet. Students were informed by their teachers that they could use Egroups-based electronic mail or chat, or even collaborative software (Netmeeting) for these exchanges; most students already currently used email and chat and a few also were familiar with Netmeeting. In order to keep a record of these exchanges, an account was set up in eGroups. The search for information was not restricted to any one medium, and indeed most teachers explicitly encouraged students not to limit their search to electronic sources. Some teachers gave their sub-teams the option to present their team's work in their school's Science Fair or in another public event; almost all of the students did.

Data sources included observational data, informal interviews, and records of communications (among students, and students and teachers) and files exchanged. Final products were not considered in the first trial, since technical problems did not allow for the completion of the Web-page report in most groups.

It did not take long to corroborate that technical problems, no matter how small, constitute the major threat to the realisation of such projects. We may have come a long way since school computing was on "technical pins and needles"; however, there is still a need for technical support when it comes to installing some software and hardware. For example, it was not possible to get the free software Netmeeting installed and running on all computers; some of the schools best acquainted with technology have installed firewalls that specifically obstruct video and voice transmission. Even where it was possible to install and run it, the problem of network speed was a major impediment: while the Montreal schools (as most public schools in the province) have high-speed cable connection, the Mexican schools are typically on 56k modems. (However, many students do have access to higher-speed connections and presumably can use this after school.) The fact that this rendered voice and video communication impossible was a major source of frustration for the students. Many previous studies have limited communications to email and chat; but in a multilingual setting, with students who are not very proficient in writing in a foreign language, it seems of capital importance to find a solution to this problem.

Another predictable source of problems relates to calendars. While the specific school cultures seem appropriate for this kind of project (since they happen to have similar curricula, amenable contents and accommodating pedagogical practices), facts such as different holidays and cultural mores make it necessary to pay close attention when establishing a detailed calendar for student work.

Group dynamics is a pervasive yet difficult issue to address. As in any team project, some sub-teams had some members who were more "active" than others. This was more likely to happen the larger the sub-teams; on the other hand, when one member "faltered," this was felt more in a pair than in a group of more than two. It thus seems important to have balanced teams (in more than simply numbers), to direct teachers' attention toward monitoring dynamics (parallel to monitoring individual and sub-team progress) and to insist with students on assuming responsibility for their peers' learning (and work). Despite problems of this nature, informal interviews showed that some students did find collaboration worthwhile, as in the case of a Montreal student who complained of a "lazy" sub-team partner but credited help from the Mexican sub-team as having allowed her/him to complete his/her part.

As for the contents, the topics themselves and the "modified Jigsaw" model for collaborative work seemed quite adequate. Two needed adjustments were detected: making sure that teachers communicate sufficiently among themselves to ensure that they can all follow the students' work, and that whole classes are involved to facilitate management by the teachers.

Despite these problems, and the fact that we were concentrating on technical aspects, informal interviews with students provided some interesting and promising observations. For example, some students claimed that, besides improving their "Internet skills", participating in the project improved their "scientific knowledge" (content), their "working skills" (procedure), their interest in "scientific topics" (motivation), and the "rigour of their work" (evaluation).

FULL CLASS IMPLEMENTATION

For the next step, teachers in the 6 participating schools used whole classes. Over 160 students participated in the 2001-2002 implementation. Fifteen teams were formed with three sub-teams of three to five students each. The project was made a compulsory part of courses and extended to cover 7 months. A detailed project calendar was negotiated with the participating teachers and compliance of progress with the calendar was closely monitored.

Students were given logins to access a special eGroups page with facilities to exchange documents, chat and send and receive email. They were asked to keep log books and post their entries for teacher examination. A researcher took on the job of website or eGroup moderator, making sure that documents were placed in right places on the website and that teachers received relevant ones at the right time. This manager, together with other researchers, programmed and took on experimental trials with chat (using MSN Messenger) and videoconferencing (using Netmeeting) among targeted sub-teams.

Researchers assisted teachers in developing a more structured framework for following-up student progress. Work expected from students was more clearly detailed and progress more closely monitored. All pertinent information was distributed in printed form and available on the eGroups website.

We realised the limits of the technical platform used. Mainly, the organisation of folders and spaces to hold the different student documents soon became a heavy task for the moderator. The inconvenience of a public and commercial site was also important: to the difficulty of contacting a heavily used site, one cannot neglect the lure of publicity that at best makes it harder to get on task, either by unavoidably torturous navigation or because of distractions on the path.

LESSONS LEARNED

Summarising the main points already mentioned, we consider that in setting up a community such as the one sought, it is essential to take into account factors of different nature but of equal importance. On the technical level, adequate support cannot yet be neglected– and maybe never will. Other projects have used ad-hoc platforms; however, since we are convinced that the generalisability of the project will depend among other things on its use of common tools, it is important to find the most adequate ones and adapt to them. We are migrating towards the use of WebCT; although it has most of the shortcomings of eGroups, it offers a commercial-free and more academically oriented environment. As well, being simple of use leads us to believe that its introduction will not require major training efforts from the teachers. Until a platform or tools exist that automate certain procedures, the role of the moderator in classifying documents, checking their timely arrival and notifying teachers, will still be essential.

Cultural aspects must be taken into consideration. This includes, in our case, countries as well as school cultures and even perhaps family ones – a topic currently under investigation by one of our researchers. The influence of this factor on the topic selection turned out to be less crucial than it was for carrying out collaborative, technology-based work. One aspect, related to variations in school calendar, is relevant for both synchronous and asynchronous work and requires special attention negotiating and "contracting" dates.

Instructional aspects were manifest at three different levels. The results concerning the choice of collaboration model, topics, subtopics and aspects were very satisfactory to all involved. In particular, this version of the Jigsaw model was conducive for the context (geographically distributed participants, integration of concepts, science non-main-curricular topics) and skills sought (research and evaluation of information, planning and executing work, writing, and negotiating syntheses).

On a second level, the importance of a framework to support and follow-up students was evident. It is essential to provide students with procedures for all tasks and models for all documents to be produced. Despite the fact that students at the high-school level are used to carrying out a number of related tasks and producing documents, they are not used to doing so in the context of distributed groups. The use of log books to record all work undertaken (very much in the manner of a lab log book) was of great help for the teachers in monitoring the progress of individual students – and thus, as well, of the sub-teams.

Finally, the involvement of teachers in student follow-up is essential. The researchers participating in the project are gradually diminishing their role in decision making and problem solving, as we believe that teacher autonomy is required if the project (establishing a learning community) is to be generalised. Meetings of researchers with teachers and with students, have been instrumental in developing this autonomy.

FURTHER STEPS

We now feel confident that the major issues regarding the set up of a viable, stable and productive learning community have been addressed. The current phase, which started in August 2002, involves some 250 students in 25 teams (a total of 75 sub-teams). While the community of practice will continue to participate supporting the students and their teachers, the main focus for this step will be on research. We are already analysing data from over 500 pre-post control-experimental group questionnaires on motivation and attitudinal factors. An instrument was developed this year to measure process skills suitable to the nature of this project, and will be used to ascertain how these skills are affected. Work is also underway regarding conceptual change, students' vision of the nature of science, teacher appropriation of instructional innovation, and cultural factors affecting collaborative learning. Finally, interest aroused by the project is making us consider its extension to other schools, from both countries and abroad.

REFERENCES

Aronson, E. (1978). The Jigsaw Classroom. Beverly Hills: Sage Pub.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Knowledge. Educational Researcher, 18, 32-42.

Bruner, J. (1996). The Culture of Education. Cambridge & London: Harvard University Press.

Crook, C. K. (1994). Computers and the collaborative experience of learning. London: Routledge.

Duffy, T. M., & Jonassen, D. H. (1992). Constructivism and the technology of instruction. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Hassard, J. (2000). Science as inquiry. Parsippany, NJ: Good Year Books.

Jones, B. F., Rasmussen, C. M., & Moffitt, M. C. (Editors). (1997). Real-Life Problem Solving: A Col laborative Approach to Interdisciplinary Learning. Washington, D.C.: Amer. Psy. Assn.

Lave, J., & Wenger, E. (1991). Situated Knowledge and Legitimate Peripheral Participation. Cambridge, UK: Cambridge Univ. Press.

Papert, S. (1986). Constructionism: a new opportunity for elementary science education. Cambridge, Mass.: MIT, Media Laboratory-Epistemology Group.

Papert, S. (1993). The Children's Machine: Rethinking School in the Age of the Computer. New York: Basic Books.

Roschelle, J. (1995) What Should Collaborative Technology Be? A Perspective From Dewey and Situ ated Learning [Web Page]. URL www.csc195.indiana.edu/cscl95/outlook/39_roschelle.html .

Salomon, G. (1992). What does the design of effective CSCL require and how do we study its effects? SIGCUE Outlook (ACM Press), 21(3), 62-68.

Winer, L.R., Chomienne, M., & Vázquez-Abad, J. (2000). 'The Electrical Circuit Simulator': Towards a Distributed and Collaborative Science Learning Laboratory. The American Journal of Distance Edu cation, 14(1), 47-62.

Jesús Vázquez-Abad
Professeur agrégé et Directeur
Département de didactique
Université de Montréal, Montréal
Canada
E-mail: j.vazquez-abad@umontreal.ca

Nancy Brousseau
Département de didactique
Université de Montréal
E-mail: nancy.brousseau@umontreal.ca

Guillermina Waldegg C.
Investigadora Titular
Departamento de Investigaciones Educativas
Centro de Investigaciones y Estudios Avanzados (Cinvestav)
México
E-mail: gwaldegg@data.net.mx

Mylène Vézina
Département de didactique
Université de Montréal
E-mail: mylenevez@yahoo.com

Alicia Martínez Dorado
Universidad Nacional Autónoma de México and Colegio Madrid
México D.F.
E-mail: aliciam@prodigy.net.mx

Janet Paul de Verjovsky
Universidad Autónoma del Estado de Morelos
Cuernavaca, México
E-mail: janet_verjovsky@yahoo.com

Enna Carvajal
DIE-Cinvestav
México D.F., México
E-mail: enna_carvajal@yahoo.com

Maria Luisa Guzman
CBTIS 8
Pachuca, México
E-mail: malu_zazueta@hotmail.com