Canada's SchoolNet
GrassRoots Program

A Study of GrassRoots Projects: Online Project-based Collaborative Learning

Study prepared
for Industry Canada
by The TeleLearning Network Inc.

TeleLearning Network Inc.

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SchoolNet GrassRoots Program

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BY TELELEARNING NETWORK INC.

March 2002

WHAT'S INSIDE

HIGHLIGHTS

In comparison to several models applied in America and elsewhere, the SchoolNet GrassRoots Program distinguishes itself by its scope and orientation

The SchoolNet GrassRoots Program is providing opportunities for relevant learning experiences and is instrumental in helping build a capacity for innovation

The GrassRoots Model constantly reaches out for more advanced teaching and learning practices in the integration of ICT

The GrassRoots Model is highly suitable in enabling school learners to acquire skills in the use of ICTs

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SCHOOLNET GRASSROOTS PROGRAM

A Study of GrassRoots Projects: Online Project-based Collaborative Learning

BY TELELEARNING NETWORK INC.

March 2002

Introduction

Dedicated to supporting teachers who integrate information and communications technologies (ICTs) into the curriculum, the GrassRoots Program has generated an increasing number of learning projects since its inception. This study identifies the characteristics of the SchoolNet Program reflecting of the progress made by professionals in transforming their roles to accomplish educational reforms, including the renewal of the role of the classroom learner. With an aim to indicate further developments and understand its impact, the present study focuses on the following question: How well are GrassRoots projects adequately preparing school learners to take on new professional profiles in a networked working environment? The assumption is that both the learner's basic interests and the social expectations of the emerging knowledge-based society can be met by thoughtful integration of information and communications technologies into the curriculum.

This report has five distinctive parts: (1) a synthesis of advances in research regarding the commonplaces of the educational situation (the learner, the teacher, the content and the context); (2) a methodology section; (3) a presentation of the interplay between new technologies, classroom processes and learning outcomes found in the GrassRoots projects; (4) an interpretation of findings; and (5) recommendations regarding appropriate support for students and teachers carrying out on-line project-based collaborative learning.

Synthesis of Advances in Research

Following a shift to project-based management in the workplace, the project-based collaborative approach is gaining momentum in the context of increasing the availability of on-line resources and networked computers. This has impacted classroom organization and management styles in terms of learner roles, the subject matter, teacher responsibility and the learning context. The **learner** is driven by four basic natural interests: communication, inquiry, construction and expression. The project-based collaborative approach focuses on placing students in the position of discovering the world and sharing the results of their explorations, investigations or problem-solving endeavors. Scientific literature shows that, in a networked classroom, the learner is also involved in new roles: active participant, creative interpreter of the world and experienced collaborator. Teachers who adopt a project-based approach engage their students in **subject-matter** learning activities that are meaningful to them and that challenge them to solve real-life problems. The **teachers'** role remains central: guiding students through cognitive and metacognitive processes, mediating access to information and knowledge, and becoming co-learners themselves. The learning **context** is enriched with networked computers acting as supportive tools to learning, allowing class members to communicate and make sense of their experiences.

Methodology

In order to investigate, present and analyze GrassRoots projects, Bruce and Levin's (1997) taxonomy, anchored in John Dewey's seminal work, was retained and adapted: network-enabled communication, inquiry, construction and expression.

This study analyzes case-study data from previous and new research (four Conference Board of Canada case studies and five TeleLearning team case studies conducted through SchoolNet's GrassRoots Program in 2000 and 2001). Questionnaires and interviews conducted in person and by phone were reviewed in order to determine ways in which GrassRoots projects impact on classroom processes and to develop a synthesis of learning outcomes for teachers and students.

Findings

The use of ICT tools described as technology support in project-based collaborative learning shows how different basic interests are pursued in a networked classroom, along with renewed classroom processes and learning outcomes. Results show that network-enabled communication is the first of the learners' basic interests (direct communication with others using the Internet, creating Web pages in all cases, etc.) to be met. Next comes inquiry-oriented projects using browsers and

search engines for theory building, data collection and data analysis activities. Construction-oriented projects involve the use of ICTs either for control (natural sciences) or for purposes of understanding (social sciences) and related creative learning production (informal-sharing Web sites, community-disclosure Web sites and information-sharing Web sites). In expression-oriented projects, teachers create a variety of opportunities for students to express themselves through new media and in new educational situations with the use of new technologies. Examples of learning projects in relation to two or more of the learners' interests are also provided.

Classroom processes indicate how ICT use transforms student learning in a positive manner. Relevant and rewarding experiences with ICTs are observed, thus providing students with more opportunities for success. On-line resources and tools boost student interest as well as complex content earlier in the curriculum. Sophisticated workplace skills, such as self-management, problem solving and creativity, are practised through a greater diversity of learning goals and projects. There is a greater range of learning by doing, and content construction by learners.

Learning outcomes identify what students are learning when the project-based approach is used by their teachers in combination with ICTs: technology skills (from the acquisition of basic technology skills to multimedia production skills); cognitive and metacognitive skills resulting from authentic problem solving, skills highly transferable to other situations; curriculum-related content knowledge; collaborative skills; increased multicultural awareness; and lifelong-learning and innovation skills.

Interpretation of Findings

GrassRoots projects are helping teachers and learners develop and adapt to a new classroom learning environment. In a growing number of classrooms, the networked computer is becoming a powerful source of information (or media). The networked computer makes project-based collaborative learning more doable. The GrassRoots Program provides teachers with relevant opportunities to take important steps in the following directions: initiating a shift away from the transmission model of teaching, playing the role of planner and manager (coordinator), guide (facilitator or coach), and assessor of process and content. Learners have opportunities to develop a sense of ownership and responsibility toward their own learning and peer collaboration. In this changing context, teachers need technical and financial support.

In comparison with several models applied in North America and elsewhere, the GrassRoots Program distinguishes itself by its scope and orientation, i.e. (1) its breadth; (2) the resources it brings to those who engage in it; and (3) the pedagogical approach it showcases. The GrassRoots model greatly contributes, both through its breadth and the support offered to all interested Canadian teachers, to making a significant break from low-level tasks. The GrassRoots model for enabling school learners to acquire skills in the use of ICTs is highly suitable, and it accelerates the shift toward advanced learning utilizing ICTs (project-based learning, cooperative and collaborative learning). Furthermore, the model constantly reaches out for more advanced teaching and learning practices.

Conclusions and Recommendations

In the transition that Canada is experiencing as it transforms into a knowledge-based society, the GrassRoots Program is providing opportunities for relevant learning experiences and is instrumental in helping build a capacity for innovation. This means building teachers' capacity for teaching and learning with ICTs and preparing tomorrow's democratic world citizens and competent workers for a networked world. In light of the above-mentioned results, this report presents nine recommendations to sustain and upscale future GrassRoots projects.

The recommendations underscore the need to **support current GrassRoots projects** by continuing to invest financially in them (1) and by continuing to provide the highest level of financing possible (2). There is also the need to **support next-generation** projects by favoring those that focus on the integration of ICTs into the curriculum at the junior and senior high school levels (3), questions and problems that are increasingly central to the curriculum (4), and the acquisition and use of advanced cognitive tools that make student thinking more and more visible (5). Another challenge is **to support the development of school infrastructures** by encouraging projects that will contribute to school-based capacity building (6). Incentives should be provided to implement mechanisms that recognize specific models to be used, promote cooperation and explicit collaboration between teachers, create mentoring among teachers and expand the reflective dimension of such projects. This also requires involving school principals in the development of synergistic ways of combining individual teachers' creative undertakings (7) and school-based professional development as a key for that capacity building. Finally, it is clear that implementing networks, including already-established partnerships between faculties of education and schools, developing new networks throughout Canada (8), and promoting projects that which reinforce the school's links with the whole community (9) would be worthwhile.

The GrassRoots Program's success stems largely from its ability to adapt to and answer the demands of our society to provide its children with opportunities for growth in innovative ways. Teachers, educational administrators and policy makers who are fond of Canada's innovation agenda are strongly advised to build on this success in order to provide K-12 learners with state-of-the-art classroom and school learning environments.

SchoolNet GrassRoots Program

A Study of GrassRoots Projects: Online Project-based Collaborative Learning

1. Introduction

The SchoolNet GrassRoots Program has been in existence since 1996 and has generated about 20 000 GrassRoots projects. This fact alone demonstrates a double event on the educational scene in Canada: (1) the integration of information and communications technologies (ICTs) into the curriculum is made possible through learning projects, and (2) the project-based learning approach is gaining momentum as ICTs are being implemented in schools and classrooms.

Canadian educators and policy makers are investing in GrassRoots, and they are keen to know how the GrassRoots model compares with theoretical approaches and other practical models. The present study, primarily rooted in the learner's basic interests, focuses on this question. The assumption is that both the learner's basic interests and the social expectations of the emerging knowledge society can be met by thoughtful integration of ICTs into the curriculum. Project-based collaborative learning is understood to be the approach of choice for providing relevance at both the individual and the social levels.

Delivering the 2001 Dewey's Invited Lecture at the annual meeting of the American Educational Research Association, David Berliner stressed that educators and policy makers must be aware of the narrowing of the curriculum, a frequently observed phenomenon in daily classroom activity. It is contrary to project-based classroom organization and management and is compatible neither with the ideal of a participatory democracy nor with "what business wants" in today's economic world. At the same meeting, McGhee and Kozma (2001) unveiled the results of a U.S. study on successful implementation of ICTs in teaching and learning. *Research results indicate that transformed roles for teachers and learners are associated with project-based or inquiry-based learning;* both are reflective of the flexible use of the technology and occur in rich contexts of systematic reform.

In Canada, the GrassRoots Program is dedicated to supporting teachers who integrate information and communications technologies into the curriculum. Both their project proposals and final reports seem to indicate that they are not only learning how to use ICTs but also renewing their teaching in ways compatible with 21st century challenges, including the innovation agenda. This study takes a closer look at the projects they conduct in an attempt to answer the following key question: How well are GrassRoots projects adequately preparing school learners to take on new professional profiles in a networked working environment? *This report provides an opportunity for the reader to appreciate what a growing number of teachers, with the support of the GrassRoots Program, are doing to help Canadians strengthen their ability to adapt to a new social environment.*

The report has five distinctive parts: (1) a synthesis of advances in research; (2) a methodology section; (3) a presentation of the interplay between new technologies, classroom processes and learning outcomes found in the GrassRoots projects; (4) an interpretation of findings; and (5) recommendations regarding further appropriate support for students and teachers carrying out on-line project-based collaborative learning.

2. A synthesis of advances in research

Project-based learning appears to be new, yet it is grounded in at least century-old notions and principles that were going, until very recently, against the tide when one considers earlier social expectations and educational practices in Canada and elsewhere. The chief pioneers of the project-based approach were John Dewey, on the experimental level, and William H. Kilpatrick, on the conceptual level. In the first quarter of the 20th century, these two professors and researchers from the United States demonstrated the effectiveness of the project-based approach and identified its main characteristics. The teachers' guide prepared for the GrassRoots Program by Grégoire and Laferrière (1998) points to Dewey's and Kilpatrick's efforts and also draws attention to the conceptualization and contribution of Ukrainian A.S. Makarenko, and French teacher Célestin Freinet and others from the "Groupe français d'éducation nouvelle."

In the nineties, the project-based approach to classroom organization and management benefited from the shift to project-based management in the workplace. It is creating a considerable increase in requirements in the labor force (knowledge workers), which draws our attention to the importance of the motivation to learn. Moreover, cognitive science demonstrated the importance of active student engagement and intentional learning. Furthermore, on-line resources and networked computers became available. Interacting synergistically, these factors apply Dewey's pragmatic view that everyone, child or adult, learns by observing the consequences of their acts and through their relations, or "transactions," with their environment. *Today, there are many studies demonstrating that placing students in the position of discovering the world and sharing the results of their explorations, investigations or problem-solving activities, as the project-based approach would have them do, represents one of the best ways of arousing and sustaining student motivation.*

So that the project-based collaborative approach can foster the assimilation of complex learning processes, the use of the following ideas and principles in connection with any of the basic components of any educational situation (learner, subject matter, teacher and context) is suggested.

2.1 The learner

Many educators theoretically agree that cultivating the child's desire to learn is critical in developing a positive attitude toward lifelong learning as well as knowledge and adequate skills. For Dewey, "interest means a unified activity" (1913, p. 15). He identified the following natural impulses of the learner as being the most important educational resources: to inquire or learn about different subjects, to use language and thereby to enter into the social world, to build or construct things, and to express one's feelings and ideas (p. 83, see also Dewey, 1943, p. 9). Throughout the past century, the practical difficulty for educators (school principals and teachers) was the lack of the educational tools required to meet the interests of the learner. Networked computers are enriching the classroom (or the school lab) learning environment. *The learner's desire to learn in a networked classroom (or computer lab) is shown in the scientific literature by the following three emerging roles: the learner as participant, sense maker or interpreter, and collaborator.*

The learner as a more active participant. The interactions that may occur in a project-based approach are more likely to enable students to be at the center of ongoing learning activities and to progressively participate in decision making in all phases of a learning project. Participation in decision making is known to heighten student engagement and to add value to the learning task (Krapp, Hidi and Renninger, 1992). *When a learning project evolves around a*

real-world problem, the student may even be more motivated by the collective interest in solving the problem than by the problem itself (Hickey, 1997).

The learner as a creative interpreter of the world. The outcomes of their Web research and empirical exploration provide students with matter for critical reflection. Through this reflection, their own discoveries and, gradually, the world itself acquire meaning. *When engaged in inductive learning, students* (in the role of an active interpreter) *make sense of the information they have with their peers.* It is through this process that information gains validity, is transformed into internal representations and acquires the status of knowledge. The interpretative abilities students may acquire—individually and collectively—are highlighted by Jerome Bruner, who, following Jean Piaget, places emphasis on this learner characteristic. In other words, "the act of understanding is no longer a process of coming to know the entities and attributes that exist in the world, but one of successfully negotiating the meaning of these objects with others" (Hewitt and Scardamalia, 1998, p. 77).

The learner as an experienced collaborator. Collaboration with peers adds another dimension to project-based learning. As Ward and Tiessen stated, project-based collaborative learning is "an instructional approach that attempts to engage students in the intentional pursuit of their own learning goals and in social interactions aimed toward the development of understanding" (1997, p. 29). *For their contribution to be meaningful and of value to others, learners must orient their actions in a way that is consistent with their personal goals, the goal of the team, the goal of the classroom and the goal of the network.* According to Hogan (1999), the following attitudes and behaviors have a positive effect on a team's progress in reasoning and understanding through open-ended inquiry and ill-structured problem settings: (1) the learner promotes reflection and regulation (e.g., students believe that active intellectual engagement is necessary for learning; students understand and accept that the goal of a task is to form ideas, not to reproduce information; students demonstrate enthusiasm for group learning and mutual explanations); (2) the learner is a contributor to knowledge content (e.g., students believe in sharing intellectual resources to get better ideas and products); (3) the learner is a creative model builder (e.g., students develop structures to gather, process and display information and knowledge creatively); and (4) the learner is a mediator for social interactions and ideas (e.g., students express their interests and engage in solving problems that arise during the project).

In short, according to this research, learners are to be placed in situations where they may progressively develop autonomy, responsibility for their learning, and awareness of the constraints and challenges pertaining to decision making. *Students refer to the teacher as a guide and, as their skills develop, are able to share their expertise with their peers and gain a sense of their own effectiveness.*

2.2 The subject matter

The conventional teacher presents the material to be learned through a series of tasks and activities. *The teacher who adopts a project-based approach must ensure that each student, and the class as a whole, makes the learning objectives their own and engages in inquiry;* learning is seen here as a conscious process that is desired and driven by "intention" (see Bereiter and Scardamalia, 1989). Moreover, according to researchers Resnick (1987) and Brown, Collins and Duguid (1989), learning activities that draw on real-life situations are more interesting to students than those used in most classrooms. With the teacher's help, students study real problems. Teachers structure their intervention by planning

activities that, while respecting student ability, present increasing levels of difficulty.

Student interactions that are found to be most successful with a given content include time for exploration, negotiations based on how they see this content, concordance on the degree of agreement they share and the action that logically ensues. The objective is to achieve a meaningful or "anchored" learning experience (see Bransford et al., 1990; Bransford, Brown and Cocking, 2000).

2.3 The teacher

The teacher's responsibility is central. *Though networked computers are a rich resource, providing direct access to information and interactive learning activities outside the classroom, the responsibility for student learning falls, first and foremost, on the teacher.* For about 20 years, cognitive science researchers, drawing on the work of Russian psychologist Lev S. Vygotsky from the 1920s and early 1930s, have demonstrated the importance of teacher mediation. The teacher's expected mediation is, in Vygotsky's view, double-edged: cognitive and metacognitive. Through metacognitive mediation, teachers bring students to gradually take over their learning process (to plan, direct, control, check and assess it). As students become more adept, the teacher places more responsibility upon them. *Under the best circumstances, the teacher's role progressively becomes that of a guide in a community of learners;* in particular, the teacher facilitates student activities through a carefully developed framework (see Brown and Campione, 1994, 1996; Cognition and Technology Group at Vanderbilt, 1993).

Penuel and Means (2000) identified seven characteristics of project-based learning using ICTs: the project (1) is anchored in the core curriculum; (2) is multidisciplinary; (3) involves students in a sustained effort over time; (4) involves students in the decision-making process; (5) is collaborative; (6) has a clear real-world connection; and (7) includes systematic assessment, both throughout the process and once the product is completed.

Teachers have an opportunity to be co-learners with their students and with other colleagues engaged in project-based pedagogy: participation in a community of practice is learning, stressed Lave and Wenger (1991). Moreover, the emerging community of practice (teachers working in networked classrooms) has new on-line means (e.g., electronic discussion forums).

2.4 The context

The learning context is most important in project-based pedagogy. The approach brought forward for consideration here is "situated" learning (see Lave, 1988, 1991). According to this approach, based on Vygotsky's theories, the acquisition of new understanding cannot be separated from the context in which it occurs. Since most people think that the student's mental representations are internal (see Anderson, Reder and Simon, 1996) and knowledge exists in the individual mind ("container model"), the suggestion that cognition is the result of the meeting of people, objects and situations (Hewitt and Scardamalia, 1998, pp. 78, 80) comes as something of a surprise. The researchers who present this new theory of learning offer the following justification: *understanding, occurring in real contexts, exists through the way in which class members (students and teachers) communicate among themselves, discuss their interpretations, and organize their processes and behaviors* (Bransford, Brown and Cocking, 2000). Having been shaped in a given context, the outlines of a learning project can be expanded through the use of the networked computer plugged into the local and world communities.

In other words, *the literature indicates that the computer-as-a-tutor metaphor is giving way to the computer-as-a-tool metaphor.* This is to say that in project-based collaborative learning, artificial intelligence, however

"clever" the digital agents may be, cannot offer the orientation and guidance given by the teacher in face-to-face or on-line interactions. It can, however, play a powerful supporting role and accelerate the pace when teachers feel encouraged to adopt more sophisticated pedagogy because of the availability of networked computers.

Hence, *a learning context enriched with networked computers calls for constant vigilance on the part of the teacher with regard to the people and other resources that can be accessed through electronic networks.* "Good teachers filter what enters the classroom to provide fundamental, concrete experiences that children can respond to, make sense of, and use to gain an understanding of the progressively more complex things and subjects to come" (Pepi and Scheurman, 1996, p. 234). These writers base their warning on the following comment by Dewey: "The first office of the social organ we call a school is to provide a simplified environment" (1966, p. 20). Next-generation tools such as Knowledge Forum assist the teacher in (a) providing an orderly but open virtual learning environment; (b) scaffolding student learning activity; and (c) keeping track of student on-line dialogues and knowledge-building processes.

3. Methodology

The research team retained Bruce and Levin's (1997) taxonomy in order to investigate, present and analyze GrassRoots projects. This choice of taxonomy presents two advantages: (1) that of reflecting Dewey's thinking and the basic interests of the child (1913), and (2) that of serving to classify the advanced applications of educational technologies, namely those supported by the National Science Foundation (NSF) in the United States. The former provides a means to understand the role of on-line tools within a learner-centered focus. The taxonomy is well-aligned with the theory and practice of project-based learning, thus it required little adaptation[1] in order to meet our research purposes. Moreover, it is conceptually sound. This is most important for making sense of, as Bruce and Levin put it, "a constructivist or integrative view of learning" (1997, p. 83) and finding consensus on what counts as innovation for both the teacher in the classroom and the policy maker in today's economy. The latter brings forth the highest standards that exist in order to acknowledge the accomplishments of teachers and students in GrassRoots projects. It lays the foundation for a later interpretation of findings that will link the achievements of teachers and learners in a bottom-up, open and inclusive innovative program with one that is top-down, highly selective and quite exclusive, that is, the NSF program.

The data for this study come from both previous and new research. The research team is using case study data gathered through SchoolNet's GrassRoots Program in 2000 and 2001: The Conference Board of Canada carried out four case studies of GrassRoots projects from four different provinces; TeleLearning researchers Ron Owston and Thérèse Laferrière carried out studies of GrassRoots projects conducted by pre-service and in-service teachers, and Ron Owston coordinated the writing of a single report. Moreover, the research team, through TeleLearning, conducted five case studies in five provinces. Personal documents, such as proposals for funding by GrassRoots, final reports, and Web sites and Web pages were also read. Questionnaires were elaborated for the teacher(s) and the school principal, and interviews were conducted both in person and by phone. The case studies are presented in Appendix A.

The case studies were reviewed in order to determine ways in which GrassRoots projects impact on classroom processes and to develop a synthesis of learning outcomes for teachers and students. In some instances in this study, the impact of GrassRoots projects (process-product) on student learning and

1 Given the use of the terms "networked computer" and "networked classroom", the main categories of the taxonomy (media for communication, inquiry, construction, and expression) were reformulated as follows: network-enabled communication, inquiry, construction and expression.

innovation was compared with that resulting from the use of other models, including those used in other countries.

Furthermore, the research team validated its observations of the classroom processes and learning outcomes found in the case studies by reviewing a sample of three percent of all GrassRoots published projects. To this end, a one-page summary of each project was prepared, that included a brief description of the project, participants, the technology used, classroom characteristics, students' activities, learning outcomes, teachers' strategies, the product or creation and its connection to the curriculum, and support (technical, administrative, collegial, parental). Blanks were left when project information was not readily available.

The findings, presented in the next section, combine quantitative and qualitative data. The case studies conducted by the Conference Board and the research team were codified according to the basic categories of the taxonomy and their respective subcategories. Case studies were classified according to specific software used to support the learning activities and products produced. The same procedure was applied to validate the results with a larger corpus: 14 additional projects with complete information, pulled out at random, were analyzed in more detail. The reader will find in Appendix B a table and a figure with additional results pertaining to the case studies and to the other illustrative projects.

In addition, the results were triangulated by assessing the degree to which ICTs were used in each of the categories and subcategories of the taxonomy as applied to the three-percent sample of all GrassRoots published projects. Two judges familiar with the data made the assessment, which was then covalidated by the three members of the research team who prepared the one-page summaries. The following three levels of use were identified: frequent use (F), moderate use (M) and rare use (R). Each level was then subdivided into three for further refinement (e.g., F+, F, F-). The next section presents, for each of the four basic interests of the learner and related activities, the findings. The wording of the results reflects the adjustments suggested by the triangulation procedure.

4. Findings

Findings are presented in three inter-related parts. The first, technology support, emphasizes the use of ICT tools in project-based collaborative learning. The second, classroom processes, indicates how ICT use transforms student learning. The third, learning outcomes, identifies what students are learning when the project-based approach is used by their teachers in combination with information and communications technologies.

4.1 Technology support

Using the adapted taxonomy, firstly, for each of the four basic categories (network-enabled communication, inquiry, construction and expression), a selection of learning objectives and activities that teachers identify when planning a GrassRoots project is presented. One can see how teachers are calling upon each of the four basic learner's interests in many diverse and creative ways. Secondly, four figures, in relation to each of the basic categories, are presented that capture the activities and products occurring in GrassRoots projects. A related table and figure may be consulted in Appendix B. Thirdly, instances where multiple interests are pursued simultaneuously in the same learning project are illustrated.

4.1.1 Network-enabled communication

GrassRoots projects foster communication more than any of the other learner's basic interests. Communication here refers primarily to sharing Internet-based information and participating in on-line

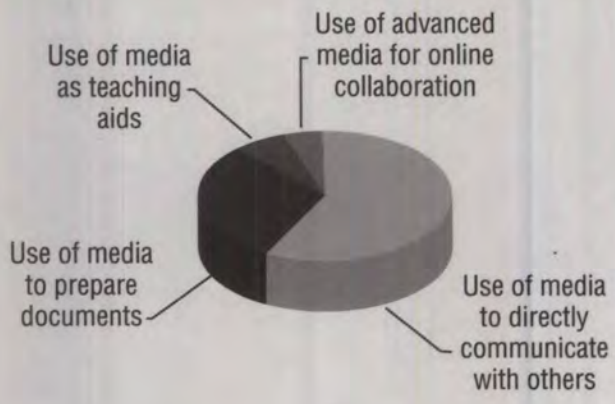
discussions to facilitate understanding. Some examples of learning objectives identified by teachers are as follows:

- Students will design, implement and critically analyze the progressive story they will build with a classroom from another province.
- Students who are learning about the rain forest during social studies will be able to formulate questions to ask E-pals who live in, have visited or will soon be visiting a rain forest area.
- Students will discuss environmental issues with an expert guest.
- Students will represent and explain concepts and procedures inherent to the dissection of a frog.
- With their peers from the United States and Japan, students will use a discussion forum to decide on their interests and the content they are going to incorporate into their shared Web pages.
- Grade 2 and 3 students will study their own communities and correspond by E-mail with partner classes across British Columbia on the following themes: My School and I, My Community, Community Development, Government and Industries.
- Students will develop deeper awareness and understanding that by working together they can create a unique product despite geographic distance and linguistic barriers.
- Students will learn how to effectively communicate their findings and experiences for a specific purpose and audience.
- In order to practice acquired language skills in French, students will send E-mail to E-pals in France and share their artistic experiences and creations in the visual art class.
- Students will conduct research through interviewing, E-mailing, reading and writing to Newfoundlanders near and far about the subject of what they remember most about Christmas in their small community.
- Students with special needs will write their own journals and books and other adapted class project work to be posted on the Web site.

Teachers and students prepare documents and conduct activities that are content-specific. Technology skills and communications skills are mastered at once. To do so, teachers and students use mostly presentation tools such as the MicroSoft Suite (MicroSoft Word, PowerPoint and Excel/Access). To communicate with other students, teachers, experts in various fields and people around the world, they use E-mail software, and html editors to construct Web pages. For instance, in the case studies, E-mail was used in 77.77% of all cases. Advanced collaborative tools such as discussion forums are beginning to be used for shared-document preparation. Figure 1a shows the distribution of the four subcategories of operations supported by ICTs and related to communication in GrassRoots projects (for more details, see the percentage table in Appendix B).

Figure 1a shows the importance of direct communication with others using the Internet. Teachers guide students through E-mail conversations on numerous specific topics and questions. *GrassRoots projects create several opportunities for asynchronous and synchronous communication with other local or distant classrooms.* As one teacher stated, "students are active in making contacts with community members that may contribute to the implementation of their project." An html editor and a server are now common tools. For instance, Web pages were created in all of the case studies, and the survey of other projects also points to a very high level of use. In some projects, students create teaching media for other school learners as teachers understand how ICTs can transform student work into an interesting and enjoyable, interactive, hands-on resource. There are numerous

Figure 1a— Network-enabled communication in GrassRoots projects



Source: TeleLerning Network Inc.

instances of advanced face-to-face communication, i.e., situations where students use their technical or social skills to help their peers. For instance, students show other students how to enact new roles when they visit other classrooms, present a project or assist younger peers with their learning. As reported in these case studies, *the use of communication tools leads to collaborative learning.*

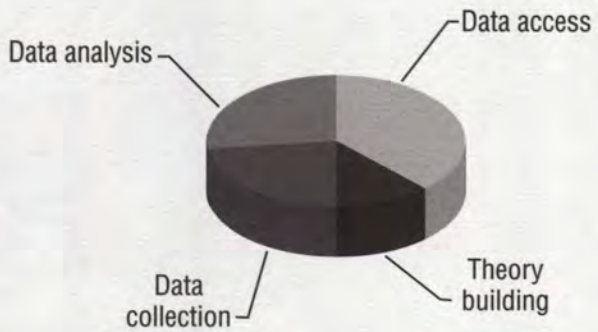
4.1.2 Network-enabled inquiry

GrassRoots projects emphasize inquiry. Teachers engage with students in a variety of projects in which inquiry is key. The following examples of learning objectives and activities demonstrate the breadth of possibilities in conducting such projects:

- Before visiting France and England, students will acquire basic knowledge about cultural, historical and geographical features.
- Students will create a virtual gallery to be published on the Internet of the works of aboriginal art that they collected in cooperation with their Australian E-pals.
- In order to build their own questionnaires, students will conduct library and Internet research on various ways of conducting valid and reliable surveys.
- Using the interactive computer microscope, students will work in cooperative groups to examine more closely the structure of plants and animals.
- Students will participate in a simulation of the United Nations and then compile their findings in the form of a Web page.
- Students will start an on-line database of conservation projects and ideas for schools across the country to use in environmental projects.
- Students will enhance their knowledge of different literary styles by collecting data to be included on a Web page and following the patterns to create their own poems.
- Students will download images and audio clips of call notes or bird songs from the Internet.

Data-access tools, mainly browsers and search engines, are the ICT tools used most

Figure 1b—Network-enabled inquiry in GrassRoots projects



Source: TeleLerning Network Inc.

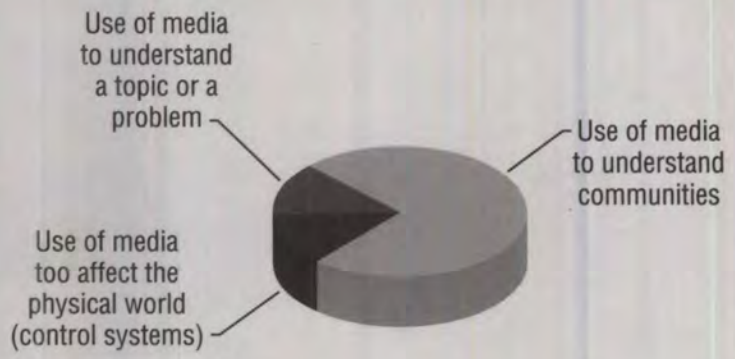
for inquiry purposes. *For beginners, teachers often create Web pages that include hyperlinks to specific Web sites or write hyperlinks on the classroom blackboard.* Teachers and students learn to use newly developed search engines. Databases, data tables and graphics are also accessed. Although the term "inquiry" applies primarily to data access using the Web in GrassRoots projects, it also encompasses, as stated in the taxonomy, three other operations: theory building, data collection and data analysis activities. Figure 1b captures the distribution of these four categories of use in inquiry-oriented projects.

Use of media for theory building may consist of asking relevant questions, drawing conclusions from recorded data to understand problems or preparing oral presentations using technical displays. Data-access tools connect students to the world of texts, videos and data, whereas data-collection tools extend their senses. They use mostly browsers for image collection, and also sound-recording devices and digital cameras. For instance, students conduct interviews with expert resource people to get the information needed to complete their projects. *Data analysis means quantifying, analyzing and interpreting the data collected.* In order to understand specific questions and problems, students analyze data utilizing software that allows them to make tables and graphs. GrassRoots projects set them on a course of using technology to gain a deeper understanding of the subject through exploratory data analysis. To a lesser extent, students use tools that support concept mapping (semantic networks) and data modeling (defining categories, relationships, and representations). In such instances, the new technology that they use makes their thinking even more visible.

4.1.3 Network-enabled construction

Construction here implies the use of ICTs either for control (natural sciences) or for purposes of understanding (social sciences) and related creative learning production. Some *examples of learning objectives identified by teachers* are as follows:

Figure 1c—Networked-enabled construction in GrassRoots projects



Source: TeleLerning Network Inc.

- Students in grades 3 to 6 will create math problems that will be used to challenge the problem-solving skills of their peers.
- Students will generate a list of projects and safety rules for the industrial technology lab.
- Students will develop and implement an on-line Web resource simulating the metamorphosis of the butterfly.
- Students will choose Mother Goose rhymes and will make and use modeling clay to create a diorama of a rhyme, take 20 pictures using a quick cam and then produce animation for the grade 1 Web site.
- Students will create an on-line simulation of the killer whale feeding process, used to prevent the whale from starving. By using spontaneous problem-solving and logical-reasoning skills, students will guide the killer whale through the steps with their mouse.
- Senior high-school students will collect and analyze data to describe the profile of a student leader.
- Students will explore the impact media (TV, radio, magazines) have on their lives and compare their findings with those of other grade 8 students worldwide.
- This project will offer a Web-based resource (a presentation and a simulation) for a self-paced tutorial about advanced manufacturing and robotics technologies. A robot will be built for a national competition along with a video document and will then be presented on the Web.
- Students will examine the impact of immigration on Vancouver and Vancouver's East Side in the 20th century, collaborate to collect data, and analyze and interpret the data to build a Web site.
- Students will create a Web site chronicling the personal experiences of individuals who lived through the Berlin Airlift, Korean Conflict, Vietnam War, Cuban Missile Crisis, Afghanistan War and Arms Race.

The construction of a Web site for the purpose of understanding one's local community is a favorite assignment among social studies teachers. The goal of the teachers and the students is to inform the world about their community by sharing

stories of their past, providing geographic information about their region, telling the stories of their community leaders, and sharing part of their current culture and language with others. Figure 1c indicates the nature of GrassRoots projects oriented toward construction.

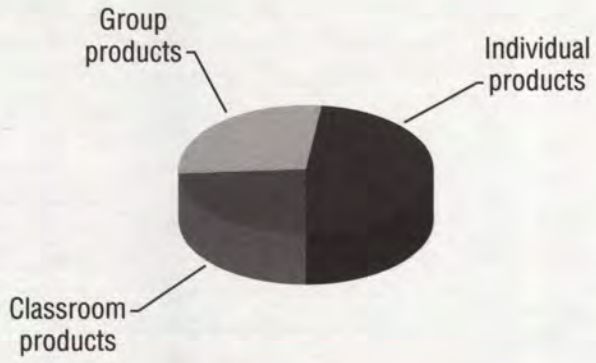
Construction of informal-sharing Web sites is very popular (88% of all case studies), as is construction of community-disclosure Web sites (77% of all case studies). Student motivation is often mentioned as high in relation to the publication of their works on the Web. Information-sharing Web sites are present to a lesser degree (22%). The construction of graphs and charts is another activity. *Both natural and social science teachers engage students in identifying problems or in creating resources* (e.g., a list of projects and safety rules for the industrial technology lab, or E-puzzles and E-quizzes) for the sake of sharing them with other students or classrooms. "Kids produce their best results for other kids," stated one teacher.

4.1.4 Network-enabled expression

Expression tools, such as scanners for digitizing illustrations, PowerPoint presentations and chat rooms, are popular with school learners. Advanced expression tools, such as iMovie and Flash, are also of great interest to junior and senior high school learners. *Examples of learning objectives identified by teachers* are as follows:

- Students will develop their artistic skills and publish their work on the Internet.
- Students will write reports about their community to their peers in another country.
- Students will make oral and multimedia presentations in different schools to showcase their project.
- Students will develop their creative writing skills and work as members of a team, simulating a newspaper publication.
- Students will create a virtual tour of their neighborhood to showcase their natural landscape and to give other students in Canada and abroad the desire to visit their region.
- Students will be invited to submit original art, poetry and literary works to be included in a published anthology. Students in computer science classes are

Figure 1d—Networked-enabled expression in GrassRoots projects



Source: TeleLerning Network Inc.

involved in publishing this material in html format.
- Students will connect through WIER with up to 14 other classes from across Canada and with a professional Canadian writer for an on-line literary collaboration.
- Students will submit illustrations for a story titled "Little Metis Internet Trip to Australia", written by the project coordinator. The tale will be published with student illustrations on the World Wide Web.
- Beginning with the pre-writing stage and progressing to the final stage, students will collaborate to create a text.

Teachers create a variety of opportunities for students to express themselves through new media and in new educational situations made feasible with the use of new technologies, e.g., working with students to create digital presentations of their findings or guiding their students through the process of movie making. Real situations as well as plays are videotaped. Resulting productions are made available on the Web. Figure 1d shows the distribution of individual, group and classroom products using ICTs in expression-oriented projects.

Teachers cultivate their students' interest for expression through the use of a variety of tools applied in greatly diverse situations. They have the opportunity to discuss private property and privacy issues. They see more of what their students can accomplish through the multiplicity of ways they express themselves. Teachers notice that students improve their self-confidence and gain a sense of accomplishment. They state that students are proud of their productions and motivated to take on challenging projects. On top of that, activities conducted by professionals (publication and video making) are now practised at school and take place in the course of general education.

4.1.5 Network-enabled multi-faceted projects

In a great number of projects, however, *more than one basic interest is pursued:* inquiry and construction; inquiry and communication; communication and construction; expression and communication; inquiry, communication and expression; inquiry, communication and construction; and even all four interests at once. Presented as a bridge to the findings that relate to classroom processes, Table 1 illustrates how the critical aspects of project-based learning (teaching strategies, learning activities, ICT support, and learning outcomes) are linked to two or more of the learners' basic interests.[2]

In short, *teachers engage students in a great variety of projects with the support of ICTs when they participate in the GrassRoots Program.* They develop time-management strategies that combine learning about technology with learning with technology. Moreover, teachers manage to respond to the basic learners' interests identified by Dewey through the pursuit of creative and innovative ways to engage students in learning activities centered around communication, inquiry, construction and expression. The above findings demonstrate that GrassRoots projects coincide remarkably with a child's basic interests.

4.2 Classroom processes

This section reports on a number of consensual observations that were made by the research team as they examined already-existing case studies, including those involving pre-service teachers; conducted additional case studies; and read through proposals and reports pertaining to other projects. The following observations are related to key processes known to be essential for student learning to occur in the classroom. Examples and quotations are included with these observations as well as links with other initiatives in project-based learning where appropriate. On the whole, these observations demonstrate the significance of what is happening in GrassRoots projects.

2 For more information on the context, learning activities and outcomes of GrassRoots projects, the reader will find in Appendix B the five (5) case studies that were conducted during this research.

Table 1. Learning projects in relation to two or more of the learners' basic interests

Learners' Interests	Teaching Strategies	Learning Activities	ICT Support	Learning Outcomes
Inquiry Communication	• The teacher stresses interaction and collaboration among learners. • The teacher tries to provide real-life situations of learning, such as planning a field trip to see salmon and inviting an expert into the class to talk to the students.	• Class outings • Data collection • Discussions with invited guests • Writing • Interviewing.	• Digital cameras • HTML coding • Graphics • Scanners • E-mail • Animation software.	Curricular outcomes: • Types of salmon • Irish history and culture • Practical application of mathematical and scientific skills. ICT skills: • Interviewing • Technical ability to use a camera, a scanner and different image-editing software.
Inquiry Construction	• The emphasis is on a finished written product from each child. • Parents and seniors are also involved by making sure that the students' work is factually correct.	• Interviewing • Note taking • Editing • Typing • Formatting documents.	• HTML • Graphics • Digital cameras • Scanners.	Skills: • Note taking • Editing • Entering and formatting text with ClarisWorks. Awareness: • Use of digital cameras and scanners • Publishing a document on the Web.
Communication Construction	• The teacher organizes and plans the project. • The teacher trains some students to be monitors in the use of ICT tools required by the project	• Technical training • Discussions for topic choice • Data collection • Mentoring activities • Peer revising • Peer editing • Web page design • Design of a manual to present to other schools • Territorial implementation of the project.	• E-mail • HTML • Scanners • Graphics • Digital cameras • Audio files • Video segments • QTVR technology.	Employability skills: • Problem solving • Creative thinking • Evaluation and methodology skills • Principles of layout and design (virtual tours) • Awareness that Internet and E-mail can be used as tools for communication and collaboration. • Awareness of one's community's most important features.
Inquiry Communication Expression	The emphasis is on: • active inquiry • hands-on learning • visual representation of thinking	Cooperative groups use the interactive computer microscope for the following: • Labeling the nature patterns found under the microscope • Choosing the patterns to put onto the Web site • Printing the slides to create booklets.	• Graphics • Interactive microscopes.	Curricular outcomes: • Question answering using the process of scientific inquiry • Use of an interactive computer microscope.
Inquiry Expression Communication Construction	The teacher plans the whole project. The class is organized so that students work together and individually to report to a group leader who then corrects and enhances the product before reporting to the teacher.	• Reading • Selecting excerpts • Typing text • Visualizing video • Editing video excerpts • Producing criteria papers for Web page selection • Collecting data • Commenting on selections • Reporting to group leader by E-mail • Correcting the work and reporting to the teacher.	• Word processing • E-mail • Internet • Video-editing software.	• Reinforcement of reading and writing skills • Criteria-based searches • Methodology and evaluation skills • Acquisition of environment-related knowledge • Collaboration and communication skills • Awareness of using different ICT tools in learning contexts.

GrassRoots projects provide K-12 teachers, including some pre-service teachers, and students with relevant and positive ICT experience. Projects provide the structure for learning by doing—*learning about ICTs shifts to learning with ICTs*. Teachers report being motivated to learn Web site construction skills (Owston, 2000). Student teachers who had the opportunity to participate in the GrassRoots Program affirm their willingness to integrate ICTs into project-based learning. Most students are enthusiastic about their publications on the Web. Positive experiences with ICTs are considered a necessary preliminary condition in order for all learners to benefit from their use, including teachers as learners. (See, in Appendix A, Case Studies A and B for an illustration of basic ICT practice in secondary school and in grades 5 and 6. For more sophisticated usage of ICTs in a multi-class context, see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* Imagine the Challenge). The following quotations point to the enabling role ICTs play in the classroom:

- With ICTs, they have instantaneous visual feedback and are constantly in real problem-solving situations; therefore, the *learning-by-doing* approach is very popular in this school (Case Study A).
- The students and teacher were fortunate to have regular and attentive technical assistance from a laboratory volunteer. His presence alone gave the students the extra boost to undertake their computer tasks with confidence. (Case Study B).
- The 3 Ts, telecommunication, teamwork and transformation (change for the people involved in the process), constitute the teacher's golden rule. She considers that it is often transformation that frightens teachers because they, too, have to remain flexible and open to change during the process (Case Study C).
- Supporting completed projects as a learning resource for other teachers and students—grade 5 teachers took their students to the grade 3 Web site to show them what the grade 3 students had done (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* Backyard Bird Feeding in Newfoundland).

GrassRoots projects have a strong tendency to emphasize collaboration over competition within and between classrooms. Teachers organize students to work in teams; most often, the jigsaw cooperative structure is used, each team member or team focusing on one aspect of a larger project (see Owston, 2000). *Cooperative and collaborative learning is a major departure from the traditional teaching-learning model,* which relies on competition for effectiveness in classrooms where all students are to learn the same material in a given time. This difficult but necessary step for a learning society is accelerated by the integration of ICTs into the classroom (as seen in Case Study A). All case studies demonstrate the emergence of collaborative behavior at various levels of interaction:

- The students developed constructive criticism skills towards other students' work (Case Study C).
- The students developed different attitudes and social skills through the collaborative work done with their peers and with the adults (Case Study D).
- [The project] develops collaborative, problem-based learning skills—students understand the choices they are making (and how they are treating other students) in a concrete situation in which they want to succeed (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* Imagine the Challenge).
- Elementary students see their stories, word games and puzzles posted on the Internet and enjoy learning from their peers and older students. Secondary

students enrol in the technology option course and mentor elementary students in developing, designing and implementing online educational games based on elementary students' work (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada*, La boîte à jeux).

- [Students] work in pairs within clearly defined parameters and, with coaching and appropriate supervision, build their teamwork skills. Assembling teams of children who can work together and will all have input within their teams—often this means putting a brighter student with one who may be struggling with the language (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada*, Backyard Bird Feeding in Newfoundland).

GrassRoots projects emphasize pedagogy and content, not just ICTs. *Project-based learning allows the integration of ICTs into the curriculum.* Their role in supporting inquiry and communication, as well as subject-matter integration, is obvious. While some GrassRoots projects compare with other projects that are supported by initiatives of an international scope such as WebQuest (http://edweb.sdsu.edu/webquest/webquest.html), other projects are comparable with small-scale initiatives like Challenge 2000. In the latter, teachers and students from California conduct project-based learning using multimedia developed in collaboration with researchers from the Institute for Research on Learning in the Palo Alto region. (Penuel and Means, 2000). Three models incorporate all of the dimensions that have been traditionally associated with a project approach to learning, such as having a real-world connection, but add the practice of producing final projects in a multimedia format as a central part of the practice. Both in GrassRoots projects and Challenge 2000, most interesting projects engage students in key dimensions of their curriculum, each of which with goals being presented as inter-related, therefore, in a balanced manner. Case Study D illustrates an explicit content-related multidisciplinary project in a K-6 context. Case Study E (Vancouver Technical Secondary School) demonstrates such integration in a rather complex multimedia product. For an extended cross-curricular project, see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada*, Imagine the Challenge.

- The teachers were willing to implement a collaborative approach to teaching and to go beyond the boundaries of traditional pedagogical strategies. The teachers' role was to engage the students in a project that was meaningful to the students and respected the requirements of the curriculum. Their role was also to coordinate the students' work by providing activities and challenges that would stimulate their critical-thinking skills as well as motivate them to undertake their work seriously and assiduously (Case Study A).
- ICTs were effectively integrated into the interdisciplinary project (geography, Canadian studies, history, French). Moreover, technology was used as a working tool throughout the project, and served to make the final product more attractive to visitors (Case Study C).
- The project allowed students to attain many important curricular objectives as well as to familiarize themselves with and use ICTs as a learning tool in a variety of ways according to their abilities (Case Study D).
- The project also underlined how integrating ICT skills into the delivery of curricula is most efficiently and effectively achieved when such an initiative is [...] designed to be supported through time as a permanent learning

resource for other teachers and students (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada*, Backyard Bird Feeding in Newfoundland).

GrassRoots projects give learners some control. *Students are provided with more choices.* They process information in small groups and create presentations for their peers. Teachers view themselves as learning with their students, and some teachers gain new understanding of their students' capabilities. Learners' control over the pace of information delivery has been researched and has been proven to affect learning outcomes significantly for high-ability students (Case Study C describes the *Program for Gifted Learners* project). It should be pointed out, however, that high-ability learners perform better than low-ability learners regardless of the medium of instruction. Learner control is not a characteristic of classroom processes that is sufficient in and of itself for all other school learners (Dillon and Gabbard, 1998).

- Using the students as a resource: The teacher takes advantage of the student's own ability for she considers them to be the best teachers (Case Study C).
- Based on this solid structure, the students could thereafter assume responsibility for the project, i.e., take part in the decisions concerning the elaboration and presentation of the content (Case Study E).
- Students initiate and drive their own learning through the use of E-mail, the Internet, telephone and video technology; at times, the project becomes a very personal experience for learners (Case Study Imagine the Challenge).
- In its third year, the project now includes collaborative initiatives in which high school classes (visual arts and music) work together to help produce animated stories and soundtracks for the elementary students' initial work (Case Study La boîte à jeux).

GrassRoots projects engage students in longer term, more complex activities. Lesser known answers are elicited by teachers, and some projects have a tendency to engage students in inquiry that makes them reason more deeply, thus relying on higher order thinking skills. Inquiry-oriented projects with a focus on deep understanding tend to follow a process such as that found in classrooms that corroborate the findings of Blumenfeld's research team in Detroit schools—identification of a driving question, conceptual grounding, data collecting, analysis and interpretation (as described in Case Study E).

- The theme of this project, which strongly reflected the reality of the students' community, enhanced the students' motivation and engagement in it (Case Study B).
- The choice of topic was very close to the students' interests. By discovering the origins of a culturally diverse community—to which many of them belong—the students perceived the project as a genuine and meaningful endeavor. This, in turn, substantially raised their interest and motivation, thus maximizing their personal involvement and efforts in the project (Case Study E).
- Students actively research and think about how to incorporate results into their school life and realize that the Internet gives access to extensive information on learning topics provided they are willing to dig deeper (previously, students used the Internet to find simple answers to questions and did not explore) (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada*, Imagine the Challenge).
- Children with behavioural problems stay focused because of the application of ICTs. The learning experience is different,

hands-on and more personal (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* This is Nova Scotia—From Individuals Out).
- [...] this reduces drop-out rates and discipline problems (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* Imagine the Challenge).

GrassRoots projects enable school learners and teachers to publish learning products and creative materials on the Web. Having one's work appear on the Web is an attractive incentive to school learners. With html editors and graphic tools, a substantial and impressive amount of original products are put on the Web. Students receive feedback from visitors to their Web site. *Writing for a real audience and showing created Web pages to their parents are also attractive to school learners.* All of the projects studied are firmly established in that kind of motivation.
- To give the students the opportunity to create a unique on-line resource for the global community to learn about their community and their culture (Case Study A).
- The resource that was created is not only intended for the students of Lower Coverdale but for the local and global community as well (Case Study D).
- Students have a wider sense of audience—instead of writing for their teachers or their classmates, they now write for their entire school, their community and the world by presenting their materials in a public forum (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* This is Nova Scotia—From Individuals Out).
- Building Web pages that showcase students' work—both the elementary students' stories, word games and puzzles and the secondary students' ICT applications and additional research (see *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001 prepared by The Conference Board of Canada,* La Boîte à jeux).

In short, *GrassRoots projects contribute to broadening classroom practices* (see Appendix B for a comparative figure demonstrating this stable effect of GrassRoots projects). They do so at a time when educational systems are searching for ways to counter the fact that teach-to-the-test strategies are narrowing the curriculum, so students can better respond to the new social expectations arising in a networked world.

4.3 Learning outcomes

GrassRoots projects cover a broad range of topics, which allow for in-depth study, thus multiplying opportunities for students to learn. In this section, a classification of learning outcomes is presented.

4.3.1 Technological skills

Participating teachers and students acquire basic knowledge of networked computers, specific software and the skills to use them effectively as well as for learning purposes. They learn the steps of searching on the Web and creating a PowerPoint presentation or a Web page. Comments such as those below illustrate the variety of circumstances linked to the acquisition of technology skills:
- Students developed ICT skills during project planning and implementation.
- During the first phase of a project, students use research engines and databases on the Internet to collect information on a specific topic. They develop research skills and strategies to find precise and relevant information among the wide range of data stored on the Internet.
- A Web site is created in the majority of projects. Therefore, during the second

phase of the project, i.e., implementation, students used a Web page-editing program, an image-editing program and a word processor at least. Many skills are subsequent to the process of Web page creation, among them are the following:

- how to upload a page with a File Transfer Protocol program;
- how to use a scanner and scanning software; and
- how to use digital cameras and software to edit photos as well as video cameras and video-editing software to create video clips.

Students learn to use E-mail to contact expert resource people, peers, teachers, group leaders, etc. Students learn not only how to use E-mail but also how to coordinate their work using on-line tools throughout the course of a project. They build their understanding of the Internet and related concepts. They also build their sense of industry by using tools, completing tasks and receiving feedback.

4.3.2 Multimedia production skills

Teachers and students who engage in producing video sequences in GrassRoots projects incorporate them into a Web site. As one teacher mentions:

- What students learned is the skill of how to combine the use of different technical supports to create a multimedia production from beginning to end.

Except for HyperStudio pages, the different kinds of multimedia products that students create in GrassRoots projects are comparable with those found in the Challenge 2000 Initiative (Penuel and Means, 2000) in which Web pages or sites, PowerPoint presentations, animations and videos, and music CDs were created.

4.3.3 Collaborative skills

Project implementation is the result of the efforts of many. *Students learn to share tasks and take responsibility for accomplishing them;* they also learn to share their knowledge for the sake of the common pursuit. Complementarity among learners (including, at times, the teacher[s]) facilitates and enhances the learning process. About working together, one teacher states: "There was an outstanding shift here from students' competition to students' collaboration." Other teachers mention outcomes such as the following:

- Students learned to rely on one another, to work as a team; they learned to compromise in order to reach a decision.
- They learned to incorporate other students' ideas as well as their own into their projects and learning activities.
- Students developed aptitudes to constructively criticize their peers' work and learn from their errors.

4.3.4 Cognitive and metacognitive skills

Student teachers also learn with their cooperative teacher and from one another as they conduct project-based collaborative learning. Discussion forums evidence the way they inform, support, challenge ad reflect with the other members of their learning community.

Teachers point to the metacognitive skills that students develop, skills that appear transferable to other contexts. For instance, in order to make progress in a given learning project, students must call on higher-level reasoning skills such as decision making, planning and research methodology. Contact with real-problem contexts is likely to foster abstract thinking skills and complex processes such as understanding, problem solving and heuristic skill development. As one teacher *states, "Students may engage in critical reflection on the relevance of their procedures."* Another teacher stresses this point: "[T]he project made them relate curriculum skills to the real world and expand on their knowledge rather than just following a learned example." With the

Internet, access to information is unlimited, and students are challenged to transform this information into knowledge for worthwhile learning results. The development of analytical skills is fostered through the selection of relevant information (e.g., relevant Web sites for a given learning project). GrassRoots teachers give the following examples:

- Students learned to target relevant information and to construct a database of hyperlinks around a specific topic.
- Students collected statistics on childrens' TV habits and organized them in charts and graphs, then commented on them.

GrassRoots projects provide numerous opportunities for engaging students in information processing (selecting, summarizing, etc.), problem solving and high-level reasoning. The activity of memorizing facts, therefore, is embedded in the production of rich materials.

4.3.5 Curriculum-related content knowledge

Projects are anchored in the curriculum in a number of ways. At times, the initial topic is studied to develop procedural skills that are clearly spelled out in the curriculum (e.g., research methodology, problem solving, writing techniques, art production, observation of scientific facts or social events). In such cases, projects are directly related to the curriculum. They often integrate two topics and more.

In other instances, projects are coherent with aspects of the curriculum that emphasize declarative knowledge (e.g., science, geography or history). For instance, students explore a central theme, gather information and discuss its meaning on the Web. In such projects, students gain a variety of knowledge:

- Students used a virtual toolkit to learn the steps of scientific dissection of animals.
- Students think outside the limited scope of the class subject. They rise above the disconnected classroom content to a higher level of awareness about the interconnectivity between subjects and acquire an interdisciplinary vision of learning.

Teachers and student teachers stress that students are learning more than what the curriculum requires them to know.

4.3.6 Increased community and multicultural awareness

A critical mass of classroom projects is dedicated to the knowledge of others. Understanding one's own local and other communities was found to be the most popular activity conducted with ICTs. GrassRoots teachers mention that "Students develop an increased multicultural awareness." For instance, they report the following:

- One little girl who had moved to Australia used the site to show to her friends where she lived before. Our First Nation kids were so excited that she took them to our site.
- They learn to accept their differences and to be more tolerant and open-minded.

4.3.7 Lifelong learning and innovation skills

GrassRoots projects provide opportunities for students to move from passive presence to active engagement, to assume responsibility in the process of learning, to develop a sense of ownership of their work, and thus to enjoy an enriched life in the knowledge society. *GrassRoots teachers who engage students in such projects point to critical skills such as knowing how to learn, learning how to work as part of a team, becoming a critical thinker, contributing to the "progressive discourse" of their community of learners.* In such projects, students teach to and learn from their peers. Pre-service students become innovators and agents of change by conducting GrassRoots projects in the classrooms in which they are student teachers:

- They prepare to be responsible citizens in a changing world. Most of all, I want them to keep having a positive attitude toward learning as they graduate and during their working career, and I hope that my contribution in this regard counts!

These findings will now be discussed in order to assess how GrassRoots projects are contributing to preparing school learners for the knowledge-based economy and society and to identify subsequent logical steps in the development of the GrassRoots Program as a whole.

5. Interpretation of findings

The GrassRoots Program's raison d'être is to offer[3] funding to schools to create innovative and interactive learning projects on the Internet that:

- foster the acquisition of academic and computer skills, as well as those related to employability, in Canadian youth;
- build unique and relevant Canadian content on the Internet;
- integrate information and communication technology into learning; and
- facilitate increased connectivity and training opportunities.

The program's strategy is built around the availability of multiple sources of information (input) and a broader variety of classroom processes (throughput) in order to contribute to the rising expectations toward K-12 school learning outcomes (output) in a knowledge-based economy and society and in a participatory democracy (as computer-literate individuals, team members, problem solvers, innovators, ICT users, portfolio keepers). This section interprets the findings described above and draws comparisons with other models.

5.1 GrassRoots projects are helping teachers and learners develop and adapt to a new classroom learning environment

In a growing number of classrooms, the textbook, which was the prevalent and often exclusive source of information, now cohabits with another powerful source of information (or media)—the networked computer. This turns the classroom into a networked classroom, one that has access to an increasing number of relevant on-line educational resources and tools. All of a sudden, resourceful and creative teachers do not have to bring as many educational materials to their classrooms in order to engage students in project-based learning. The following integrated perspective on their respective roles is articulated and offered for reflection to GrassRoots officials:

- **The role of the networked computer.** *Networked computers provide the opportunity to access information found on Web sites and databases as well as the possibility of communicating with people on-line* (from peers to local community members and experts in various fields of practice). Moreover, network computers provide new tools for enhancing classroom processes. These tools may either enhance or transform the learning experience by making project-based collaborative learning more doable.
- **The role of the subject matter.** In the context of a shift away from the transmission model of teaching, learning does not simply mean building internal cognitive representations of a specific content being provided in a "ready-to-store" fashion by an external source. Learners construct their understanding of a given topic, question or problem.
- **The role of the teacher.** What teachers have to do when conducting a collaborative project with their students is captured in the following *roles: planner and manager (coordinator), guide (facilitator or coach) and assessor.* Teachers help, for

3 See "About Us" Web page at http://www.schoolnet.ca/grassroots/e/info.centre/index.asp

instance, students associate the divergent and convergent processes of a specific project with a scale of goals (ranging from individual to network goals). Teachers coordinate students' work and process the results either face-to-face, or on-line (see also Soloway, 1996: Bracewell et al., 1998; Shaffer, 2000; Laferrière et al., 2001).

- **The role of the learner.** *Learners have opportunities to develop a sense of ownership of and responsibility toward their own learning* (see also Paris and Turner as quoted by Hickey, 1994). Learners gather information and facts then process them (the inescapable constructivist principles of assimilation and accommodation) in order to add to their knowledge base.
- **The role of peer learners.** Assigned an active role as team members or ICT users, students are learning to "deliver." Under proper conditions, they engage in intentional learning (the learner-as-a-researcher metaphor), and there are concrete signs that they participate with their teacher(s) in classroom content planning, organization and management.

Project-based collaborative learning with networked computers becomes most effective to learners through what they experience and how they reflect upon it. The GrassRoots Program provides teachers with relevant opportunities to take important steps in this direction.

This does not mean, however, that teachers do not need technical and administrative support in order to conduct GrassRoots projects, e.g., support and authorization, for instance, to modify the computer lab schedule, to obtain permission from parents or to contact local community members. Access to networked computers and technical support go together. At times, the latter is missing, and teachers are stretched to the limits of their resourcefulness. *Undertaking GrassRoots projects requires equipment and software, so funding awarded to them is also a means to acquire software.* Teachers and pre-service teachers report that the school or the school district advance funding when necessary to help a specific project get under way (e.g., to buy an html editor or a Web cam).

5.2 The GrassRoots model is most distinctive in its scope and orientation

Throughout this study, no other models were found that are moving beyond learning about ICTs, i.e., the mastery of basic technology skills, to learning different parts of the curriculum through the use of ICTs with as much breadth as the GrassRoots Program. Moreover, *the program embraces project-based collaborative learning, a transformative rather than conservative approach, and it provides financial incentive to teachers* interested in moving in this direction. Thus, the GrassRoots Program distinguishes itself by (1) its scope; (2) the resources it brings to those who engage in it; (3) the pedagogical approach it showcases. As discussed below, *it is a model that stands out as unique when compared with other models.*

The model practiced most is that of a few pioneer educators, such as Judy Harris from the University of Texas (Austin), who use their Web sites to promote the project-based approach. Harris is a university professor who writes books on the subject and develops a virtual community of educators interested in project-based learning. Her Web site is at the following address: http://ccwf.cc.utexas.edu/~jbharris/Virtual-rchitecture/Telecollaboration/more-telecollaboration.html. She has been invited to hold workshops in Canada both in Quebec and in Alberta. The following Web site refers to her work at length: http://www.cssd.ab.ca/tech/learn/exploring.html. Virtual organizations such as The Global Schoolhouse also provide support to teachers interested in on-line project-based collaborative pedagogy (see

http://www.lightspan.com/teacher/pages/projects/default.asp?_prod=LS&_nav=T2_proj).

Another model consists of inviting **individual school learners** to participate in on-line projects under the leadership and coordination of a third party. In this model, the virtual community becomes a substitute classroom, and the student's teacher may or may not be aware of the activity being carried out by the learner. Examples are NASA Kids (http://kids.msfc.nasa.gov) and ThinkQuest (http://www.thinkquest). Though learners' school letter grades may improve as a result, there is no direct relationship between the learning that is occurring in the classroom and the on-line learning activities.

The study of **specific topics** is another project-based learning model, one that usually reflects a remote top-down approach, e.g., WebQuest. Teachers interested in project-based learning of limited scope are offered support through a server from San Diego State University and its Department of Educational Technology (http://edweb.sdsu.edu/webquest/). Other universities have joined in the initiative. Another example is the study of the Monarch as a science project, which is financed by the Annenberg Foundation and involves students from all over North America (http://schools.gorge.net/hrcsd/westside/monarchs.htm).

Another model is that of a specific on-line tool providing focus, support, modeling and membership in a virtual community of interested teachers. This involves mainly software used for communication (e.g., FirstClass) and expression (e.g., HyperStudio). For inquiry and construction models, tools developed by research teams with funding from the National Science Foundation in the United States are utilized, especially in Illinois (Covis, http://www.covis.nwu.edu), Michigan (Model-It, http://www.umich.edu/~pbsgroup/PIViT.html), California (Knowledge Integration Environment (KIE), http://www.kie.berkeley.edu/KIE.html) and Massachusetts (GenScope, http://genscope.concord.org/involved/index.html). Knowledge Forum (http://www.learn.motion.com/Research.html), a collaborative knowledge-building tool also developed through funding from NSF, combines the use of specific on-line tools for supporting collaborative learning projects based on the solution of real problems. All of these models provide a research base from which the GrassRoots Program may benefit in its future developments.

When a project is focused on solving real problems, "students acquire and apply concepts and principles in their investigations, formulate plans, track progress, evaluate solutions, and produce artifacts related to the problem," report Krajcik, Blumenfeld, Marx and Soloway (1994, pp. 483-484). These cognitive science researchers are working with teachers in the State of Michigan (Detroit public schools) to implement the project-based approach in secondary school science classes. "Orchestration among the features," assert the authors, "results in classrooms where students are afforded opportunities to construct knowledge actively and to think critically and are motivated to take responsibility for their learning" (p. 486). They are concerned with the sustainability and scalability of their program, however (Blumenfeld, Fishman, Krajcik and Marx, 2000).

Over the past decade, Blumenfeld, Soloway, Marx, Krajcik, Guzdial, and Palincsar (1991, p. 369) have developed an understanding of project-based learning as "a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of authentic problems. They have noted the prevalence of low-level tasks – the basic

instructional unit – in classrooms and argued that they "contribute to students' lack of understanding of content and process and poor attitudes toward learning and schooling" (p. 371). Along with other leading researchers in the new theory of learning (Bereiter and Scardamalia, 1989; Brown, Collins and Duguid, 1989; Resnick, 1987), they see how introducing more cognitively complex tasks provides opportunities for solving real problems as a remedy to that situation. For Blumenfeld, Soloway, Marx, Krajeik, Guzdial and Palinesar (1991), the project-based collaborative approach is the most promising path to solution.

Through the breadth and support it offers all interested Canadian teachers, the GrassRoots model greatly contributes to making a significant break from low-level tasks. Since its inception, the GrassRoots Program has helped school teachers and students learn about ICTs and integrate them into the curriculum. These are the primary objectives to be met, and they will continue to be so as long as learning about ICTs will be required for students. This model will accelerate the shift toward learning with ICTs in advanced ways (project-based learning, cooperative and collaborative learning). The literature shows that learning projects are more effective than learning content (e.g., specific software) outside of a context (a specific project). Moreover, the classroom produces content, and publishes it on the Web for others to access it. The GrassRoots model has proven to be doable as well as scalable; it has clearly demonstrated this when compared with other models applied in North America and elsewhere. Furthermore, *the GrassRoots model keeps reaching out for more advanced teaching and learning practices, as shown by the criteria that are not only used to accept projects but undergo revision on a yearly basis.* Also, GrassRoots officials stay informed about the research base in this matter and invest in transferring it to teachers. For instance, advances of the inquiry process are suggested by the notions of "a driving question" and "progressive discourse" – see the updated version of the teachers' guide, entitled *Project-based Collaborative Learning* (Grégoire Inc. and Laferrière, 2001) at the following address: http://www.tact.fse.ulaval.ca/ang/html/projectg.html

6. Conclusions and recommendations

In Canada, GrassRoots projects as a whole are a very important catalyst for teachers and students in the discovery of an incredible tool, the networked computer, and of means for renewing K-12 classrooms. Case studies clearly demonstrate that, as students from all over Canada learned about curricular topics and questions, the Program provided them with opportunities to learn how to use information and communications technologies. *GrassRoots projects are* a sure investment on the part of all concerned. They are *highly relevant for eliciting the behavior most often associated with a knowledge-based society and Canada's innovation agenda*: cooperation and collaboration, on-line communications, higher-order thinking skills and the like. Along with networked computers and proper support, there are clear signs that GrassRoots projects are contributing to ecological shifts in the culture of teaching and learning.

6.1 Conclusions

Once more, it must be recognized that the GrassRoots Program has been providing opportunities for learning experiences directly relevant to the needs of the knowledge-based economy. *GrassRoots projects contribute to having both teachers and students adopt on-line practices and build lifelong-learning attitudes and skills.* Indirectly, the program presents school administrators with an opportunity—and a challenge—to

speed up the process of integrating new technology into schools: teachers ask for specific equipment and advocate that their GrassRoots project could help pay for it; teachers want more time in the lab or computers in their classrooms; teachers rethink their role in the classroom and engage learners in new roles (performers, publishers, producers) before, during and after project implementation; and teachers reassess their evaluation practices. In short, in the transition that Canada is experiencing as it transforms into a knowledge-based society, the GrassRoots Program is instrumental in helping build a capacity for innovation.

Moreover, *the GrassRoots Program is aptly in line with the new theory of learning* (Brandt, 2000; Bransford, Brown and Cocking, 2000), *which stresses the importance of social interaction in teaching and learning*. The networked computer is helping teachers who practice project-based collaborative learning to carry out that complex task. For instance, on-line collaborative tools leave traces of learners' interaction as they present ideas and opinions or as they struggle with understanding a problem; the teacher may attend to the content of the exchange between students and monitor the level of their participation and understanding.

Furthermore, *the GrassRoots model encourages teachers to use on-line resources and tools in ways that are relevant in their own individual educational contexts.* Teachers identify the learning objectives—they decide on the nature and level of student participation when choosing a project and related resources and activities. Some projects may require access to the Internet at all stages, whereas others may not. Some projects may be more advanced than others. For instance, inquiry-oriented projects may start with the teacher's personal Web page specifying which html pages are suitable for student consultation, or they may start with a driving question stemming from a classroom discussion.

In short, the GrassRoots Program is most instrumental in helping Canadian school teachers and learners build their ability to use information and communications technologies. Reports from teachers consistently stress the following:

- the use of the computer as a tool and as a source of motivation for students;
- perceivable positive effects in all subject areas;
- the move away from the factory-school model and toward project-based classroom management; and
- the potential of project management for role-building in a knowledge-based society.

The GrassRoots Program is far-reaching (breadth and depth) in encouraging and supporting teachers who engage their students in project-based collaborative learning, thus building their capacity for teaching and learning with ICTs and preparing tomorrow's democratic world citizens and competent workers for a networked world. In light of the above-mentioned results, the following recommendations are presented for future steps.

6.2 Recommendations

The positive response from teachers and school principals regarding the GrassRoots program constitutes a strong plea not only for sustaining but also for upscaling GrassRoots projects. Hence, the following recommendations.

6.2.1 Supporting GrassRoots projects

Recommendation one: To continue financial investment in the GrassRoots projects. Proof of the impact of information and communications technologies on teacher practices and student learning is growing: mastery of ICT skills, project-management skills, collaborative skills,

higher-order thinking skills and others. The GrassRoots Program is a reflection of the ability of policy makers, Canadian teachers and other key educators to work in an all-encompassing fashion. As Linda Roberts, head of the Office of Learning Technology in Washington, pointed out, investing in building skills is critical. The GrassRoots Program is a skill-building and innovation-generating program.

Recommendation two: To provide GrassRoots projects with the highest level of financing possible. As word spreads and examples accumulate, more and more teachers are interested in undertaking a GrassRoots project, or a second or third one. The program's total financial support, therefore, must increase given the 16 500 schools in Canada and the 300 000 school teachers that make up the teaching force. Canada is a world leader in ICT integration into schools and classrooms (Pelgrum and Anderson, 1999). Also, within each province and territory, it has a skilled teaching force that is now learning about ICTs and learning to teach with ICTs. Other countries (e.g., the United Kingdom), however, are implementing large-scale plans, and for Canada to maintain its leading edge, policy makers must keep investing generously in the quality of instruction and the abilities of the teaching force.

6.2.2 Supporting next-generation GrassRoots projects

Recommendation three: To favor projects that focus on the integration of ICTs into the curriculum at the junior and senior high school levels. Whereas elementary school teachers innovate and carry out GrassRoots projects in increasingly creative ways across a variety of subject matter, secondary school teachers are more subject-matter bound. Encouraging technology teachers and teachers specializing in other subject matter to develop GrassRoots projects together is another substantial step toward ICT integration into the curriculum. To this end, it is recommended that project proposals and reports require the signatures of both a technology teacher and a teacher specializing in other subject matter.

Recommendation four: To favor projects that focus on questions and problems that are increasingly central to the curriculum. As long as there are basic technology and methodological skills to be developed, the nature of the topic being studied is not an issue. The study of advanced topics and authentic questions are further ahead benefits to be expected, stressed Dede (1998). The National Science Foundation in the United States promotes such projects through the grants it provides to researchers and teachers. The Buck Institute for Education[4] acts as a consultant in this matter and reports that the more projects center on important aspects of the curriculum, the more expectations are increasing in terms of learning outcomes, including gains in those skills that are transferable to different subject matter (e.g., critical analysis of information, research methodology, problem analysis and solving, data organization and reflection on the learning process (metacognitive strategies)).

Recommendation five: To open a strand of projects that will focus on the acquisition and use of advanced cognitive tools that make student thinking more and more visible. In the United States, the National Science Foundation is funding the development of lighthouse models and dedicated equipment, which are expensive and do not scale well without additional funding. As a result, however, next-generation Web-based tools are becoming available on the market—there are advanced mindtools, including concept-representation tools and modeling tools (see Jonassen, 2000). In the recent years, the TeleLearning Network of Centres of

4 The Buck Institute for Education is a nonprofit research and evaluation organization based in California dedicated to improving schools by advancing knowledge about the practice of teaching and the process of learning (http://www.gie.org).

Excellence has funded the development of a leading-edge collaborative knowledge building tool (Knowledge Forum). It is suggested that a strand of projects be opened that could be dedicated to integrating such tools into on-line project-based collaborative learning.

6.2.3 Supporting school infrastructure development

Recommendation six: To encourage projects that will contribute to school-based capacity building. As they integrate ICTs, schools must deal with the changing nature of the challenge they face: connectivity, high-quality content, changing roles of teachers and school learners, and more advanced assessment practices and tools. Developing a project-based collaborative learning infrastructure at the school level is understood to be key. Therefore, incentives should be provided to implement the following:

- Mechanisms that recognize specific planned practices (e.g., with the collaboration of students, the teacher manages a list of priorities). Such a strategy would help the teacher in making decisions consistent with the orientations of the school, the opportunities provided by a specific project and the expected learning outcomes.
- Mechanisms that recognize cooperation and collaboration among teachers.
- Mechanisms that create opportunities for knowledge transfer among teachers through mentoring and exchanging knowledge and expertise.
- Mechanisms in line with the reflective-practitioner model for building the metadimension of teaching through practice and on practice.

Recommendation seven: To involve school principals in the development of synergistic ways of combining individual teachers' creative undertakings with school-based professional development. Owston's (2000) report mentions that "The greatest impact of GrassRoots may well be on teacher skills. Teachers almost universally report increased confidence and skill in ICT use and in organizing project-based instruction in their classrooms." Teachers go to the GrassRoots Web site. They rarely apply for funding without first browsing through the projects that other colleagues have planned or reported on. When they participate in a larger project (e.g., school district projects), they learn from one another. Although these non-linear, bottom-up support systems for the professional development of teachers are most important and must continue, other forms that take the unique missions and development plans of individual schools into account are also important. To support school principals and their projects in this regard would also be most worthwhile.

Recommendation eight: To build on existing partnerships between faculties of education and schools and to support developing partnerships. Well-designed on-line activity may support collaboration between schools and faculties of education. Participation in discussion forums proves helpful to pre-service teachers learning the project-based approach in the schools of the Laval University Network of Associated Schools. Implementing such networks everywhere in Canada would be worth undertaking.

Recommendation nine: To promote projects that reinforce the school's links with the community. Many meaningful projects are strongly anchored in the school's local community. Projects that provide opportunities for the school principal or the personnel to find community resources and to benefit from those resources help strengthen the

connection of the school with its local community.

In short, the GrassRoots Program is nothing less than a success story when one considers what teachers and students can learn and accomplish when applying the project-based approach. The GrassRoots Program can become even better as projects stress knowledge creation. Now that society demands more knowledge, creativity, collaborative problem solving and sound methodological abilities, K-12 classrooms and schools must develop to meet these new needs. Teachers, educational administrators and policy makers who are fond of Canada's agenda for innovation are strongly advised to build on the GrassRoots Program's success in order to provide K-12 learners with state-of-the-art classroom and school learning environments.

References

Anderson, J., Reder, L. and Simon, H. (1996). Situated learning and education. *Educational Researcher, XXV* (4), 5-11.

Bereiter, C. and Scardamalia, M. (1989). Intentional learning as a goal of instruction. In L.B. Resnick, ed., *Knowing, learning, and instruction: Essays in honor of Robert Glaser.* Hillsdale, New Jersey: Lawrence Erlbaum Associates, 361-392.

Berliner, D.C., Biddle, B.J., and Bell, J. (1996). *The manufactured crisis: myths, fraud, and the attack on America's public schools.* Perseus.

Blumenfeld, P.C., et al. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, 26 (3 and 4), 369-398.

Blumenfeld, P.C., Fishman, B.J., Krajcik, J. and Marx, R.W. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational Psychologist*, XXXV, 149-164.

Bracewell, R., Breuleux, A., Laferrière, T., Benoit, J. and Abdous, M. (1998, updated in 2001). *The emerging contribution of on-line resources and tools to teaching and learning.* Industry Canada: SchoolNet.

Brandt, R.S., Ed. (2000). *Education in a new era: ASCD yearbook.* Alexandria, Virginia: Association for Supervision and Curriculum Development.

Bransford, J.D. et al. (1990). Anchored instruction. Why we need it and how technology can help. In D. Nix and R. Spiro, Eds., *Cognition, education and multimedia. Exploring ideas in high technology.* Hillsdale, New Jersey: Lawrence Erlbaum Associates, 115-142.

Bransford, J.D., Brown, A.L., and Cocking, R.R., eds. (2000). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press. Available on-line at http://www.nap.edu/books/0309070368/html/

Brown, J.S., Collins, A. and Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, XVIII* (1), 32-42.

Brown, A.L. and Campione, J.C. (1994). Guided discovery in a community of learners. In K. McGilly, ed., *Classroom lessons: Integrating cognitive theory and classroom practice.* Cambridge, Massachusetts: MIT Press, 229-270.

Brown, A.L. and Campione, J.C. (1996). Psychological theory and the design of innovative learning environments : On procedures, principles, and systems. In L. Schauble and R. Glaser, eds., *Innovations in learning: New environments for education.* Mahwah, New Jersey : Lawrence Erlbaum Associates, 289-325.

Bruce, B.C. and Levin, J.A. (1997). Educational technology: Media for inquiry, communication, construction, and expression. *Journal of Educational Computing Research, XVII* (1), 79-102.

Cognition and Technology Group at Vandberbilt (1993). Anchored instruction and situated cognition revisited. *Educational Technology, XXXIII* (3), 52-70.

Dede, C. (1998). The scaling-up process for technology-based educational innovations. In C. Dede ed., *ASCD 1998 yearbook on learning with technology.* Alexandria, Virginia: Association for Supervision and Curriculum Development, 199-216.

Dede, C. (2000). Emerging influences of information technology on school curriculum. *Journal of Curriculum Studies, XXXII* (2), 281-303.

Dewey, J. (1913). *Interest and effort in education.* Boston, Massachusetts: Houghton Mifflin C.

Dewey, J. (1943). *The child and the curriculum/The school and society.* Chicago, Illinois: The University of Chicago Press.

Dewey, J. (1966). *Democracy and education. An introduction to the philosophy of education.* New York, New York: Free Press. Available on-line at http://www.ilt.columbia.edu/academic/texts/dewey/d_e/contents.html

Dillon, A. and Gabbard, R. (1998). Hypermedia as an educational technology: A review of the quantitative research literature on learner comprehension, control, and style. *Review of Educational Research, LXVIII* (3), 322-349.

Grégoire, R. and Laferrière, T. (1998). *Collaborative project-based learning: A guide for teachers.* Industry Canada: SchoolNet. Available on-line at: http://www.tact.fse.ulaval.ca/fr/html/sites/guidep.html

Grégoire Inc. and Laferrière, T. (2001). *Project-based collaborative learning with network computers.* Available on-line at http://www.tact.fse.ulaval.ca/ang/html/projectg.html

Hewitt, J. and Scardamalia, M. (1998). Design principles for distributed knowledge building processes. *Educational Psychology Review, X* (1), 75-96.

Hickey, D.T. (1997). Motivation and contemporary socio-constructivist instructional perspectives. *Educational Psychologist, XXXII* (3), 175-193.

Hogan, K. (1999). Sociocognitive roles in science group discourse. *International Journal of Science Education*, 21 (8), 855-882.

Jonassen, D.H. (2000). *Computers as mindtools for schools: Engaging critical thinking*, 2nd edition. Columbus, Ohio: Merrill.

Kitagawa, K., Watt, D., Lacroix, E. *Canada's SchoolNet GrassRoots Program, Case Studies 2000/2001* prepared by The Conference Board of Canada, February 2001. Available on-line at http://www.schoolnet.ca/grassroots/e/project.centre/toolkit/index.asp

Krajcik, J.S., Blumenfeld, P.C., Marx, R.W., and Soloway, E. (1994). A collaborative model for helping teachers learn project-based instruction. *Elementary School Journal, 94*, 483-497.

Krapp, A., Hidi, S. and Renninger, K.A. (1992). Interest, learning, and development. In K.A. Renninger, S. Hidi and A. Krapp, eds., *The role of interest in learning and development.* Hillsdale, New Jersey: Lawrence Erlbaum Associates, 3-28.

Laferrière, T., Bracewell, R., Breuleux, A., Erickson, G., Lamon, M. and Owston, R. (2001). Teacher education in the networked classroom. Paper presented at the 2001 Pan-Canadian Education Research Agenda (PCERA), Laval University, Quebec. Available on-line at http://www.cmec.ca/stats/pcera/symposium2001/LAFERRIERE.O.EN.pdf

Lave, J. (1988). *Cognition in practice.* Mind, mathematics and culture in everyday life. Cambridge, England and New York, New York: Cambridge University Press.

Lave, J. (1991). Situating learning in communities of practice. In L.B. Resnick, J.M. Levine and S.D. Teasley, eds., *Perspectives on socially shared cognition.* Washington, D.C.: American Psychological Association, 63-82.

Lave, J. and Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge, England and New York, New York: Cambridge University Press.

McGhee, R. and Kozma, R. (2001). New teacher and student roles in the technology-supported classroom. Paper presented at the annual meeting of the American Educational Research Association, Seattle.

Owston, R. (2000). *Case studies of GrassRoots implementations.* Industry Canada: SchoolNet.

Paris, S. G. and Turner, J.C. (1994). Situated motivation. In P. Pitrich, D. Brown, & C. Weinstein Eds., *Student motivation, cognition, and learning. Essays in honor of Wilbert J. McKeachie,* 213-237. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc.

Pelgrum, W.J. and Anderson, R.E., Eds. (1999). *ICT and the emerging paradigm for lifelong learning: A worldwide educational assessment of infrastructure, goals and practices.* Amsterdam, The Netherlands: International Association for the Evaluation of Educational Achievement.

Penuel, W.R. and Means, B. (2000). Observing classroom processes in project-based learning using multimedia: A tool for evaluators. Palo Alto, California: Center for Technology in Learning SRI International. Available on-line at: http://www.ed.gov/Technology/TechConf/1999/whitepapers/paper3.html

Pepi, D. and Scheurman, G. (1996). The emperor's new computer: A critical look at our appetite for computer technology. *Journal of Teacher Education, XLVII* (3), 229-236.

Resnick, L.B. (1987). Learning in school and out. *Educational Researcher, XVI* (9), 13-20.

Robson, M. (1994). Working with groups on sensitive issues. In H.C. Foote, C.J, Howe, A. Anderson, A.K. Tolmie and D.A. Warden, eds., *Group and interactive learning.* Southhampton: Computational Mechanics Publications, 377-382.

Sandholtz, J.H., Ringstaff, C. and Dwyer, D.C. (1997). *Teaching with technology: Creating student-centered classrooms.* New York, New York: Teachers College Press.

Scardamalia, M. and Bereiter, C. (1999). In D. Keating & C. Hertzman Eds., *Today's children, tomorrow's society: The developmental health and wealth of nations.* New York, New York: Guilford, 274-289.

Shaffer, D.W. (2000). This is Dewey's vision revisited. In D.T. Gordon Ed., *The digital classroom: How technology is changing the way we teach and learn.* Cambridge, Massachusetts: Harvard Education Letter, 176-178.

Soloway, E. (1996). Teachers are the key. *Communications of the ACM, XXXIX* (6), 11-14.

Tucker, M.S. (1986). Computers in the schools: What revolution? *Journal of Communication,* Fall.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, Massachusetts : Harvard University Press.

Ward, D.R. and Tiessen, E.L. (1997). Adding educational value to the Web: Active learning with Alive Pages. *Educational Technology, XXXVII* (5), 22-31.

Appendix A
Case Studies

A: Waycobah First Nation Community (Nova Scotia)

B: La ConnectAction des générations (Québec)

C: The Rideau Canal: Ottawa's Community Waterway (Ontario)

D: Lower Coverdale Community Web Site (New Brunswick)

E: The Impact of Immigration on Vancouver (British Columbia), with a Special Focus on Vancouver's East Side

CASE STUDY A:
Waycobah First Nation Community (Nova Scotia)

Overview

The *Waycobah First Nation Community* project was created to showcase the community of Waycobah. The goal of the teachers and students was to inform the global community about the Waycobah First Nation by sharing stories of their history, providing geographic information about their region, telling the stories of their community leaders, and sharing part of their current culture and language.

The project started when the mathematics and computer-related studies teacher at Waycobah First Nation Secondary School found out about the GrassRoots contest and decided to participate in the "Communities@ca" category by engaging her students in the project by building a community Web page. For this interdisciplinary project, she collaborated with the senior high Mi'kmaq studies and language teacher. In her class, students compiled profiles of the seniors that were then integrated onto the Web site. The teachers planned the project with support from The Mi'kmaq Kina'matnewey Technical Support people (now known as the Atlantic Canada First Nation Help Desk (www.firstnationhelp.com)), who also provided the school with the space to host their Web site.

Background

General

This was the first GrassRoots project to be implemented at Waycobah First Nation Secondary School, which has an enrollment of approximately 70 students in grades 7 to 12. There are 12 full-time staff members, including the teaching staff, Principal and support staff. The Project Coordinator is considered to be the authority within the school on the use of information and communications technologies (ICTs) as a teaching and learning tool.

Technological Resources

At the outset of the project, the school had limited technological resources and little funding to equip the 15 stations of the computer lab with a network connection. The project was conducted with only one networked computer for all of the students. The school bought a new scanner and a microphone to provide more resources for the project. The school had one digital camera and borrowed a second to facilitate the students' work.

Project Description

- School: Waycobah First Nation Secondary School.
- District: Waycobah First Nation.
- City: Waycobah First Nation, Cape Breton.
- Province: Nova Scotia.
- School E-mail: wfnss@auracom.com.
- Teachers: Lisa Lunney, Phyllis Googoo.
- Grade levels and participating classes: Computer-related studies 12, Mi'kmaq language 11/12, Mi'kmaq studies 10, along with other students who wanted to contribute.

- Number and ages of students: 35 students ranging from 13 to 20 years of age.
- Language: English.
- Link to the project Web site: http://kinu.ns.ca/~waycobah/waycobah.html
- Awards: GrassRoots Project of the Week, GrassRoots Project of the Month, part of SchoolNet Communities@ca selection of 1999.

Learning Objectives

Curriculum-related Objectives

- To help the students gain a better understanding of the geography, history and political structure of their community as well as the stories of its founding members.
- To give the students the opportunity to create a unique on-line resource for the global community to learn about their community and culture.

ICT-related Objectives

- To acquire the skills necessary for creating and maintaining a Web page, such as learning how to use the html coding language and how to scan and edit pictures.
- To learn how to use the Internet as a research tool.

Teachers' Strategies

- Adopting a collaborative approach to learning and teaching: The teacher had already been using cooperative learning practices in her classroom. In her understanding, teamwork builds solid classroom dynamics, improves social interaction and facilitates the emergence of good group behavior and attitudes.
- Providing project-based learning opportunities: Through the project-based approach, learning outcomes are achieved through practical projects that involve, as much as possible, real-life situations and activities. In fact, the learning style of First Nations students is more suited to practical tactile approaches. With ICTs, they have instantaneous visual feedback and are constantly in real problem-solving situations; therefore, the learning by doing approach is very popular in this school.
- Adopting an interdisciplinary approach to learning: Teaching can be dramatically improved by building connections between disciplines, thereby making learning more meaningful for students. The community Web page project is a combination of two subjects: native studies and computer-related studies.
- Coordinating the project: During in-class activities, the teacher monitored the students to confirm that they were working as teams and provided the necessary feedback to facilitate student learning.

Project Activities

Planning

- The two teachers collaborated to plan the project. The first step was deciding which project to carry out, and the second was to make sure that the students and staff were willing to get involved. While elaborating their plan of action, they discussed the curricular and technical objectives that they were to target, planned the relevant activities and agreed upon a schedule.
- The team had to ensure that the school had the necessary resources for the project. This required downloading some Web page-editing software and purchasing a scanner.

Implementation in the Classroom

- Brainstorming: The teachers guided the students through a brainstorming session in order to decide on the specific content of their Web page.
- Conducting research and collecting data: The students collected photos and information about the community, such as its geography and history. Interviews with First Nation leaders, grandparents and neighbors were also conducted.
- Preparing the Web site content: The students engaged in various activities such as transcribing the interviews and creating profiles of the community elders, and selecting and recording Mi'kmaq words and expressions.
- Designing the Web site: The students designed the Web page layout and uploaded the content onto it.

Evaluation

- The majority of the activities were collaborative, and the teachers attributed letter grades based on the students' overall contribution and the quality of the finished project.
- As part of the students' evaluation, the teachers monitored the students' progress and evaluated how well they were working each day.
- The students who wrote stories and profiles for their native studies classes were given marks as if the work had been assigned as a regular paper.

Learning Outcomes

Curriculum-related Skills

- Meeting the objectives of the curriculum: Students learned about the history, patrimony and geography of the community from early days to the present: The students were able to gain a deeper understanding of the cultural wealth their community has to offer the province of Nova Scotia.
- Developing interdisciplinary skills: In addition to acquiring the curriculum-related skills in social studies and technology, students had the added benefit of improving their writing skills by preparing the texts for the Web pages as well as developing interview techniques while obtaining information from members of the community.

ICT Skills

Students acquired skills related to creating and publishing a Web page:

- uploading pages with ftp;
- coding with html;
- scanning and editing pictures; and
- recording, digitizing and editing sounds.

Collaborative Skills

- Gaining collaborative and interpersonal skills: The students learned how to cooperate in the pursuit of a common objective (giving and receiving information, compromising in order to reach a consensus, acting with leadership, treating others and their work with respect, etc.).
- Developing problem-solving skills: Students developed the ability to communicate their ideas and to use their creativity in order to solve problems in an innovative fashion.

Attitudes

- Cultural pride and awareness: Through their effort and with the cooperation of members of the community, the students were able to produce a finished project that reflected the Waycobah First Nation in a positive light. It portrays their community as a dynamic collectivity with a culture having much to offer the global community.
- Increased self-confidence: In addition to developing a greater sense of cultural identity and pride, the project provided the students with a greater sense of self-confidence in their overall ability.
- Motivation: The positive outcome of the project filled the students with the desire to undertake other similar projects.

Challenges

Pedagogical Challenges

- Dealing with little previous knowledge of ICTs: The students needed extensive technical support during their first steps with the computer until they improved their skills.
- Managing the students' expectations around limited technological resources: The teacher had to schedule the allotted time rigorously and find ways to maintain students' motivation.
- Organizing the classroom: As a team endeavor, it was important to ensure that each student was actively participating in the learning process and contributing equally to the final product.

Organizational Challenges

- Meeting the deadlines for the GrassRoots Communities@Ca contest.
- Working with only one networked computer for the whole group.
- Dealing with a connection problem and computer crash one week before the deadline.

Support

Technical Support

- The teachers planned the project with the help of the Mi'kmaq Kina'matnewey Technical Support people, now known as the Atlantic Canada First Nation Help Desk (www.firstnationhelp.com). In addition to providing the school with the space to house the site and with useful technical advice, this organization held a one-day training session in the school for the teachers and students.

Administrative and Social Support

- The Principal of the school approved the project and encouraged the teacher to make her innovative and challenging idea a reality. His open-mindedness and willingness to engage in an innovative approach to teaching contributed, in a way, to the success of the project.
- Families, seniors of the community and resource people were supportive of the students and the teacher.
- The school board provided funding for a scanner.

Impact

Impact on Teachers and Students

- Innovative pedagogy: The teachers were willing to implement a collaborative approach to teaching and to go beyond the boundaries of traditional pedagogical strategies. The teachers' role was to engage the students in a project that was meaningful to the students and respected the requirements of the curriculum. Their role was also to coordinate the students' work by providing activities and challenges that would stimulate their critical-thinking skills as well as motivate them to undertake their work seriously and assiduously. The teachers' ability to work together, efficiently coordinate the project and guide their students through the different stages of the project compensated for the limited technological resources and technical support available in the school.
- Strong student engagement: The project successfully stimulated and challenged the students as well as reinforced their motivation. For example, some students enjoyed spending time on the project so much that they dedicated time beyond regular classroom hours to work on the project and manage its different challenges.
- Student pride: Once the project was completed and the deadlines and challenges overcome, the students emerged with a sense of accomplishment and satisfaction regarding the skills they acquired and the effort they made. By gaining insight into their heritage, they came away with a deeper sense of pride toward their community, language and culture.

Impact on the School, Local Community and Community at Large

- Community involvement: One of the greatest successes of the project was bringing the whole community together by involving its members in a technologically linked learning activity, which contributed to enhancing awareness of the wealth of the Waycobah culture and community and of what it has to offer the global community.
- Resources for later initiatives: The school has developed project-based strategies and experience that can be passed on to other teachers and other classes. Since 90% of the teachers in Waycobah First Nation Secondary School use ICTs in a limited way (E-mail, searches, surfing), the teacher has designed a step-by-step procedural manual for other teachers to consult. In so doing, they benefit from her experience and expertise in the use of ICTs and feel more confident in their ability to use ICTs with collaborative learning.
- Cultural resources: The Web site is the first Internet resource to allow the global community to learn basic linguistic features of the Mi'kmaq language.
- Recognition: The Web site is a source of pride for the whole community. The project's visibility extended throughout all of Canada and even to other countries. Teachers and students from Australia contacted the school and congratulated the whole team for their Web page. Their feedback was very gratifying and gave the Waycobah teachers and students a positive attitude toward implementing another project in the future.

Analysis

The present study documents a case of a small, culturally homogeneous secondary school's first attempt at implementing a collaborative ICT-based project. Students develop technological skills while relating to and inquiring about their own community and understanding their roots at a deeper level. The study demonstrates how a school with limited technological resources and efficient project management can successfully

undertake such projects. Its interdisciplinary focus shows how a collaborative approach to teaching social studies and the use of ICTs can provide rich learning experiences for students as well as for the community, which, in turn, not only enhance their cultural pride but also encourage awareness and acceptance of cultural diversity on a global scale.

Research Acknowledgements

Interviews with Lisa Lunney, the teacher who coordinated and implemented this project, and John Hendsbee, the Principal of the Waycobah First Nation Secondary School, were conducted. This case study is based on a close analysis of the project Web site, in particular, the project report "Our Story" Web page.

CASE STUDY B:
La ConnectAction des générations (Québec)

Overview

The goal of the "Connect Action of the Generations" project was to bridge the gap between the youth and seniors of the community of Ste-Marguerite, Quebec. This project served to provide the children of Ste-Marguerite with an opportunity to gain a better understanding of their community, in terms of its history and traditions as well as the lifestyle of its members. The fruits of this collective project were then made available on the Internet. Twenty-eight grade 5 and 6 students attending L'étincelle Elementary School took part in this activity during the 1999-2000 academic year.

Background

General

Some students had already been involved in producing a short film on the subject of how the founding fathers had settled the area and established their town. Since the students were faced with a lack of adequate knowledge concerning the lifestyle of the village at the time of its founding, it was clear that the next step would be to implement the ConnectAction project in order to provide sufficient information that could be integrated into the film.

Technological Resources

The school had a computer laboratory containing 20 networked computers and was equipped with the technological resources needed to complete the project, such as a CD writer and a computer reserved exclusively for video sequencing.

Project Description

- Grade levels: 5 and 6.
- Number of schools involved: 1.
- Number of classes involved: 1.
- Number of participating students: 28.
- Name of the participating teacher: Johanne Morin.
- State of the project: On-line.
- Scope of the project: Local and international after its publication on the Internet.
- Language: French.
- ICT resources: Access to Internet and E-mail, html coding, scanner, digital camera, word processing software.
- Project Web site:
  http://generations-canconnect.ic.gc.ca/francais/sitesweb/index.asp?ProjectID=220

Learning Objectives

Curriculum-related Objectives

- To enable the students to learn more about the lifestyle of the community's founding fathers.
- To help the students acquire social and interpersonal skills through interviewing people and collaborating with their classmates.
- To help the students develop methodological and analytical skills that would be useful in collecting and adapting data for use in the short film's script.
- To help the students acquire better French writing skills.

ICT-related Objectives

- To allow the students to develop the skills necessary for word processing and E-mail.
- To help the students learn how to use a digital camera and scan images.
- To enable the students to develop html encoding skills.
- To enable the students to design and publish a Web site.

Teachers' Strategies

- Encouraging active participation of the students: The teacher directly involved students in the decision-making process and encouraged them to participate in the choice of project activities in order to reinforce their interest and active involvement. In so doing, she also enhanced their motivation.
- Creating a collaborative work environment: The students were encouraged to share their skills and work together in order to find creative solutions to the challenges they encountered throughout the process. The teacher defined herself as a guide and moderator in the classroom rather than a lecturer.
- Encouraging project-based learning: The teacher's approach was such that the chosen activities and assignments were all related to the project.
- Integrating different disciplines: The teacher favored an interdisciplinary approach to learning. The students learned skills or acquired knowledge in French, history, and information and communications technology.
- Remaining open to error: The teacher allowed herself to make mistakes in order to learn from them and improve her management strategies.

Project Activities

Planning

- Recruiting seniors willing to cooperate with students and their teacher.
- Planning and organizing face-to-face and virtual interactions with the seniors.
- Organizing workgroups and distributing tasks among the students.

Implementation in the Classroom

- Conducting interviews: The students interviewed seniors who were familiar with the history and lifestyle of the founding fathers of the village.
- Writing and proofreading tasks: The students wrote interview reports as well as profiles of the seniors based upon the interviews and other information collected. Their peers proofread the reports and other material to be included on the site. The teacher proofread

the students' writing to correct errors in French usage and style.
- Creating the Web site: The students were responsible for designing the Web pages and uploading and publishing the Web site. The students also scanned and edited photos of the seniors and other illustrative images that were to be used.

Evaluation

The teacher evaluated the students based on the following criteria:
- the quality of their texts;
- their participation in the project;
- their ability to participate actively during teamwork activities; and
- their ability to use the computer and its applications.

Since peer feedback is an important element in the collaborative classroom, it is worth noting that the students were included in the evaluation process.

Learning Outcomes

Curriculum-related Skills
- Meeting the objectives of the curriculum: The students were able to acquire knowledge and skills in different disciplines, particularly French writing skills, history and information and communications technology.
- Developing and reinforcing methodological and critical-thinking skills: The students were able to improve their skills related to data collection (consulting book and Internet sources and conducting interviews) as well as data analysis (extracting relevant information). They were also able to judge the quality of their own work.
- Transferring knowledge: The students were able to apply their new skills and acquired knowledge to different contexts.

ICT Skills

The students acquired the following ICT skills:
- using word processing software;
- scanning and editing images;
- designing, building, uploading and publishing web pages; and
- sending and receiving e-mail messages.

Collaborative Skills
- Gaining interpersonal skills: Due to the cooperative nature of the learning environment, the students learned to work together toward achieving common goals throughout the entire process. While engaging in peer feedback activities, the students were able to develop their ability to tactfully provide constructive criticism regarding the work of other students.
- Gaining autonomy: Since the teacher adopted the role of guide, the students learned to work independently, i.e., to depend less on the teacher and more on themselves and their peers in problem-solving situations.
- Learning personal accountability: The students improved their ability to act responsibly throughout the project, e.g., organizing their duties, effectively managing their time in order to respect deadlines, fulfilling the demands of the task.

Challenges

Pedagogical Challenges

- Having little previous knowledge of ICTs: In general, the students had to go beyond the boundaries of their usual efforts to master the different tools.
- Dealing with parental concerns: Initially, there was some hesitation toward the project on the part of the students' parents. Some were not very comfortable with the idea of allowing their children to have total access to the Internet. To solve this problem, the teacher selected relevant sites that the students could visit for data collection.

Organizational Challenges

- Overall, no major obstacles were encountered. The project was well structured as the teacher was able to rely on and follow the procedure and recommendations offered by SchoolNet. The teacher who initiated the project was able to implement it smoothly and integrate it into the curriculum. The short film was no trouble either. Collaboration with other teachers in the school, however, remained a challenge.

Support

Technical Support

- The students and teacher were fortunate to have regular and attentive technical assistance from a laboratory volunteer. His presence alone gave the students the extra boost to undertake their computer tasks with confidence.

Administrative and Social Support

- Given that the seniors were highly cooperative and open enough to share their knowledge with the students, the project was even more pleasing and motivating to the students.

Impact

Impact on Teachers and Students

- The data collected and used to write the seniors' profiles were crucial to writing the script for the short film.
- Having sufficient technological resources and regular, assiduous technical support allowed the students and the teacher to engage in the project with confidence.
- The theme of this project, which strongly reflected the reality of the students' community, enhanced the students' motivation and engagement in it. It also helped the students develop a greater awareness of the outside world as well as a greater sense of belonging to their community's heritage.
- The project left the students with a sense of accomplishment and a sense of pride that encouraged them to engage in future projects and to develop a positive attitude toward accepting challenging activities in their future careers.

Impact on the School, Local Community and Community at large

- Through the students' contact with the seniors of the community, harmonious ties between the two groups were reinforced.
- By publishing their collective project on the Internet, the students were able to share their work with other children and provide their community with more visibility on an international level.

Analysis

The present study documented a case of implementing a collaborative ICT-based project at the primary school level in one class. It shows how the use of ICTs can be integrated into an already-existing cooperative approach to learning where the students gain a greater sense of collaboration while making progress as far as autonomy, meaning and responsibility are concerned. They showed engagement in their work and gained greater knowledge while developing technical and collaborative skills, and cultivating positive attitudes among themselves and toward new technologies.

Research Acknowledgements

The present case study was conducted on the basis of the documents presented to SchoolNet (project proposal and report, as well as the project Web site), in addition to interviews with the teacher, a volunteer member of the community and the Principal of L'étincelle Elementary School.

CASE STUDY C:
The Rideau Canal : Ottawa's Community Waterway (Ontario)

Overview

The Rideau Canal: Ottawa's Community Waterway project presents a virtual visit to the Rideau Canal, an important feature in the national capital of Canada whose vocation has changed since its construction. The project focuses on the history, geography and actual features of the canal. It was carried out during the 1999-2000 school year by 90 students in Grades 4 to 6 of the PGL program (Program for Gifted Learners) and their teacher at the St. Elizabeth School in Ottawa.

The students decided to deal with a particular feature of their area, the Rideau Canal, as an illustration of their community. Throughout the visit, Gatino, a virtual mascot created by the students, helped the virtual tourist discover the Rideau Canal. The Web site is the result of an entire year's work for the grade 6 program. The ultimate goal was for the students to produce a unique resource that would not be a reproduction of one already existing on the Web. The students decided, therefore, to build their site specifically for other children of their age who would like to know more about the Rideau Canal.

Background

General

Within the Program for Gifted Learners, students from different schools of the School Council met at St. Elizabeth School in order to collaborate on a special project. There were about 30 students per group (grades 4 to 6). In order to provide a certain degree of continuity for the teacher, the students committed to the Program for a 3 year period.

For the past 4 years, the teacher has been emphasizing the integration of information and communications technologies (ICTs) in such a way as to allow students to discover the power and innumerable resources of the Web. In addition, most of the resources and projects created previously have been enriched by the new students coming into the program.

From the outset, students were involved in planning and implementing the project. For the 1999-2000 project, students wanted to take their time and deal with a project directly related to their community since they focused on an international project the previous year.

Technological Resources

The school is equipped with a laboratory where students have access to 25 computers once every other week. There is also a computer, which is connected to the Internet and is equipped with the software necessary for implementing the project, inside the classroom. However, it is worth noting that the school purchased animation software and a digital camera in order to facilitate the students' work.

Project Description

- Grade levels: 6 (conducting research and building the Web site), 4 and 5 (evaluating the product).
- Number of schools involved: 1.
- Number of class groups involved: 3.

- Number of participating students: 30 (grade 6), 60 (grades 4 and 5).
- Participating teacher: 1.
- State of the project: 2000 to present.
- Source funding of SchoolNet: Individual activities of $300 each.
- Communities@ca: First Prize winner ($3000).
- Scope of the project: National.
- Language: English (translation into French is envisaged).
- ICT resources: Multimedia (creation of audio resources), Java Applets, Internet, E-mail, html, graphs, a digitizer, a digital camera.
- Project Web site address: www.occdsb.on.ca/~sel/rideau/index.htm

Learning Objectives

Curriculum-related Objectives
- To give the students the opportunity to learn about a particular element of their community while integrating as many objectives of the Ontario curriculum as possible.
- To give the students the opportunity to introduce their international peers to the community in which they live.
- To enable students to be knowledge creators, not mere knowledge consumers.
- To permit this special group (PGL) to work for other pupils.

ICT-related Objectives
- To integrate ICTs into their school interdisciplinary project.

Collaborative Skills Objectives
- To give the students the opportunity to work together throughout the planning and development processes in order to create an original resource intended for other children.

Teachers' Strategies

- Respecting tight planning: Involving the students in all stages helps motivate them and holds them accountable for their contributions to the project. The project planning was almost perfect. Once the main decisions were made, the project was easily brought under way.
- Respecting the 3 Ts: The 3 Ts, telecommunications, teamwork and transformation (change for the people involved in the process), constitute the teacher's golden rule. She considers that it is often transformation that frightens teachers because they, too, have to remain flexible and open to change during the process.
- Building on past efforts: Her experience from other projects helped her to involve and supervise the students in more effective ways throughout the project.
- Using the students as a resource: The teacher takes advantage of the students' own ability for she considers them to be the best teachers.
- Demanding excellence: The teacher maintains high standards and gradually increases her demands in order to keep the students motivated.
- Effectively managing ICT resources: ICTs are used by all the students involved in the project so that each student has the opportunity to develop different types of competence. Thus, even though tasks are divided up among the team members, all students are able to improve their technical skills in the laboratory. ICTs were effectively integrated into the

interdisciplinary project (geography, Canadian studies, history, French). Moreover, technology was used as a working tool throughout the project, and served to make the final product more attractive to visitors.
- Finding the necessary resources: Throughout the project, the teacher encouraged the students to take the necessary steps to get in touch with community members who were able to assist in making the project possible.

Project Activities

Planning
- Organizing with the students: In September and October, decisions were made concerning which project the students wished to undertake, planning the stages of the project and agreeing on a schedule.

Implementation in the Classroom
- Collecting data: Grade 4 and 5 students collected data, information and photos.
- Defining the Web page design: The headings to be included in the Web page were defined, and tasks divided among all the students of the group. Then, in teams, the principal features of the Web page (background, character, color, image layout) were defined. The students first agreed on the important fact that the page should have a simple form so that attention would be drawn to the content. Later on, the students made suggestions and agreed on a final choice to which they had to be seriously committed throughout the whole year!
- Conducting interviews: The students met with resource people from the community. The students had to undertake all of the steps related to the interviews (calling, meeting, asking for permission to use resources and photos).
- Constructing the site: The grade 6 students built the Web site based on the design specifications.

Evaluation
- The grade 4 and 5 students evaluated the finished project.
- The students reflected together with their teacher on the approach followed and the learning outcomes achieved.

Learning Outcomes

ICT Skills
- Developing technology skills (html coding, multimedia, Java applications, etc.) thanks to mutual assistance among students of the same group.

Collaborative Skills

The students developed the following:
- the ability to work in teams, collaborate and help one another;
- awareness of self-importance in fulfilling a collective project;
- constructive criticism skills toward other students' work; and
- awareness of environments other than their own when many students from several schools are involved in the same project.

Attitudes

The students have improved their attitudes in the following ways:

- A greater sense of self-satisfaction from knowing that their work has gained national recognition.
- Awareness with respect to criticism concerning reference sources, Internet plagiarism and the importance of creating a unique product.

Challenges

Pedagogical Challenges

- Collaborating: The most outstanding challenge was learning to work as a team because certain frustrations occur when the whole class must agree on important decisions. For instance, the choice of the Web page size was time-consuming as the students found it hard to reach a consensus on the colors and the background to be used.
- Teaching gifted children: Working with gifted learners is no easy task as they all have to continue developing their intellectual skills. Furthermore, they are less inclined to work in a team as they are accustomed to successful individual work.

Organizational Challenges

- Lacking adequate technological resources: The lack of computers was another challenge to contend with. Students had a single computer within their classroom and access to the laboratory for only 50 minutes every two weeks. Nevertheless, these difficulties led the students to prepare their work in advance and carefully manage their time in order to use the laboratory to its fullest potential.

Support

Technical Support

- The Internet was an easy backdrop for cooperative work. It enabled the students to discover certain useful resources and to work with technical resource people.
- The Coordinator did not rely on the technology instructors available within the School Counsel.

Administrative and Social Support

- The teachers worked together.
- The Coordinator, as guide, played an important role in the project.
- The Administration of the school supported the project.

Impact

Impact on Teachers and Students

- Successful management: The teacher in charge of the project played an important role in its success, in terms of coordinating the activities and integrating the use of ICTs into it. The planning stage of the project allowed the students to develop their time-management skills. Once the planning was settled between the students and the Coordinator, it was strictly respected by the whole team; this was instrumental to the success of the project.

- Collaboration: By being encouraged to approach their work in a cooperative manner, the students were able to develop their ability to work together while working toward a common goal.
- Interdisciplinary study: The variety of subject matter allowed the students to be involved in a more integrated project and to meet the objectives of the curriculum.
- Recognition: The prizes that the students were awarded increased their expectations as well as those of the other teachers in the school. This, in turn, placed pressure on the teacher to outperform in subsequent endeavors. In the long run, the students' expectations rose.
- Attitudes toward the Internet: The teacher introduced her students to the extraordinary possibilities of the Internet thus raising student awareness of and improving critical-thinking skills toward all facets of the Internet.

Impact on the School, Local Community and Community at Large

- Sound investment: The teacher would like to use the funds provided for training purposes, rather than investing in technological resources, for she feels that the participants should know how to use the school's existing resources before purchasing any new equipment.
- Positive role models: Given the project's success, the teacher's experience serves as an inspiration to others at the school and encourages greater involvement on their part as they become more confident in their ability to be included in her efforts. They have become aware of her expertise, which will ultimately bring about bigger projects to which they and their students may contribute. Thus, this project not only involves several schools, but also encourages many teachers to work with this teacher as a Coordinator in the future.

Analysis

The present study documented a case of implementing a long-term, collaborative, ICT-based project at the primary school level for gifted students. Its interdisciplinary focus shows how collaborative projects and the use of ICTs can be adapted simultaneously to different subject matter to provide an enriching and challenging learning environment. Students were given some control, and expressed themselves as they had the opportunity to inquire about the Rideau Canal. They developed multimedia production skills as well as lifelong-learning and innovative skills. The study also demonstrates how successful long-term implementation of GrassRoots projects contributes to maintaining high standards of excellence in such ways that students gain knowledge and valuable skills and teachers develop favorable attitudes toward implementing collaborative- and project-based pedagogy.

Research Acknowledgements

A 5 hour interview with Dalia Naujokaitis, Project Coordinator, was conducted. An analysis was made of the project proposal presented to SchoolNet as well as the report published on the Web site. An analysis of the "2000 Communities@ca" First Prize-winning Web site itself was also carried out.

CASE STUDY D:
Lower Coverdale Community Web Site (New Brunswick)

Overview

The Lower Coverdale community Web site project was implemented as a schoolwide initiative during the 1999-2000 school year at Lower Coverdale Elementary School in Lower Coverdale, New Brunswick, as part of the "Communities@ca." contest. Nearly 100 students, four teachers, the school's principal, and volunteers from the Lower Coverdale Access Center contributed to its completion.

Students from Kindergarten to grade 6 worked together to present Lower Coverdale as a lively community. Student groups focused on different themes such as the community's geography and history. To do this, the students engaged in collecting data from the Internet and book sources as well as conducting fieldwork (interviews). Moreover, several students contributed their own creations ranging from texts and graphics to interactive quizzes and a directory of Web links, for publication on the Web site.

Background

General

Lower Coverdale Elementary School is located within a community of 2500 inhabitants and has approximately 100 students and four teachers. Due to the small scale of the school and community, the entire school was able to work together on the project and easily recruit many members of the community to help the students learn more about their region.

Technological Resources

The school is equipped with a laboratory of 20 networked computers, one digital camera and a color printer. There is also one computer, and sometimes two, in each classroom; in some cases, the computer is not networked. When not operating as a school, the laboratory becomes an Access Center for the community.

Project Description

- Grade level: K-6.
- Number of schools involved: 1.
- Number of classes involved: One kindergarten class, one first and second grade class, one third and fourth grade class, and one fifth and sixth grade class.
- Number of participants: 100.
- Number of participating teachers: 4.
- Establishment of the project: 2000 to present.
- Financing from GrassRoots: GrassRoots communities@ca, winner for the year 2000.
- Scope of the project: Provincial (national and even international, when Web sites are visited by people from other provinces or countries).
- Language: English.
- ICT resources: Internet, E-mail, html coding, a digital camera, Hot Potatoes (the on-line questionnaire version), word processing software.
- Project's Web site address: http://cap.unb.ca/nb/lowercoverdale/

Learning Objectives

Curriculum-related Objectives

- To help the students meet curricular objectives in English, geography, social studies and technology by working on a project that is meaningful to them.
- To allow the students to discover different aspects of their community.
- To enable the students to develop methodology and critical thinking skills.

ICT-related Objectives

To allow students to gain a better knowledge of ICTs and to develop technical skills such as the following:

- conducting Internet research;
- using word processing software;
- scanning pictures; and
- sending and receiving E-mail.

Teachers' Strategies

- Implementing an interesting and meaningful project: The teacher chooses a theme about which the students are knowledgeable and that reflects their interests as it applies directly to the community.
- Stimulating the students to use a vast inventory of resources: The students were encouraged to exploit all available resources within the school and beyond. The students acquired their information through books, the Internet and interviews with members of the community.
- Involving students in important decision-making processes: The students were fully responsible for the content and presentation of the Web site (color, background, etc.).
- Choosing appropriate activities: Each teacher targeted learning tasks that met curriculum-related objectives of each grade level. They were determined in conjunction with the objectives of the English, geography and social studies programs.

Project Activities

Planning

- Recruiting collaboration: The Coordinator initiated the project. With the support of the School Principal, she presented the project proposal to the three teachers whose subject matter was relevant. They readily agreed to participate in the project.
- Planning the objectives: The four participating teachers held meetings to determine the objectives of the curriculum.
- Determining the learning tasks: The teachers then determined the types of tasks that would be central to carrying out the project. Project responsibilities were then assigned according to the abilities of each level in such a way that the use of ICTs in the classroom and involvement in the project became progressively more active and creative from one grade to the next.

Implementation in the Classroom

- Presenting the project: The students were eager to participate in the project. They were especially attracted to the idea of having an opportunity to publish their work on a Web site and participate in a nationwide contest (Communities@ca).

- Creating student groups: Students formed work teams. They were then assigned different tasks.
- Conducting research and collecting data: The students engaged in different research activities such as consulting books and databases as well as using search engines on the Internet in order to find useful materials such as texts, maps of the area and models of on-line interactive games and quizzes. The students also communicated and conducted recorded interviews with members of the community (resource people, laboratory volunteers, seniors) through E-mail, the telephone or in person.
- Processing data: Students proceeded to engage in various activities such as producing texts, elaborating a list of useful Internet links, making illustrations and creating questionnaires. Most of the responsibility for organizing and creating the Web site fell upon the higher grades.

The following is a description of how the contributions of each grade level were accomplished by the students:

- Kindergarten and Grades 1 and 2: Each student made a drawing accompanied by a sentence explaining why Lower Coverdale is a special place. Volunteers from the Access Center then scanned the pictures that were to be placed on the Web site.
- Grades 3 and 4: Using a word processor, the students composed texts about their impressions of Lower Coverdale. Another activity consisted of evaluating different Web sites and choosing the ones to include on the Web page.
- Grades 5 and 6: These students contributed the most to the content of the site. They wrote reports based upon the interviews and integrated sound files of the interviews onto the site. They also developed interactive games and quizzes.

Evaluation

- Work evaluations took place in class and were based on each student's ability to meet the objectives of the curriculum through the various tasks. The grade 2 and 3 teachers focused on evaluating writing and artwork, whereas grade 4 and 5 students were evaluated on their listening and oral expression skills.

Learning Outcomes

Curriculum-related Skills

- The students not only met the requirements but also exceeded the objectives related to the curriculum (English, geography, social studies and art) if one considers the attitudes and the skills that were developed. The students made gains in their methodology skills, such as conducting research, analyzing data and learning to respect copyrights.
- The students increased their knowledge of the history of their community as well as its people. The interviews with seniors proved to be particularly enriching for the students because they proved to be a great source of interesting anecdotes.

ICT Skills

- The students developed ICT skills related to Web design.
- The students achieved a greater awareness of the repercussions of their on-line presentation. This was emphasized on two occasions: when one of the students moved to Australia and was able to use the site as a means of showing her classmates where she came from and when students from Alberta sent messages praising their work.

Collaborative Skills

- The students developed different attitudes and social skills through the collaborative work done with their peers and with the adults. For example, they learned the value of mutual respect when offering and receiving constructive criticism or compromising. They also learned the importance of each person's individual contribution to successfully completing a project.

Attitudes

- By realizing the extent to which they could learn from their seniors, the students developed respect and interest toward them. This improved relations between the two groups.
- The students were satisfied with their joint and individual contributions to the project and were proud of winning the GrassRoots "Communities@ca" contest.

Challenges

Pedagogical Challenges

- Distributing the workload: Since the tasks of each level were to be complementary to the tasks of other levels, the teachers had to target activities that were appropriate to the students' abilities and the established curriculum for each level, and at the same time respected the demands of the contest.
- Adapting to new demands: The volunteers had to adapt to working with groups of children of different ages. The experience was nevertheless very rewarding for them.

Organizational Challenges

- Meeting the requirements of the workload: A great deal of the work had to be accomplished after school hours, which required tremendous flexibility and collaboration on the part of the volunteers, parents and students.
- Coordinating the design and structure of the Web page: In order to present an orderly, uniform and aesthetically pleasing Web site, the students worked hard to harmonize the diverse mass of work generated from the different levels.
- Certain students had recorded their interviews in order to integrate sound clips, but were unable to do so.

Support

Technical Support

- Because the Project Coordinator played an important role in organizing the project as well as in providing ICT support and organizing the Web contributions, the teachers were able to devote themselves to creating activities that were directly related to the school program.
- Many volunteers helped the students with various tasks, such as using ICTs, correcting their texts or guiding them to useful information.

Administrative and Social Support

- The School Principal wholly supported the initiative.
- Members of the community's Access Center and parents were willing to let the students work at the school outside of regular class time.

Impact

Impact on Teachers and Students

- Ability to meet the demands of the curriculum: From an academic standpoint, the Lower Coverdale community Web site was a success in that the project allowed students to attain many important curricular objectives as well as to familiarize themselves with and use ICTs as a learning tool in a variety of ways according to their abilities.
- Increased student engagement: Among the greatest achievements of this project was the level of motivation and involvement on the part of the students. Since classroom time was spent mostly on work relating to the curriculum, after school time was spent on work relating to ICTs. Thus many of the students worked after school and after Access Center hours, including evenings and weekends.
- Strong leadership: The Coordinator's ability to master the technological tools and to take charge of the project played an important role in involving and supporting the other teachers involved in this project.

Impact on the School, Local Community and Community at Large

- Strong involvement and enriched community awareness: The Lower Coverdale community Web site distinguishes itself by the substantial participation on the part of several members from the community (1 200 people from school and Access Center personnel and volunteers, seniors, salespeople, parents, etc.). Their commitment to the project gave meaning to the students for they were able to discover many aspects about their surroundings, that would not have been possible otherwise. This, in turn, stimulated their motivation and involvement at the different stages of its production.
- Greater community visibility: The resource that was created is intended not only for the students of Lower Coverdale but also for the local and global community as well.

Analysis

The present study documented a case of implementing a schoolwide, ICT-based project at the primary school level in a small community. Students had a relevant and positive experience with ICTs. They communicated with members of their community and met curricular objectives at greater length. The study details how collaborative projects and the use of ICTs can be coordinated in such a way that the contributions are complementary between levels and provide a stimulating and challenging learning environment for students in all grades. The study also demonstrates how implementing a GrassRoots project in a small community generates large-scale support for student learning and encourages stronger community ties.

Research Acknowledgements

This case study was carried out with the help of documents presented to SchoolNet's GrassRoots Program (the project proposal as well as the Web site of the project). To this was added an interview with Mrs. Sandra Perkison, the Project Coordinator.

CASE STUDY E:
Statistics Canada (Profiling Canada)
The Impact of Immigration on Vancouver(British Columbia) with a Special Focus on Vancouver's East Side

Overview

The Impact of immigration on Vancouver (British Columbia) with a Special Focus on Vancouver's East Side project was carried out in eight class groups in Vancouver Technical Secondary School and in one class group in Templeton Secondary School, both based in a Vancouver district known for its multicultural character. Five teachers and over 225 students took part in this project from January to May 2000. The students wanted to study the different aspects that have an impact on immigration in Vancouver. Thus each of the participating groups worked on complementary themes. To do so, they had to collect data from diverse sources, namely books, the Internet and the databases of Statistics Canada. In addition, the students went out into the field to collect data by interviewing community members and taking relevant pictures. The final product was then published on the Internet.

Background

General

The idea was first initiated by the Project Coordinator's will to launch a project that would be motivating for students as well as being tied to and meeting the school curriculum requirements of each group. Because the students come from diverse cultural backgrounds, the possibility of studying the impact of immigration seemed to be an appealing theme. The opportunity to discover their own origins and their way of life appeared fitting, all the more since Vancouver Technical and Templeton secondary schools are both located in a cosmopolitan district of Vancouver. In such a context, applying information and communications technologies (ICTs) seemed to be the natural choice as a tool that would prove to be useful for collecting, sharing and processing information.

Technological Resources

Each school had at least one laboratory equipped with computers, a network connection, digitizers, and a digital camera. In Vancouver Technical Secondary School, several classrooms are also equipped with two or three network-connected computers. Roughly speaking, the necessary technological resources were readily available.

Project Description

- Number of schools involved: 2.
- Number of class groups involved: 9.
- Number of participating students: 225.
- Grade levels: 10, 11 and 12.
- Number of participating teachers: 5.
- State of the project: Since 2000.
- Source funding of SchoolNet: Collective project with a fixed fund of $5500.

- Range of the project: Provincial (international when taking into account the indirect impact of the project).
- Language: English.
- ICT resources: Internet, E-mail, html coding, a digital camera, a digitizer, graphs, word processing software.
- Project Web site address: http://vantech.vsb.bc.ca/project

Learning Objectives

Curriculum-related Objectives
- To allow the students to discover the impact of immigration on Vancouver in the 20th century and, in particular, on Vancouver's East Side.
- To allow the students to understand their individual as well as collective origins.
- To help the students achieve their school curricular objectives (geography, human sciences, technologies) through a project that is meaningful to them.
- To help the students understand how the immigrants' experiences and contributions are closely tied to the shaping of Canada.

ICT-related Objectives
- To integrate ICTs as a learning tool within a curriculum-related project.

Teachers' Strategies

- Organizing and planning the project structure: To establish a strong structure for the project, the coordinator and his colleagues specified the objectives, schedule, and organization and design of the site. Based on this solid structure, the students could thereafter assume responsibility for the project, i.e. take part in decisions concerning the elaboration and presentation of the content.
- Implementing a cooperative work structure: Each of the groups involved was responsible for creating a different part of the project, which would meet the requirements of their school level and curriculum. The work was distributed in such a manner that within each group there were different teams whose tasks were complementary as a whole. Since the students worked together, the teacher played the role of guide and facilitator.
- Developing a team of experts: According to their skills, the students contributed to the project's implementation, which allowed the whole group to achieve a more elaborate collective product.
- Creating inter-related activities: Other activities undertaken inside or outside the classroom were closely tied to project-related activities. For example, educational outings became an opportunity to collect field data.

Project Activities

Planning

The planning stage of the project proved to be the most lengthy, lasting 2 months. It is worth noting that the students were not directly involved at this stage.
- Proposing the project: The project coordinator presented the proposal to the school administration and to the five teachers who were to be involved in the project.
- Coordinating the resources: Meetings were held with the Project Coordinator and the five

participating teachers. During these meetings, the teachers defined the way each of them would contribute to the project in a way that would respect its theme and to relate it to their respective subjects.

- Elaborating the major objectives of the project: According to the discipline and content taught, each participating teacher proceeded to elaborate the major objectives and choose those related to the curriculum. The objectives targeted were those relevant to the programs of history, human sciences, geography, multicultural education, computing technologies and English. In order to link the objectives of each discipline and school level, the teachers chose subtopics that were all complementary to each other as well as relevant to the main theme.

Implementation in the Classroom

- Presenting the project to the students: Once the project structure and objectives were clearly determined by the Coordinator and the participating teachers, the project was presented to the students.
- Conducting book and Internet research and collecting data: This stage was certainly the most complex, and the students were tremendously involved in it. Grouped into teams, the students went out to interview community members and collect data, such as photographs of institutions set up by the communities they were studying.
- Quantifying and analyzing the collected data: This involved using graphs to assemble the data and extracting the relevant information.
- Participating in the different research, discussion, Web page creation and design teams either in school or at home.

Evaluation

- The students' work was evaluated in relation to the curricular objectives (history, geography, etc.) that were targeted in the project. There were evaluations of each team's written work as well as oral presentations showcasing their contribution to the final project. The objectives related to the ICTs were not evaluated in a summative way.

Learning Outcomes

Curriculum-related Skills

- Fulfilling the objectives of the curriculum: The project allowed the students to achieve several important objectives of the school curriculum, particularly in geography and human sciences.
- Acquiring methodology and critical-thinking skills: The project helped the students master skills related to time management, data collection (book and Internet research, and field data through interviews) and data analysis (distinguishing pertinent from less pertinent information, interpreting graphs, etc.).
- Acquiring greater understanding and awareness: The students were able to gain a better understanding of the evolutionary processes of human institutions, their own and their classmates' origins, and the contribution of cultural diversity to the wealth of their community.

ICT Skills

The students acquired the following ICT skills:

- designing and building Web pages;
- digitizing images;
- using a digital photo camera;
- retrieving information from on-line databases;
- creating tables and graphs by means of spreadsheet software;
- using word processing software;and
- sending and receiving E-mail messages.

Challenges

Pedagogical Challenges

- Dealing with variable degrees of computer skills: At the outset of the project, not all teachers and students were at ease with the different ICT-based tasks. Adopting a cooperative approach to the project, as well as being able to rely on the expert groups helped compensate for that difficulty.
- Encouraging equal participation: As the students worked in teams, it was difficult making sure that each member contributed to the project.

Organizational Challenges

- Managing the time factor: The teachers had to deal with busy schedules and heavy time constraints for project meetings.
- Coordinating the groups and subgroups: Complications arose due to the sheer size of the project. Some problems involved taking diverse contributions from the subgroups and subprojects and making them uniform in order to present a harmonious and aesthetically pleasing final product on the Web site.

Support

Technical Support

- No particular support was provided for the project, except suggestions on how to integrate ICTs into the different subjects in a pertinent and meaningful way.
- The students had access to E-Stat (Statistics Canada).

Administrative and Social Support

- The teachers were able to cooperate effectively among themselves and support one another throughout the entire process.
- Mr. Mueller played an important role as the Coordinator of productions and presentations.

Impact

Impact on Teachers and Students

- Successful respect of the curriculum: The choice of carrying out a project centered more around subject objectives than on technology alone encouraged the teachers to devote more time to the project, especially since it revolved around the subject matter that was to be taught in the first place. The choice of the structure and theme of the project by the

participating teachers themselves gave more sense to the use of technology and, therefore allowed the students to use ICTs more effectively. Given the rigorous structure of the project, the teachers were able to work independently and needed little support from Mr. Mueller as Project Coordinator, for he adopted the role of teacher as well.

- Project theme: The choice of topic was very close to the students' interests. By discovering the origins of a culturally diverse community—to which many of them belong—the students perceived the project as a genuine and meaningful endeavor. This, in turn, substantially raised their interest and motivation, thus maximizing their personal involvement and efforts in the project.
- Effective cooperation: The collaborative framework that Mr. Mueller adopted, i.e., the use of expert teams, allowed for more student involvement since the students could make their particular skills beneficial to the other participants as a whole (e.g., Web page team). As a result, the need for external ICT support decreased, as the students with expertise in that area were able to take on part of the responsibility for ICT tasks when the skills of other students were lacking.
- Successful integration of ICTs: Given that the students had few computers, they used ICTs in a variety of ways in accordance with their level of skill. Considering that this project was strongly centered around subject matter objectives, the ICTs were presented more as a research and data-handling tool than as an end in themselves. Also, it turns out that students' computer use in the classroom to communicate, conduct research and handle information was carried out in more regular and natural ways in comparison to their laboratory use.

Impact on the School, Local Community and Community at Large

- Improved community ties: Students from two different schools and community members successfully collaborated in this joint effort. The project strengthened the relations among them by creating more open-mindedness toward cultural diversity within their community.
- Greater visibility: External recognition (namely by SchoolNet) led to visits from outsiders.

Analysis

The present study has documented a case of implementing a collaborative ICT-based project at the secondary school level in two different schools. Its interdisciplinary focus shows how collaborative projects and the use of ICTs can be adapted simultaneously to different subject matters in joint school efforts. Students engaged in inquiry at a deep level, and learned technological skills and gained community and multicultural awareness.The study also demonstrates how structured planning and clearly defined responsibilities on the part of the teachers lead to successful project management, foster learner engagement, and facilitate the process of gaining greater knowledge, developing technical and interpersonal skills and cultivating positive attitudes among the students involved.

Research Acknowledgements

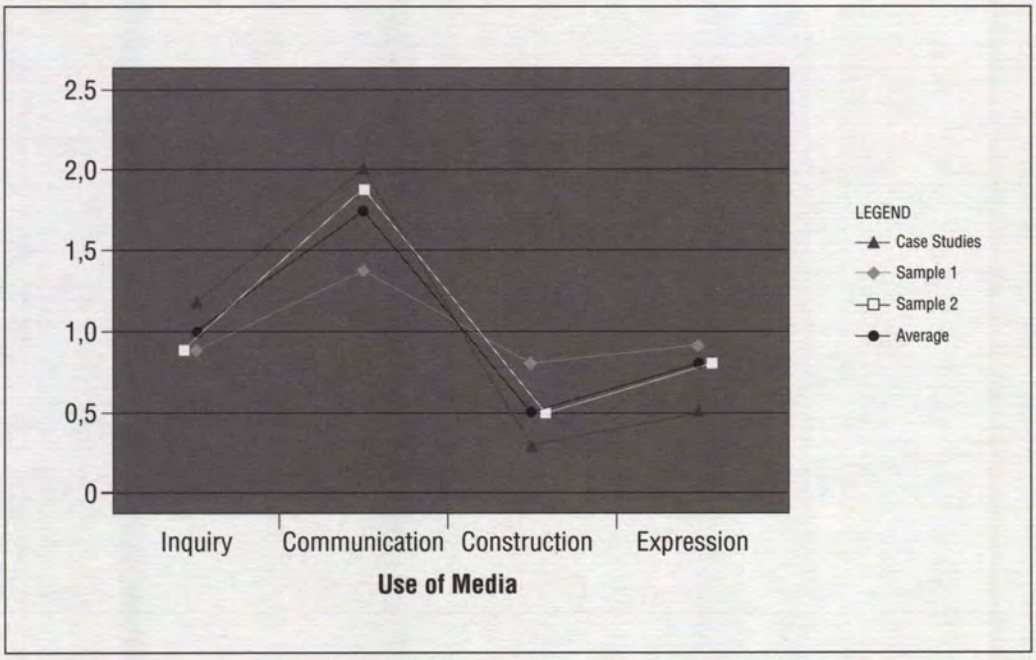
The present case study was conducted on the basis of the documents (the project proposal, report and Web site) presented to SchoolNet as part of the initial GrassRoots Program and an interview of approximately 90 minutes with the Project Coordinator, Mr. Peter Mueller.

Appendix B
Table and Figure

Table 2—Percentages of specific operations conducted within each of the four basic learners' interests

Network-enabled Communication	Theory building 12%	Data access 38%	Data collection 27%	Data analysis 23%
Network-enables Inquiry	Use of media to prepare documents 30%	Use of media to directly communicate with others 58%	Use of advanced medial For online collaboration 5%	Use of media as teaching aides 7%
Network-enabled Construction	Use of media to affect the physical world (control systems) 13%	Use of media to understand communities 74%	Use of media to understand a topic or a problem 13%	
Network-enabled Expression	Individual products 48%	Group products 28%	Classroom products 24%	

Figure 2—Comparison of three sets of data: case studies and randomly selected projects (two samples)



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