The Telesat/SchoolNet Multimedia Satellite Trials Project: An action-research evaluation

Final Report

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EXECUTIVE SUMMARY

The goal of the Multimedia Satellite Trials Project (MSTP) was to establish a broadband enabled learning environment to support teacher professional development and student collaborative learning in remote locations in Newfoundland, Ontario and Quebec. From 2001-2003, trials were conducted in twelve schools in these provinces. Telesat, SchoolNet, the Communications Research Centre (CRC), and provincial organizations and ministries combined their resources to provide remote schools with better connectivity using satellite delivery of broadband and to assess results at both technical and pedagogical levels. Teachers, school principals, school district and university personnel helped shed light on ways to better serve remote Canadian schools.

In its evaluation of the MSTP the Canadian Education Association took into consideration the interests and preoccupations of the partners while keeping the focus on the pedagogical and organizational aspects of the use of satellite technology. Quantitative and qualitative data were gathered and analyzed.

This report helps develop a better understanding of the possibilities of broadband for remote elementary and secondary schools. Individual school portraits, provincial case studies, and a final report were produced. The data collected in the evaluation point to the fact that satellite connectivity provided the participating schools with the technical capability to search the Internet, conduct video-conferencing, and download video files. These schools carried out activities at the local, provincial, national and international levels that tested the relevance and feasibility of making use of these technical capabilities. Individual and collaborative projects were emphasized.

The findings reveal the broader technical, pedagogical, and organizational contexts for the use of satellite technology:

Technology

- **More than 80 % of the use of the satellite connectivity provided during the project involved the use of the Web (HTTP protocol).** Learning activities integrated web browsers more than videoconferencing and video download. Thus it is normal that schools that also had a fast land Internet link preferred use of this type of link because it proves to be more efficient. It must be noted that the satellite link is the least powerful with this type of application.

- **The Internet satellite link is not intended to compete with a fast land-line; instead, it is intended to offer this service where a land-line is not available.** The use statistics do confirm that satellite access meets a real need for remote schools that cannot get a land-line. Schools in the project that are located in isolated areas made greater use of the satellite link than did schools in less isolated areas.
- **The satellite link tested in this project was the connectivity mode most adapted for broadband videoconferencing between schools.** At present, in regard to broadband videoconferencing in public IP mode, the best solution is that all schools be connected with fibre optic cable on a shared Ca*NET type private network. Universities use Ca*NET. However, for schools, although a satellite link is not able to compete with a fast land-line for Internet navigation, the same cannot be said for videoconferencing. In the case of the latter, a fast land-line cannot compete with a satellite link for videoconferencing in IP mode, except on a private network, due to network traffic congestion.
- **Where teachers used videoconferencing, there was relatively little impact on the total consumption of bandwidth even though this application consumes considerable amounts of bandwidth.** This lack of impact is due to the characteristics of integration of use in teaching and learning. Unlike integration of web browsing, videoconferencing could not be integrated as often and as easily into classroom activities. To hold a videoconference, the activity must be planned with another group. The two groups must carry out the activity at the same time. It is significantly more difficult to organize synchronous than asynchronous activities. There is little need for concern related to bandwidth even in cases where collaborative exchanges with videoconferencing are encouraged.
- **Some pilot schools had a higher level of readiness than others for undertaking the trials.** They all needed technical support, but some schools were more ready than others for pedagogical support, including online advanced professional development. Telesat and CRC provided basic technical support. Moreover, there was funding from provincial sources (Newfoundland and Quebec) or resources from school districts (in Ontario and elsewhere) to assist with basic technology training in the use of the satellite-based system (Internet access, videoconferencing, video download).

Pedagogy

- **Leading partners and school principals relied on volunteer teacher(s).** They received basic training in the use of the satellite-based system, and offered either onsite or online pedagogical support to one another. The project was instrumental in providing both a context and support that encouraged teachers to apply learner-centred and collaborative approaches. SchoolNet provided support through the NIS and Grass Roots programs. There were unfulfilled expectations, but few comments regarding the inadequacy of some activities. For instance, in spite of the absence of Web page filters, there was an absence of pornographic sites and other undesirable types of the same kind in the list of the sites most visited by the participating schools. The teachers in the trials carried out excellent monitoring.

- **The project brought high-speed communications to remote schools in a way that met their expectations.** Schools capacity to network was enhanced: students had opportunities to know other students, and teachers to plan, coordinate and conduct learning activities. That collaboration most often took the form of working together to generate ideas for using the connection with their classes, to plan and coordinate activities such as videoconferences, and to find solutions to technical problems they were experiencing. The potential for such collaboration was easier to see at the district or provincial level.

Management

- **The vision of the network-enabled remote school remains unachieved.** System-wide administrative support for teachers to engage in innovative teaching is critical, but unlikely until better student learning is demonstrated. Better distribution of technology knowledge among the staff, ICT integration to the curriculum, and time management were issues.

RECOMMENDATIONS

1. **The availability of a satellite link for remote rural schools is of primary importance for achieving equality of opportunity in the 21st Century. The needs of the most remote rural schools in this regard have to be voiced, recognized, and acted upon.**

2. **The window of opportunity for collaborative teaching and learning supported by broadband must be seized first at the classroom, school, and school district levels before higher-level linkages are attempted.**

3. **Broadband-activity implementation plans must include provisions for teacher time reallocation as well as connectivity fees.**

4. **Ways of fostering creative relationships between informal and formal learning are needed including recognition of teacher participation in one another's learning.**

5. **For better value-added outcomes similar trials should be extended so as to run for three years. Teacher comfort and commitment levels need time to develop as does the development of an effectively collaborating teacher community.**

6. **The potential of satellite connectivity for enhancing education needs to be explored more systematically and over a longer time frame to confirm these initial findings. Further study is recommended.**

7. **Future plans should include the identification of a school district and/or provincial coordinator who would help 1) make the connections between remote schools for “high-interactivity / low-visibility” learning activities and projects, and 2) plan high-visibility learning projects in which remote schools will participate alongside other schools.**

INTRODUCTION

The goal of the Multimedia Satellite Trials Project (MSTP) was to establish a broadband enabled learning environment to support teacher professional development and student collaborative learning in remote locations in Newfoundland, Ontario and Quebec. From 2001-2003, trials were conducted in twelve schools in these provinces. Telesat, SchoolNet, the Communications Research Centre (CRC), and provincial organizations and ministries combined their resources to provide remote schools with better connectivity and to assess results at both technical and pedagogical levels. Teachers, school principals, school district and university personnel helped shed light on ways to better serve remote Canadian schools.

The project's technical goal was to test broadband access on Anik E2 using multimedia equipment as a means of preparing for the upcoming availability of the new Anik F2 satellite. Telesat's plan was to offer broadband access to provide schools with the technical capability to 1) conduct video-conferencing, 2) download, produce and distribute video files.

The project's pedagogical goal was to test the relevance and feasibility of the following objectives:

- To make use of new digital media (video, telecollaboration tools);
- To engage in collaborative projects;
- To provide opportunities for teachers to become familiar with the material provided by Telesat and partners, including access to digital video databases;
- To develop new research tools using digital video data;
- To encourage schools to produce video-supported educational resources.

The Canadian Education Association undertook an action-research evaluation of the MSTP. The purpose of this evaluation was to gather data that will help develop a better understanding of the possibilities of broadband for remote elementary and secondary schools. As action research, the purpose was also to provide feedback to leading partners and schools. This approach was conceptualized as an iterative process, and as one sensitive to the social and cultural environment of the participants. To this end, individual school portraits, provincial case studies, and a final report were to be produced.

This report presents the technical and pedagogical findings of the action-research evaluation of the MSTP. In addition to the findings, the report outlines the broader technical and pedagogical contexts for the use of satellite technology. Finally, some organizational and structural challenges are outlined and conclusions and lessons learned are noted and recommendations made.

CHAPTER 1

BACKGROUND

The MSTP project was conceived jointly by Telesat and Industry Canada through SchoolNet. Education partners and the Communications Research Centre (CRC) represented the other key partners[1]. These leading partners put forth a vision of the network-enabled remote school. This chapter first outlines this vision and follows with a description of the partners along with their interests, preoccupations, and expectations.

THE VISION

At the outset of the Project, the leading partners wrote:

> *Our thirteen participating schools are excited by the empowerment that broadband connectivity will bring to this project. The schools envision how this new high-speed broadband capability will intensify and further personalize the individual learning experiences of their students.*
>
> *For example, the enriched teleconferencing capability will facilitate increased inter-school interactivity among teachers and students. Heightened interactivity will mean increased impact on learning.*
>
> *Being interlinked into a virtual knowledge community for an entire school year will make possible kinds of learning which earlier static technologies, such as chalkboard and textbooks, could barely hint about, or even more modern technologies, such as e-mail and Web pages, could only point toward.*

The leading partners wanted to create a network of remote schools. Implicitly embedded in this vision of the network-enabled remote school were high expectations in terms of curriculum integration of information and communication technologies (ICTs) for pilot schools.

PARTNERS IN THE VISION

The partners' focus was to learn about the technical or institutional barriers that would have to be removed in order to make easier use of the technology in this context. Each partner brought its specific organizational interests, and own contributions to the planning and implementation of this project. The partners were as follows:

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1 More information on partners of the trials is available at http://www.telesat.ca/schooltrials/English/participants/gov_corp.html .

Telesat

Telesat was the broadband provider for the pilot schools. Its focus for the trial was on providing fast and reliable connectivity access. Telesat's future goal is to use Anik F2 to provide broadband access[2] that will compete with DSL and cable modem anywhere in Canada. With the Multimedia Satellite Trials Project (MSTP), Telesat wanted to know about the usefulness, ease of use and performance of its satellite system.

Through its Research and Development Branch, Telesat provided broadband access to all pilot schools. The equipment provided included antennas, transmitters and receivers, and other communication material such as phone lines. Telesat selected, configured, and coordinated the installment of the communication tools and software including a server and videoconferencing system and was responsible for their proper functioning throughout the trials.

The Communications Research Centre (CRC)

Like Telesat, the CRC was interested in the benefits of and problems associated with the applications made available to pilot schools. Previously, it conducted an experiment that accelerated TCP/IP traffic on the servers provided to these schools for accessing Web pages, FTP transfer and e-mail, etc. CRC personnel installed broadband material in Quebec, and Ontario pilot schools. The CRC Team assisted in responding to trouble-shooting requests, helped train school personnel, and even organized broadband-based activities such as one held with the Canadian Space Agency. Moreover, the CRC made the connection possible between the network of pilot schools and Ca*NET 4, thereby allowing connections with schools and universities outside the primary network.

Industry Canada/Schoolnet

Industry Canada, through its SchoolNet Initiative, provided funding for the MSTP and its evaluation. The need to provide Canadians with knowledge-based skills in order

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2 As defined by The National Broadband Task Force (2001), the term "broadband" refers to a high-capacity, two-way link between an end user and access network suppliers capable of supporting full motion, interactive video applications.

for industries to be attracted to or retained in Canada served as the motivation for this partner's involvement in the project. SchoolNet wanted to determine what access to broadband could be offered to pilot schools in general and in particular it wanted to assess the value-added of broadband for its GrassRoots and Network of Innovative Schools programs. Moreover, SchoolNet wanted to know the extent to which provincial and national inter-school communication was important and useful to pilot schools. In this regard, it was interested in determining how access to broadband and ICTs contribute to the changing nature of work and learning environments.

Provincial ministries/organizations

In Newfoundland, the Student/Teacher Educational Multimedia Network (STEM~Net) (http://www.stemnet.nf.ca) was interested in broadband. This organization had been involved in another broadband initiative, LearnCanada, funded by CANARIE. STEM~Net provides learning opportunities and resources for students and educators in the primary, elementary and secondary school systems throughout Newfoundland and Labrador. STEM~Net serves as the provincial partner with SchoolNet, and operates in partnership with other educational stakeholders, including the provincial Department of Education, the Faculty of Education at Memorial University of Newfoundland, schools, school districts, libraries, private and public sector partners, and the Centre for Distance Learning and Innovation (CDLI.) STEM~Net also facilitates and provides professional development and resources for educators, and promotes productive relationships between educational stakeholders and public and private sector partners. STEM~Net plays a leadership role in such areas as research and development in educational networking, and in promoting the sharing of best practices between educators, the involvement of students and educators in technology-related activities, and the involvement of schools and school districts in national and international activities. In addition, STEM~Net plays a leadership role in the development and maintenance of educational networking throughout the province, and in providing the infrastructure and support needed to distribute and share curriculum resources.

In Quebec, the Ministère de l'Éducation, le Ministère de la Culture et des Communications, the CRC, Telesat and Industry Canada had been working together on a pilot project for connecting schools through bi-directional communication via satellite. The two ministries provided funding to support pilot schools through the GRICS Society. This funding helped resolve technical problems, and funded basic training. At the same time, the Quebec Government was planning its own broadband initiative (Villages branchés), and early MSTP results informed that initiative.

In Ontario the primary broadband initiative currently underway is the Advanced Broadband Enabled Learning project funded by CANARIE and several public and private partners, under the leadership of York University. This two year research and development effort builds on the successes of the earlier LearnCanada broadband project. Its goal is to develop a sustainable and scalable collaborative learning model for teacher professional development employing broadband-enabled tools and resources. Broadband services provided through Ca*NET 4 have been made available to three Ontario and three Alberta schools, together with software and resources aimed at helping teachers learn about and apply principles of collaborative inquiry learning as they design and implement curriculum units incorporating the use of broadband modalities such as videoconferencing and digital media streaming. The model is practice-embedded; teachers work together by means of videoconferencing and other online collaborative tools to develop and implement these curriculum projects, which are designed to facilitate collaborative inquiry learning in their classrooms. These projects themselves make use of the affordances that broadband provides, so that students are given the opportunity to participate in videoconferencing sessions and use streaming media. The project includes a number of professional development resources, activities, and personnel to facilitate the development of new pedagogical approaches and the creation of an ongoing community of practice to sustain the momentum for educational change.

Pilot schools

The Multimedia Satellite Trials Project (MSTP) attracted the participation of 12 remote schools plus a resource centre located in a school district (13 sites), their administration and teaching staff. Three schools were in Ontario, five in Québec and four in Newfoundland. All were in remote or rural areas of each province. Of the 12 schools, four were K – 12 schools, one offered grades 7 – 9 and four were K-6 schools. (See list of participating schools in Appendix A). Six of the schools were also members of Canada's SchoolNet Network of Innovative Schools (NIS).

Leading partners (Telesat, SchoolNet, CRC and provincial organizations and ministries) provided resources to pilot schools in order for them to conduct broadband-based learning activities. School districts, which were interested in broadband trials for the sake of their capacity building, also provided guidance and resources. They participated in the selection of the pilot schools, and helped with the installation and functioning of the technology.

SPECIFICATIONS

The trials were conducted within a context that specified certain technical, pedagogical and administrative or management parameters. The following section of this report outlines these three types of specifications.

Technical specifications

The MSTP provided pilot schools with an infrastructure and telecollaborative tools as follows[3]:

- Broadband satellite connectivity that supported high speed video streaming and two-way data services.
- Access was provided to repositories of multimedia learning objects to support professional development of teachers and K-12 student collaborative project based learning (e.g., local video on demand streaming and downloading).
- Satellite broadband gave access to the “regular” Internet, Telesat’s central server, and CANARIE’s CaNet*4 fibre optic network (the latter was used by research universities and some other partner sites).
- Web tools to access information and engage in asynchronous collaborative learning were available.
- H.323 video conferencing equipment was provided for real time point- to-point and multipoint teacher and student interaction. The videoconferencing system was enriched with tools for collaboration, including electronic whiteboard, remote application sharing and collaborative file and document editing.
- Web caching was school-based, and offered video storage.
- Web hosting and web casting for established educational projects was also available.
- Video capture and video editing tools for student collaborative multimedia projects were provided.

Pilot schools were well equipped with up-to-date computers to be integrated within a range of teaching and learning approaches. In most cases, in addition to a computer lab, individual classrooms utilized from one to three computers. Sets of handheld and portable computers functioned as mobile labs.

Basic technical training was offered to at least one local person per site.

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3 EMS Technologies (satellite terminal) and Callisto (video servers) developed the platform.

Pedagogical specifications

Schools were asked to put forward proposals for projects and a pedagogical development plan was proposed as follows:

- Define the pedagogical focus (e.g. project based learning) with teachers and principals participating in the project.
- Select curriculum topics to be supported within the broadband-enabled learning environment.
- Select multimedia learning objects that support the selected learning topics.
- Metatag and post learning objects to multimedia repositories.
- Select mentors/experts to support the defined learning activities.
- Determine if the school wishes to collaborate or work in isolation from the other connected sites.
- Hold an organizational session for those sites that wish to collaborate in multi-site collaborative projects.
- Determine staff development needs of the teachers.
- Provide web based and broadband peer coaching applications for teacher professional development.

Moreover, the following learning and teaching possibilities were highlighted by Telesat, SchoolNet, and local champions:

- High-speed Internet access will provide students and teachers of the remote community access to learning material and e-learning courses on the World Wide Web.
- Multimedia learning objects to support selected collaborative learning activities will be identified, vetted by teachers and stored in a distant multimedia repository accessible via the satellite connection to CA*NET 4. The initiative will be an attempt to leverage the work presently under development within the CANARIE LearnCanada, POOL, and BELLE projects to provide multimedia learning objects to schools and universities connected to Ca*NET 4.
- Remote schools within the project will have the option to participate within the CRC VirtualClassroom program, which connects students from across Canada and the world, to engage in broadband collaborative learning activities.
- Peer coaching and expert mentoring for students and teachers will be conducted.
- Distant peer-to-peer coaching and expert mentoring will be provided to the school to provide opportunities for collaboration and sharing best practices and different perspectives.

Furthermore, having accepted to be linked together virtually, the pilot schools faced the challenges of intercultural connections and collaboration between local cultures, provincial cultures and curricula, and English, French and aboriginal cultures.

Project management specifications

Leading partners identified conditions for the success of the project. They were as follows:

Connectivity

- ✓ Minimum one year trial (with possibility of another year of service)
- ✓ Installation and operation of multimedia equipment in all 13 sites by December 31, 01.
- ✓ Adequate training and support to be provided by Telesat and CRC
- ✓ On site monitoring and reporting
- ✓ Connection to CA*NET 4
- ✓ Bandwidth usage measurement by each school during trial
- ✓ Post-trial evaluation and report

Consultations

- ✓ Schools and their school boards/districts consulted on terms and conditions of their participation (goals, benefits, timing and duration and evaluation of trial)
- ✓ Schools and their school boards expected to contribute resources and/or $ to the project
- ✓ SchoolNet to provide ongoing support through appropriate programs (NIS, Grass Roots, etc)

Expected Outcomes

- ✓ School staff and students experience high-speed access to Internet and off-site pedagogical resources
- ✓ Students have opportunities to link up with other schools and do collaborative work
- ✓ Students have access to off-site learning material and interactive learning
- ✓ Teachers comfortable with multimedia equipment and applications
- ✓ Staff has access to and is using new multimedia learning applications
- ✓ Schools are paired with NIS schools for mentoring
- ✓ Students develop and operate their web sites
- ✓ Schools apply and qualify for GrassRoots project funding

Applications and content

- ✓ Appropriate interactive learning material and learnware available
- ✓ Monitoring of applications used and their effectiveness
- ✓ Trials' learning activities successfully integrated into existing e-learning programs and networks
- ✓ Pedagogical support available to teachers
- ✓ Post-trial evaluation

Competencies

- ✓ Teachers and staff to be trained in use of multimedia equipment
- ✓ Staff and students linked up with other schools and learning networks

- ✓ Schools have shared information among themselves and with trial manager on their learning experience
- ✓ Post-trial evaluation of competencies acquired

This chapter has provided background information related to the MSTP partners, their vision, interests, expectations, and contributions. It also outlined the technical, pedagogical and project management specifications related to the project. The following chapter presents a technical overview and context for the project.

CHAPTER 2
TECHNICAL CONTEXT AND OVERVIEW

The Multimedia Satellite Trials Project (MSTP) was meant to test satellite technology for use by remote schools. In this chapter, the technical context is provided in terms of the activity carried out at the national and at the international levels. Following a description of the context is an overview of satellite technologies, including consideration of its characteristics and principal advantages and disadvantages, as well as mention of some of the modifications made by Telesat and the CRC to improve use of the technology.

CONTEXT

Canadian context in the use of broadband

In recent years The SchoolNet Advisory Board (SNAB), which includes representatives from all Canadian provinces and territories has often discussed issues related to connectivity. Its concern for serving all Canadian children has been highly manifest. A number of committees have been formed by Industry Canada in order to address the potentials of bandwidth and issues related to connectivity infrastructure, technical limitations, costs, barriers and models, pedagogical and social benefits as well as challenges. SchoolNet has been providing funding to document the early results of use of information and communication technologies for teaching and learning (see for example Grégoire et al., 1996; Bracewell et al., 1998; Laferrière et al., 2001). It has also documented best practices or case studies (see Kitagawa, 2001), and evaluated some of its own programs (see Dibbon, 2002; Owston & Wideman, 2001; and Laferrière 2001).

As mentioned above, CANARIE is funding the Advanced Broadband Enhanced Learning (ABEL) Project that is exploring the use of broadband as a means of fostering teacher professional development in ICT use. Schools from Ontario and Alberta as well as education faculty from two universities are participating in this two-year project. The Quebec government has launched the program entitled *Villages branchés*, and the Alberta government has launched the SuperNet program[4].

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[4] For more information, see http://www.meq.gouv.qc.ca/drd/tic/villages.html and http://www.albertasupernet.ca/the+project/background/related+broadband+initiatives.htm

International context in the use of broadband

At the international level, other initiatives are also in progress:

- Singapore
  - Fast Track @School (Fast Track@School) is championed by the Infocomm Development Authority of Singapore (iDA Singapore) with support from the Ministry of Education (MOE). It aims to make Singapore ONE (S-ONE) relevant and useful to schools and to jump start in getting schools, teachers and students to use S-ONE for teaching and learning. http://schools.s-one.net.sg/index.html
- United Kingdom
  - (Hammersmith & Fulham Education Department). National Grid for Learning (NGfL) & Broadband connection to LGfL Extensive programme of funding to ensure that all schools meet government targets for ICT provision and achieve Broadband connection to the Internet by August 2004.
- Australia
  - Some initiatives are in progress to increase broadband to schools. The Networking the Nation Initiative (NNI) is focusing on extending access to rural and remote schools.
- United States
  - E-Rate Program provides funds for carriers to extend broadband access to all public/non-profit classrooms. The Technology Opportunities Program (TOP/NTIA) provides grants to schools and many other public entities, typically in poorer/rural/remote areas.
- New Zealand
  - One initiative is providing a video conferencing bridge for 3 years that will facilitate quality video conferencing between up to 200 schools.

There are many questions that will need to be answered as countries provide broadband access to rural and remote areas as an essential component of capacity building in the 21st century. Industry Canada's report, entitled *The new national dream: Networking the nation for broadband access,* addresses issues such as the following ones: availability of broadband at a price reasonably comparable to that of more densely populated areas; range of content and service providers, and the building of community capacity. The Multimedia Satellite Trials Project (MSTP) can be seen as an experiment in the building of a capacity for collaborative broadband-based activity among schools. Industry Canada's Broadband for Rural and Northern Development Pilot Program (see http://www.largebande.gc.ca/index_e.asp / http://broadband.gc.ca) is another attempt at supporting remote schools wanting to engage in innovative broadband-based activity.

OVERVIEW OF SATELLITE TECHNOLOGIES

It is important to specify certain characteristics of the satellite-based type of connectivity, particularly with respect to accessing the Internet. This precision must be brought to bear in order to understand the type of connectivity provided by the project. Of interest is the interaction between the characteristics of this type of link and the use that the schools have made of it, taking into account the land-lines (or terrestrial links) that were already available to them. It should be remembered that the majority of the schools in the project had access to a terrestrial Internet link (telephone lines, cable etc.) in addition to satellite-based connectivity. They thus had the choice between a land-line or a bi-directional satellite link.

The following section of this report provides an overview of the characteristics, principal advantages and disadvantages satellite technologies. Modifications made by Telesat and the CRC to improve use of the technology are also described.

Characteristics of a satellite link

More and more people in Canada, and in the world in general, use satellite to receive television signals. In order to better understand the characteristics of a satellite connection, we will examine a well-known example; that of the diffusion of signals of satellite television and by cable. In some situations, the consumer does not have a choice regarding the mode of reception of television signals if he or she lives in a remote area because, often, satellite is the only service available. In cases where digital service may be desired, the territory served by cable distributors is limited. The satellite solution can, on the other hand, be installed anywhere. The same is true for the type of satellite connection used in this project.

Users of satellite television remark that climatic conditions such as rain can affect the quality of the signal, and that this effect is perceptible on their television screen. The same holds true for Internet connections by satellite. In both cases, the signal must cross a distance of about 32,000 kilometers. This represents the distance separating the geostationary satellite from the ground. Unlike a land-line, the signal is not forwarded in a wire coated with a protective sheath. The signal is therefore more sensitive to climatic conditions.

The distance which the signal crosses in the case of satellite is much larger. A radio signal also travels at a speed definitely lower than that of light in a fibre optic cable.

The combined effects of a longer distance to travel at a slower speed in the case of a satellite link are easily perceptible when one looks at a news report in which a journalist is using a satellite link. There is always a delay in time between when the question is asked and when it is answered. It is for this reason that short exchanges are avoided so as to attenuate this impression of rupture in the conversation. If one transposes this example in the case of Internet use via satellite, one can compare the short exchanges with the consultation of Web pages, and the long exchanges with file transmission. This analogy makes it possible to understand why accessing Web pages using a satellite connection can cause dissatisfaction among users accustomed to a land-line.

In this example, during a news report, the information is transmitted without taking into account the loss of content that could occur. It can happen that the quality of sound and image is altered when UDP protocols are used. When transmitting data, it is necessary to ensure that the transmitted information is identical to that received. Checks are carried out automatically, at regular intervals using TCP/IP protocols. The transmission is taken up again as long as the transmitted information does not correspond exactly to that obtained. It is the same for communications by land-line; but given that these take place in a less hostile environment (protective sheath, shorter distances, higher speeds), the losses of information are generally less and, as a result, the number of retransmissions is reduced. During communication using a TCP/IP protocol, these factors mean that, for the same bandwidth, a land-line is still more effective. For all of these reasons, one must avoid comparing, for a TCP/IP type communication, a 2 Mb satellite link with a 2 Mb land-line.

Principal advantages

In the light of the preceding explanations, the principal advantage is that this type of fast and bi-directional satellite link is available everywhere, even if the school is located in an isolated place. This advantage is one of availability of the service. In the case of very remote schools, the advantage is also an economic one. It is at present unfeasible to connect certain schools by fibre optic cable. During an analysis of the data related to the uses of the satellite link, it will be possible to note that schools that had a land-line in addition to the satellite link preferred the latter for certain applications.

Principal disadvantages

Bad climatic conditions can result in a higher number of retransmissions by satellite because these conditions slow down access and, in extreme cases, they can result in the loss of the satellite signal. Climatic conditions do not affect land-lines.

This principal disadvantage is most tangible for students and teachers during Internet navigation. Given the distance from ground to satellite, the speed of the connection as well as the fact that the (TCP/IP) protocol requires a large number of exchanges to validate the information, Internet navigation is slowed down. It is technically possible to mitigate the effects partially, but this slowness will remain an irritant for the user who has used a fast land-line. One can also note this effect in cases in which a journalist is reporting via a satellite link.

While those who use satellite communications TCP/IP regularly are likely to be aware of these disadvantages, such is not the case for the average user. If the latter is not well informed, dissatisfaction vis-a-vis this type of Internet communication may result. The non-informed user will always tend to compare the bandwidth available to him/her via satellite to the same bandwidth on a land-line and, consequently, will view a TCP/IP satellite link unfavorably.

It is important to remember that, at present, more than 80% of the schools' use of the Internet is for web browsing, and that it is this type of use of a satellite link that is the least powerful.

Improving Internet navigation by satellite

The problems caused by the use of TCP/IP applications with a satellite link have been known for a long time. So too have several solutions to partially resolve these problems. In order to better identify these problems, an experiment was carried out at the beginning of the Telesat project. In one of the schools which took part in the project, we measured the actual speed of the remote loading of a file by using the same software with Windows 98 and Windows 2000. These remote loadings were carried out several times consecutively and in alternation. The mean velocity obtained was around 12 kilobits per second (Kbs) with Windows 98, and of 24 Kbs with Windows 2000. This variation can be explained by the different way in which the TCP/IP protocol was established in these two versions of Windows. These tests were carried out without any modification made to the satellite link. One of the technical partners, EMS, provided us a list of modifications to be made to the TCP/IP protocol for these two versions of Windows. Once these changes were carried out, the mean velocity obtained for the remote loading of the same file, for Windows 98 as well as for Windows 2000, rose to 90 Kbs. Although the improvement is spectacular in the case of remote loading of a file, such is not the case for the display of Web pages, because these are typically comprised of a large number of small files the state of which must be verified after each transmission. In the case of the uploading of a file, it is possible to ask Windows to transfer more information before completing checks for accuracy. This procedure can be applied to a Web page when it is made up of only one image containing a lot of information. Viewing the images of NASA represents a fine example of how this procedure might work. However, the procedure is unlikely to work with typical web pages.

Modifications made by Telesat and the CRC

It is hard to imagine modifying the TCP/IP protocol of all the computers in the project schools. In the context of a pilot project that preceded this one, a trial was conducted of a new TCP/IP protocol for satellite communications developed by the researchers at NASA. Taking part in this project were the schools Pierre-de-Lestage of the Samares District and more particularly the school Ulluriaq of the Kativik district. It was necessary to adapt the protocol for use in education. A new protocol SCPS was used in order to improve the speed of TCP/IP communications by satellite, without the need to modify the TCP/IP protocol on each work station. A FreeBSD server was added to the school sites in order to be able to use this new SCPS protocol. This same server was also used as a central cache for Web sites visited by schools. The use of a central cache facilitated increasing the apparent efficiency of the satellite link during use of a browser by individuals in a school.

With this server it was possible to automatically intercept the school's TCP/IP communications and to subsequently make them use this new protocol in order to improve the efficiency of the satellite link. One of the secondary advantages obtained by use of this server was to be able to tabulate and separate TCP/IP traffic from the protocols like UDP, which is used for other Internet applications such as videoconferencing.

The above technical information was meant to provide the reader with some background in order to better understand the use of the satellite link with the schools involved in this project. In the next chapter, the conceptual framework and the research questions are presented.

CHAPTER 3
CONCEPTUAL FRAMEWORK, EVALUATION DIMENSIONS AND RESEARCH QUESTIONS

The purpose of this chapter is to present the conceptual context or framework that guided the action-research evaluation of the MSTP project. The framework allowed the researchers/evaluators to interpret the findings of the study in a broader context of technology use in educational contexts. Following an explanation and description of the conceptual framework are the specific research questions that allowed the researchers to systematically inquire into the achievements of the project. The questions are presented within four evaluation dimensions.

CONCEPTUAL FRAMEWORK

Leading partners wanted to know what pilot schools would do with broadband connectivity, and what technical or institutional barriers might exist. They were also interested in understanding how such trials could be instructive for stakeholders confronted with broadband as an issue of equality of opportunity for school learners. The partners were looking for evidence that the investment in broadband is worthwhile for schools. This action-research evaluation finds its relevance in addressing these questions.

The search in the literature for heuristics that would inform the analysis of broadband-based activity (socio-technical designs and evaluation) did not lead to anything near Nielsen's (1994) ten heuristics with regards to the design of user-friendly interfaces (usability evaluation). The study of the deployment of broadband for use in elementary and secondary education is still at the phase of identifying enablers and inhibitors. The same holds true in sectors like higher education, health, the workplace, and the home.

The general evaluation framework for multiple stakeholder projects developed by Barfurth et al (2002) in the Learn-Canada project (social infrastructure, technical infrastructure, physical space, interaction style and content) informed the decision to adapt a conceptual framework developed previously in a study of ICTs. The study entitled *The emerging contribution of online resources and tools to K-12 classroom learning and teaching* (Bracewell et al., 1998, and updated in 2001 by Laferrière et al.) highlighted the fact that technology is not the only prerequisite condition for impact to occur on learning and teaching. Technical and administrative support is key in order for teachers to integrate ICTs. Moreover, it has been found that when the teacher takes on a facilitative rather than a transmission role and when the content is not pre-organized, students tend to be more engaged and learning outcomes are more likely to be positive. This framework is congruent with current learning theory (see Bransford, Brown, & Cocking, 1999). Learned observers know, however, that “The first generation of e-learning applications did little more than transfer the method and structure of the traditional classroom to an online environment” (e.g., Downes, 2003).

One first adaptation of the model was made: the original sequence of the basic elements of the Bracewell et al. model (teacher, content, learner, and context) was modified to better reflect the importance given to connectivity and partners’ roles in MSTP. The other adaptation was to focus on access to and support for broadband-based activity as far as Internet use and technology integration were concerned.

Moreover, these components are embedded in a logical process, which enables an exploration of the relationship between technology access, the teaching process and effects on student learning. Thus, it is possible to produce combinations of analysis that reflect uses of the Internet, and the broadband connections at the schools, as well as the levels of satisfaction with the teaching and learning environment expressed by students and teachers. It is also possible to draw from these results lessons for future projects, activities, and initiatives.

The four components of this framework are the Learner(s), the Context, the Teacher, and the Content. Each of these components is described below.

	LCTC-		LCTC+
Learner(s)	Low access	⟷	High access
Context	Limited support	⟷	Extensive support
Teacher	Transmitter	⟷	Facilitator
Content	Pre-organized	⟷	Constructed

a) **Learners (continuum: from "limited access to broadband-based activity" and "high access to broadband-based activity").** This component considers learners' access to broadband-based classroom activities. Limited access meant that few broadband-based learning activities did occur. High access requires ease of use and stability of the platform. Learners are typically school students but they are also teachers in cases where professional development activities were part of broadband activity. These elements are examined along a LCTC continuum from low access (LCTC-) to high access (LCTC+).

b) **Context (continuum: from a context of "low external support for broadband activity" to "high levels of external support").** This component examines the context in which efforts to carry out broadband-based activity occurred within and outside the schools. The context is defined in terms of technical, pedagogical and administrative support. Internal and external support is considered. Support could be provided by local champions who foster technological innovation, school teachers offering guidance to their colleagues at local or distant sites, and even school learners. These elements are examined along a LCTC continuum from low external support (LCTC-) to high external support (LCTC+).

c) **Teachers (continuum: "transmission" to "facilitation").** This continuum examines the role of the teacher, from using broadband to transmit content, to facilitating situations in which more active learning would occur. This component considers whether the teacher used broadband simply to enhance traditional teaching methods, or whether technology was used to enable constructive and collaborative learning environments for students. Different learning outcomes may be expected depending on whether teachers use broadband to present content to students or to perform such roles as structuring group work and collaborative student projects. New roles and activities may also become possible (e.g., the role of providing online expert advice, guidance, or mentoring; the activity of monitoring student progress in online collaborative environments. These elements are examined along a LCTC continuum that ranges from transmission of content (LCTC-) to facilitation of learning (LCTC+).

d) **Content (continuum: "pre-organized" to "constructed").** This component examines the learning content used by teachers and students. Whether the content is pre-organized, pre-packaged, or fixed or whether learning content is co-constructed by students and teachers through the use of broadband technology may make a difference as regards learning outcomes. These elements are examined along a LCTC continuum from pre-organized content (LCTC-) to constructed content (LCTC+).

These four components, and each associated continuum, define the conceptual framework used in this action-research based evaluation.

EVALUATION DIMENSIONS AND RESEARCH QUESTIONS

The MSTP leading partners faced a number of challenges, from determining the best ways to conduct the consultation process and involve schools in the project to the identification of the kinds of outcomes to be expected from the trials for the pilot schools. They wondered whether they could bring all participating sites "on-line" simultaneously. The assumption was that installment of in-house equipment on time would not be an issue, but that schools themselves would possibly experience problems with the operation of the equipment. They planned to monitor the situation carefully to ensure that each school would get the necessary support to maximize benefits. They asked themselves about the value-added (VA) for pilot schools, and established the following bottom line: the VA was to exceed existing level of connectivity and ICT/Internet use. They also wondered whether one year was long enough to maximize benefits for participating schools.

The evaluation team verified the consistency of its conceptual framework by clustering partners' intents and interrogations around the four basic components (learner, context, teacher, and content). Through this process, the following four evaluation dimensions were identified: learner access, supportive context, educational usefulness, and value-added.

a) **Learner access**

Access to broadband for learners was the technology advance that partners wanted to provide to pilot schools through the designed satellite-based system.

Therefore, many specific questions can be related to whether or not this intent was achieved, and to which level:

- Was the system easy to use?
- What was the perceived impression of the performance of the system for, Internet access, video conferencing, and video streaming/serving?
- What were the other applications for which the system was used? What were the benefits of, and problems with, these applications?

b) Supportive context

Partners wanted to provide needed supports. They were aware that technical support such as basic training in the use of the software and trouble shooting would be required. Professional development was another form of support identified as necessary early in the process. Moreover, the conceptual framework pointed to the necessity of administrative support for teachers to engage in innovative teaching. Specific evaluation questions were as follows:

- Who were the supporters, or “champions,” who fostered technological innovation, or those who provided technical or pedagogical support, guidance, or advice, to schools?
- What forms of support were available for broadband use and were they sufficient? What, if any, were the related problems?
- Were broadband-based activities integrated to the provincial curriculum?
- What were the technical or institutional barriers that needed to be removed in order to make the use of this system more attractive and useful? What are the remaining barriers?

c) Educational utility

The new digital media provided by the satellite-based system were meant to be useful to school participants for engaging in collaborative projects, including the production of video-supported educational resources. Instructional approaches (transmission or facilitation) and content (pre-organized or constructed) were determining factors according to the conceptual framework. But contrary to the original conceptual framework, instructional approaches and content were considered together in order to assess the educational usefulness.

Teachers’ instructional approaches when using broadband could be traditional or innovative. Specific evaluation questions related to teaching were as follows:

- Were teachers transmitters or facilitators?
- Did teachers coordinate student use of technology to work effectively in individual or group learning contexts?
- Has teachers’ understanding of the use of broadband changed over the course of the project? If so, in what specific ways?

- How has the satellite system been useful to teachers and students? For which applications? In which order?

Activities conducted on broadband may vary greatly in content, and be curriculum-related or not. The specific evaluation questions related to content were as follows:

- What types of broadband-based activities did they conduct?
- Was content packaged or co-constructed?
- Did broadband activities fit into the local curriculum?

d) Value-added

For leading partners, value-added was to exceed existing level of connectivity and ICT/Internet use. School-to-school collaboration was also identified as a value-added element. Moreover, it is known that teachers are more likely to be interested in using technology when learning outcomes are in sight.

Offering better connectivity to schools was a key goal for the partners. The level of connectivity was examined with regard to pilot schools' expectations and satisfaction with the satellite-based system. The specific evaluation questions related to connectivity levels were as follows:

- Have school experiences with broadband meshed with their initial expectations?
- Did the project provide a platform for schools to enjoy the advantages of high-speed access?

One of the benefits of connectivity is sharing information and learning resources and learning from each other's experience. Support was provided to enable the schools to interact with other schools. Some pilot schools, which were part of SchoolNet Innovative Schools Network (NIS), had the possibility of attending a face-to-face meeting in the Fall of 2002. Moreover, integration of the trials into other existing e-learning programs or networks could be understood as another manifestation of school-to-school collaboration. The specific evaluation questions were as follows:

- Did the system provide connection over the Internet to other learning institutions? To what extent did teachers work with colleagues from within their school or from another school in joint planning or curriculum development for broadband use?
- Was provincial and national inter-school communication important and useful for teachers and students, and if so, was the system in place used for that purpose? What obstacles were encountered?
- Did school leaders evolve their views of a networked school and its activities?

Value-added for schools can hardly be considered without an appreciation of the learning outcomes for school students and for teachers as well as other school personnel. Specific evaluation questions related to learning were as follows:

- Were changes observed in student behavior or motivation?
- What were the student benefits from the use of broadband?
- Where they any negative consequences of broadband use for any of the students?

Pilot school's efforts for getting a broadband connection on a more permanent basis were considered as an indication of the perceived value of broadband for their school and/or local community. Another indication considered was the information shared with educators and school administrators through post-trial evaluation reports (provincial and final reports) (lessons learned and best practices developed).

This chapter presented the conceptual context or framework that guided the action-research evaluation of the MSTP project. The conceptual framework was then related to four evaluative dimensions. For each of these dimensions, specific research questions were outlined. The following chapter describes procedures related to methodology for the action-research evaluation. Included in the description is an outline of participants, data-collection techniques and ethics procedures.

CHAPTER 4
METHODOLOGY

The purpose of action research is twofold: to foster innovative action, and to better understand the ongoing change process. Collaboration between researchers and practitioners characterizes the process as a whole. The Multimedia Satellite Trials Project (MSTP) was no exception. This chapter provides some insight into how the goals of the action research were achieved. It outlines the intervention and research carried out by the research team[5]. In relation to the latter, this chapter also outlines information sources, ethics procedures, data collection and analysis procedures, dissemination and limitations.

INTERVENTION COMPONENT

Early in the process, researchers joined the project implementation team by participating in phone teleconferences on a regular basis. They provided updates on the research plan: preparation of questionnaires and interview schedules.

Portraits of use of broadband by the pilot schools were created in the early stages of the project implementation. In September 2002, each pilot school was presented with the first iteration of the portrait of its use of broadband and overall participation in MSTP, and asked to validate its content. Adjustments were made where necessary. Portraits were updated early in 2003, and again in July 2003.

These portraits were at the basis of the intervention component of this action-research-based evaluation (Argyris, Putnam, & McLain Smith 1985; McLaughlin & Thorpe 1993; Dick, 1997). The portraits allowed the research team to take note of how the MSTP was being implemented within each pilot school, to offer feedback to pilot schools, to provide opportunities for pilot-school participants to reflect back on their action, and to provide support and professional development. A final portrait was sent to each school at the beginning of the 2003 school year with a thank you letter in appreciation of its participation in the project. To respect confidentiality, individual school portraits were not made public.

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[5] A principal investigator working in a university of each of the participating provinces and territories conducted the research for his/her own area, and supervised intervention and research assistants. Researchers were from different backgrounds, and they added one consultant with adequate knowledge of technology-related aspects of the project.

The last three activities that relate to the intervention component were as follows:

- Transition conversations with pilot sites to ensure continuity of activity through possible avenues once the satellite connection ended on May 31st, 2003.

- The preparation of public provincial case studies regarding the planning, conduct, and evaluation of broadband activities. Provincial reports were sent to pilot schools and provincial leading partners.

- The writing of an evaluation of and recommendations for the pedagogical and social possibilities as well as organizational, structural and cultural limits for schools and classrooms to access Anik F2.

RESEARCH COMPONENT

Literature reviews were conducted in April 2002 and April 2003 for the identification of relevant research and evaluation criteria and parameters. The following parameters emerged as common in the literature: ease of use/usability, enablers and inhibitors, and usefulness (e.g., user's motivation (parameters: curriculum-related), richness (parameters: diversity and scope) (see Flagg, 1990; Garzotto et al, 1995; Barfurth, 2002)).

In order to ground the evaluation process in participants' goals, interests, expectations, and interrogations, data were gathered as early as May-June 2002 (Phase I). Though the approach to evaluation was goal-based, Scriven's (1972) concept of goal-free evaluation was taken into account in the sense that outcomes are to be compared to the needs of those who are impacted by a project. Moreover, as recommended by Russell (2001), attention was also given to the implementation (process) because teachers adapt technologies to their instruction in different ways (p. 153). Therefore, the goals and interrogations generated by the leading partners as well as the applied conceptual framework which includes teaching approaches drove the evaluation methods utilized.

Information sources

The evaluation research team employed information in quantitative and qualitative formats gathered from a variety of sources: project documentation including web-based materials, computer-generated data on the use of the satellite-based system, and participants (leading partners and pilot schools' personnel and school learners).

Project-related documentation was scrutinized in order to identify the project goal, and leading partners expectations and questions. Documents generated by the reporting activities of Doug Walker were included. Additional information was gathered during conference calls attended by the key partners of the project.

The automatic use of the new SCPS protocol provided invaluable data concerning the deployment of applications that make use of a TCP/IP protocol. Use of a cache also made it possible to obtain interesting data related to Internet navigation in the schools. The software "Webtrends" was used by Telesat for statistical purposes to determine the use made of the Web in schools. These reports were available only for the schools that undertook Internet navigation via satellite. This was the case for five schools out of the twelve that took part in this project. Other statistical data were provided by the software "NTOP" which tabulated, in a different manner, the use that was made of the Internet in each one of these schools. It was also possible to use data related to the Internet use of the thirteen sites taking part in the project. In order to understand the computer-generated data, it was important to provide more information on the choice made by the schools to take part in this pilot project.

Such a choice is always difficult. It is only at the end of a project that one can truly inquire as to the impact of certain site selection criteria. One of these criteria consisted of choosing schools located below a given latitude and not very far away from the major roads, so as to reduce the cost of the antennas and any expenses related to logistics. In this way, it was possible to avoid high travel expenses in the event of problems and, also, to provide better support for the users by intervening quickly. Fortunately schools were included which did not meet these criteria, because data from these schools turned out to be critical for the current evaluative study. In the future, the latter schools are likely to correspond to the target customers for which this satellite service is intended.

Data were also collected through online questionnaires and telephone, videoconference, and onsite interviews with students and teachers at three different times: May-June 2002, Fall 2002 and May-June 2003.

Ethics procedures

Consent for teacher participation was obtained through use of a consent form accessed online by participants[6]. Consent forms for student participation in the interviews were obtained from the web site by the principals of three of the schools, and were signed by parents of the students, returned to the principals, and forwarded by facsimile to the researchers. Copies of the student consent forms were forwarded to a few schools by facsimile, due to the schools' lack of satellite Internet access past May 31st, 2003, and were returned to the researchers after they had been signed by parents of the participating students.

Data collection techniques

Questionnaires. The questionnaires were located online at http://www.telelearning-pds.org/u/telesat/research.html. The instruments included four specific questionnaires for each of the principal, ICT support, teachers, and students of each of the pilot schools. The first iteration of the questionnaires was produced in the spring of 2002, and the second in the spring of 2003. The last iteration of the principals' questionnaire consisted of 24 questions, related to Teaching Approaches, Administrative Activities, Teaching Activities, Learning Activities, Expectations, and Professional Development Activities and Support. The ICT support questionnaire consisted of ten questions. The teachers' questionnaire consisted of 17 questions. The students' questionnaire consisted of 13 questions.

Online questionnaires[7] were completed by a small number of participants, but consulted by a greater number of participants.

Interviews. Interviews with principals, ICT support and teachers relied on the questions from the online teachers' questionnaire, and interviews with students relied on

6 The consent form for adult participants was accessible at http://www.telelearning-pds.org/u/telesat/research.html

7 Online questionnaires are available at http://www.telelearning-pds.org/u/telesat/research.html

the questions from the online students' questionnaire. Interviews with two other relevant informants (local champions) used adaptations of the school principal's questionnaire.

Participants in the interview phase of the research included all school principals for a total of 12 interviews[8]. A total of 24 interviews were conducted with teachers, and 37 students were interviewed. Moreover, interviews were conducted with ICT support personnel for a total of 5. Interviews were conducted face to face, on the telephone, or using the videoconferencing system.

Data analysis

Quantitative analysis was conducted on computer-generated data. Questionnaire and interview data were analyzed in terms of the conceptual framework and specific evaluation questions. Attempts at identifying themes and patterns were undertaken regarding the activities carried out by the schools, capacity building, and the effects of the connection on the learning environment, and on participants.

Dissemination

The study produced nearly five hundred pages of text (portraits, provincial case studies, and this final report). Early and final portraits were shared with individual schools, provincial case studies with local champions and pilot school leaders, and the final report will reach pilot schools as well as school district, provincial and federal agencies. All documents were written in a way as to inform decision-making.

Limitations

At the action level, one limitation was the duration of the trials. The approximately one year long period was far too short for any significant outcome to be measured given the new possibilities made available and the scope of innovative practices that could occur. Delays in intervention funding also impeded the timely deployment of planned facilitation activities at participating schools.

At the research level, the conditions of the trials varied greatly from pilot school to pilot school. Pilot school capacity in the use of ICT differed greatly. Some had access to a technology expert and others not. In a few schools, half of the teachers or more

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[8] Activities planned for one school district's resource centre (13th site) did not materialize.

were involved whereas, in others, only one teacher participated in the trials. Therefore, the number of students who experienced broadband also varied greatly.

This chapter provided insight into how the goals of the action research were achieved. It outlined the intervention and research carried out by the research team. In relation to the latter, this chapter also outlined information sources, ethics procedures, data collection and analysis procedures, dissemination and limitations. The following two chapters present the findings that result from the research undertaken.

CHAPTER 5
PRESENTATION AND DISCUSSION OF TECHNICAL FINDINGS

Data from several sources shed a complementary light on the use that was made of the satellite link by the participating schools. The data also provide a perspective on the variations in schools' use of the satellite link. This chapter discusses these variations and considers as well issues related to the use of videoconferencing, consumption of bandwidth, use of video, absence of web page filters and leaving exit ports open.

VARIATIONS IN SCHOOLS' USE OF THE SATELLITE LINK

In order to illustrate the extremely unequal use which was made of the satellite link by the schools, data related to two of these schools are presented here below. These figures represent the sum of information forwarded from the school to the satellite with all applications combined. The IP address was voluntarily withdrawn from the tables in order to preserve the confidentiality of the schools. In the first case, we can observe that over a period of thirteen days the satellite link was used to transmit 8.1 megs of data and to receive 8.7 megs.

Table 5.1: Use of the satellite link in Case 1

IP Address	[unicast]
First/Last Seen	04/15/03 09:40:53 - 04/28/03 11:59:39 [13 day(s) 2:18:46]
Host Location	Remote (outside specified/local subnet)
Total Data Sent	8.1 MB/156,918 Pkts/0 Retran. Pkts [0%]
Broadcast Pkts Sent	0 Pkts
Data Sent Stats	Local (100 %)
IP vs. Non-IP Sent	IP (100 %)
Total Data Rcvd	8.7 MB/142,496 Pkts/0 Retran. Pkts [0%]
Data Rcvd Stats	Local (100 %)
IP vs. Non-IP Rcvd	IP (100 %)
Sent vs. Rcvd Pkts	Sent (52.4 %) Rcvd (47.6 %)
Sent vs. Rcvd Data	Sent (48.3 %) Rcvd (51.7 %)

We can compare identical statistical data, based over the same period of time, with another school in the project. It can be observed that, in this case, the school used its satellite link in order to transmit 882,9 megs and to receive 2,7 gigs of data.

Table 5.2: Use of the satellite link in Case 2

IP Address	[unicast]
First/Last Seen	04/15/03 09:40:53 - 04/28/03 11:53:39 [13 day(s) 2:12:46]
Host Location	Remote (outside specified/local subnet)
Total Data Sent	882.9 MB/3,853,007 Pkts/0 Retran. Pkts [0%]
Broadcast Pkts Sent	0 Pkts
Data Sent Stats	Local (100 %)
IP vs. Non-IP Sent	IP (100 %)
Total Data Rcvd	2.7 GB/4,651,272 Pkts/0 Retran. Pkts [0%]
Data Rcvd Stats	Local (100 %)
IP vs. Non-IP Rcvd	IP (100 %)
Sent vs. Rcvd Pkts	Sent (45.3 %) Rcvd (54.7 %)
Sent vs. Rcvd Data	Sent (24.1 %) Rcvd (75.9 %)

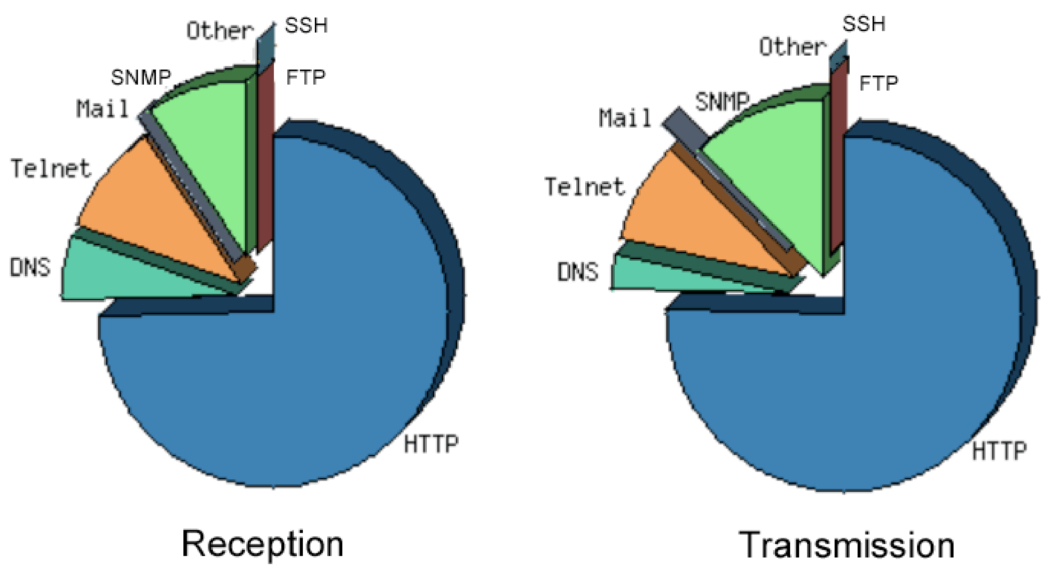
The two schools served a clientele similar in age but, in the second case, the number of students was lower by 25%. This example illustrates the considerable variations in use between schools. In the schools of this pilot project, the hardware and software which was installed was identical and, often, this installation work was carried out by the same people. All the schools used the same satellite and the same point of uplink at Telesat, in Ottawa. One can thus eliminate the resources and equipment installed and the satellite link to explain the significant differences in use made of the satellite link.

In the case of the first school, a disconcerting fact is apparent. The amount of information transmitted and received is almost identical. In educational circles, however, these figures are rarely identical. Received information always largely exceeds that sent. In the case of the second school, one notes that this rule is complied with. There is, for this second school, three times more incoming than outgoing traffic, which is in conformity with a normal use for a school or district.

The principal difference between these schools comes from their geographical situation. In the first case, the school had use of a terrestrial Internet link. Given that a fast land-line is more effective for navigation than is a satellite link, this school did not connect the total of its network to the satellite link. Only the Windows 2000 station used for the videoconference was connected to the satellite. It should not be forgotten that navigation still represents the principal use of the Internet in a school.

We can consider the importance of use of the Web compared to the other applications in these two schools. In the case of the first school, we can note the importance accorded to the "HTTP" protocol, as much in relation to reception as transmission, compared to other TCP/IP protocols.

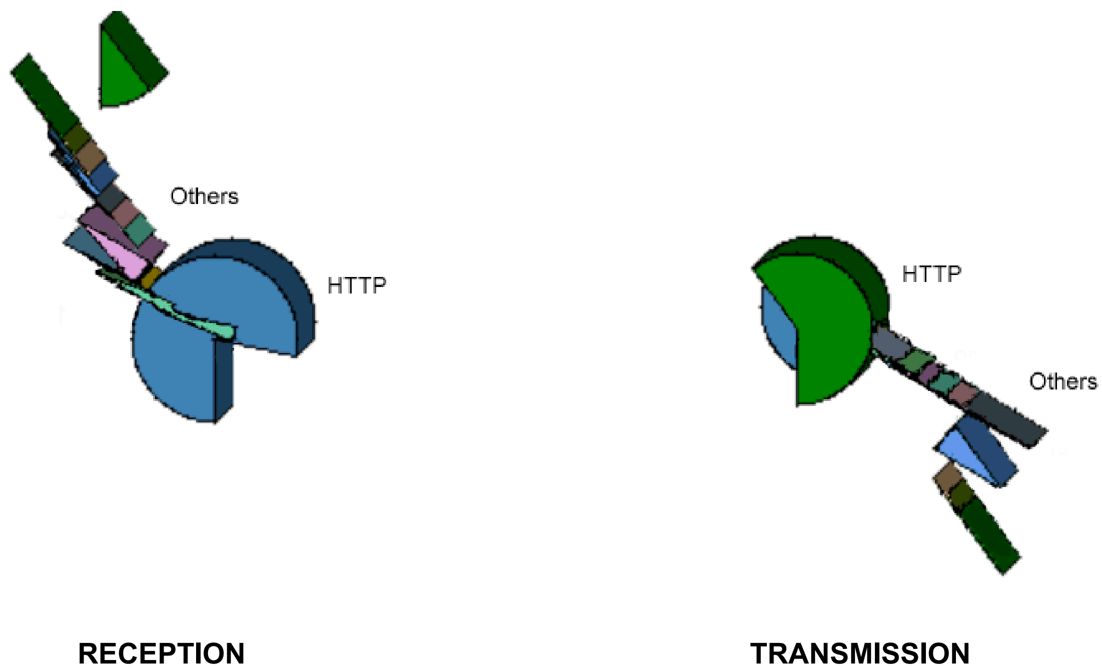
Figure 5.1: First case of use of HTTP protocol compared with other applications



These pie graphs present a "DNS" piece that is used for the resolution of the domain names for the translation of http://www.telesat.ca into 198.96.185.2, because the computers and Internet only work in numerical mode. The protocol used by Web browsers is "HTTP"; for the file transfer, one uses "ftp". "SSH" is a protocol used to control a computer remotely and "telnet" is an older and nonprotected version. "SNMP" is an administrative protocol of Internet networks. In short, each Internet application is associated with a protocol (port) or if, one prefers, with a door of communication. The first 1024 ports are reserved for the programs that are used most often on the Internet. Thus, when one wants to analyze the nature of Internet traffic in a school, it is enough to look at which ports the computer communicates with to know the programs which are used.

Now let us compare identical data, based over the same period of time, with our second case, where the total network of the school was connected to the satellite link.

Figure 5.2: Second case of use of HTTP protocol compared with other applications



The graphs are definitely denser, and are more difficult to read. This can be explained by the fact that a wider range of TCP/IP protocols was used as much for transmission as for reception. We can consider this issue further on given that the immediate objective is to compare the importance of the HTTP protocol with the others. It can be noted in this figure that about 80 % (blue area) of any received information relates to Web pages. It is normal to note that the protocol "HTTP", in reception has much less importance compared to the total TCP/IP traffic because it is only used to send URL (e.g. http://www.telesat.ca/schooltrials) requests and to validate received information.

The second case is more interesting to study, because it represents use made of the satellite link for the total of the school and not only for one work station as in the first case. It is useful therefore to observe the importance of the TCP/IP protocols compared to the others, and for this same period.

Table 5.3: Comparisons of protocol uses

Protocol	Data Sent		Data Rcvd	
TCP	837.7 MB		2.6 GB	
UDP	44.8 MB		102.0 MB	
ICMP	345.2 KB		161.7 KB	

Once again, we can note the prevalence of TCP/IP protocols compared to the others, including UDP protocols that are used for videoconferencing. We can also note the prevalence of the "HTTP" protocol[9] compared to the total of TCP/IP protocols.

These data illustrate in an eloquent way the prevalent place that web browsers occupy in a school environment and, in particular, within the network of the pilot schools of the project. It is thus normal that a school with a fast terrestrial Internet link privileges use of this type of link if it proves to be more efficient in more than 80 % of the cases as is shown by the analysis of the data.

The particular profile which emerges from the case studied is not unique. It can be found in eight of the thirteen sites of this project. Table 5.4 presents data from a third school representing the total of its satellite traffic, for the same period of time.

[9] The HTTP protocol is a TCP protocol. In Table 5.2, http was the most used protocol (about 80 %) of all TCP protocols. UDP protocols are used for videoconferencing. Videoconferencing represent over 80 % of UDP traffic.

Table 5.4: Use of the satellite link in Case 3

IP Address	[unicast]
First/Last Seen	04/16/03 09:29:48 - 04/28/03 11:59:45 [12 day(s) 2:29:57]
Host Location	Remote (outside specified/local subnet)
Total Data Sent	4.5 MB/76,826 Pkts/0 Retran. Pkts [0%]
Broadcast Pkts Sent	0 Pkts
Data Sent Stats	Local (100 %)
IP vs. Non-IP Sent	IP (100 %)
Total Data Rcvd	4.0 MB/63,403 Pkts/0 Retran. Pkts [0%]
Data Rcvd Stats	Local (100 %)
IP vs. Non-IP Rcvd	IP (100 %)
Sent vs. Rcvd Pkts	Sent (54.8 %) Rcvd (45.2 %)
Sent vs. Rcvd Data	Sent (52.7 %) Rcvd (47.3 %)

The data from a fourth school for which the profile is similar to the second case studies confirm the analysis completed previously. The following table presents the total use for the fourth school.

Table 5.5: Use of the satellite link in Case 4

IP Address	[unicast]
First/Last Seen	04/15/03 09:41:10 - 04/28/03 11:55:51 [13 day(s) 2:14:41]
Host Location	Remote (outside specified/local subnet)
Total Data Sent	203.2 MB/1,118,445 Pkts/0 Retran. Pkts [0%]
Broadcast Pkts Sent	0 Pkts
Data Sent Stats	Local (100 %)
IP vs. Non-IP Sent	IP (100 %)
Total Data Rcvd	1008.0 MB/1,378,368 Pkts/0 Retran. Pkts [0%]
Data Rcvd Stats	Local (100 %)
IP vs. Non-IP Rcvd	IP (100 %)
Sent vs. Rcvd Pkts	Sent (44.8 %) Rcvd (55.2 %)
Sent vs. Rcvd Data	Sent (16.8 %) Rcvd (83.2 %)

In this last case, it is apparent that the amount of received information is five times larger than that sent. This was not the case of the third school where these figures were almost identical. The data which follow also reveal the prevalence of use of TCP/IP protocols in this school.

Table 5.6: Use of protocols in Case 4

Protocol	Data Sent		Data Rcvd	
TCP	196.4 MB		996.7 MB	
UDP	6.6 MB		11.3 MB	
ICMP	213.5 KB		29.0 KB	

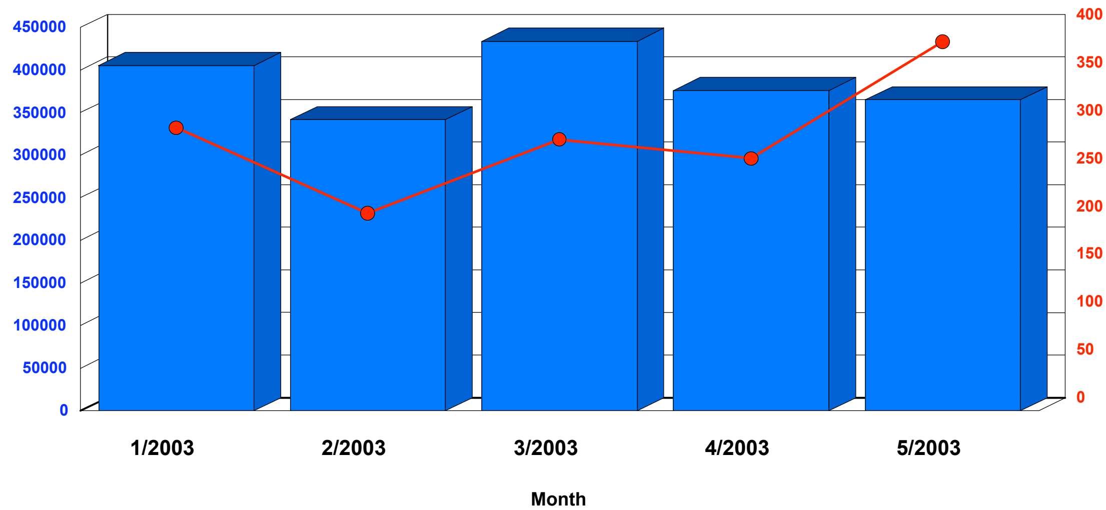
It appears overall that two types of profiles for these schools are discernable: one for schools which employ a fast land-line and one for those that do not. The first and the third school had such a link; they made little use of the satellite link, unlike the second and the fourth school. It was also noted that more than 80 % of the use of the Internet in a school is based on use of the Web (HTTP protocol). It is with this type of application that a satellite link is the least powerful.

The Internet satellite link is not intended to compete with a fast land-line; instead, it is intended to offer this service where a land-line is not available. These results can, in total, appear very disappointing for Telesat but, in a way, they hardly are surprising given that the trials were conducted with only five sites of the thirteen in this project using satellite transmission as their only Internet link. It will be important in evaluating this pilot project to observe its impact on the customers for which this link is intended. The use statistics do confirm that satellite access meets a real need for remote schools that cannot get a land-line.

USE OF VIDEOCONFERENCING

Looking beyond the total use of statistics, the videoconferencing service placed at the disposal of the schools for this project can be considered a success for the schools, whether or not they possessed a fast land-line. The following graph presents videoconferencing use during the last five months of the trials. What is particularly interesting to note is the red line in this graph which illustrates the monthly use of the service. To evaluate each red point of this graphic, and to determine monthly use, it is necessary to refer to the scale on the right. The graduation from the left will be of more interest to managers of data-processing networks because it refers to the average bandwidth (in bps) which was used by each videoconferencing session.

Figure 5.3: Call activity by month



The total number of videoconferencing connections for this period was 1432. This figure being raw data, must not be equated with the actual number of exchanges between the participating schools in a context of work. These data are similar to data in a register that one signs on entering and leaving a building; one can suppose that a work meeting took place if the stay within the interior of the building is sufficiently long. Taking into account these limits in the analysis of the logs of the videoconferencing software, we can make several observations. In general, we can observe that the videoconferencing software was used in the twelve schools and that the frequency of use varied considerably from one site to another. We can also observe that there were a great number of communications (324) of less than a minute which are best ignored. In these cases, we can assume that the contacted person was undoubtedly not online, or the purpose of the call was to verify the correct operation of the system. There were also great variations from school to school in the number of sessions of more than one minute. While some schools had anywhere from 0-15 sessions of this type, others had from 20-100 with two schools having 121 and 244 sessions respectively. The significance of these observations will be considered in the pedagogical analysis of this project.

The data related to these videoconferencing sessions reveal that "point-to-point" communication was primarily used by the schools. Overall, only about thirty multipoint sessions were identified. That is not to say that there were not more but the "point-to-point" sessions largely dominated. From an organizational point of view, a multipoint conference is more onerous to put in place. From a technical perspective, for a multipoint conference, the services of Telesat or of the CRC were required because they had the necessary equipment.

If the eight schools that had a fast land-line preferred this type of connection for Internet navigation, such was not the case for videoconferencing. No school used its land-line to videoconference with the software provided by Telesat. With the satellite connection, it was possible to obtain sound and visual quality almost comparable with a commercial videoconferencing service. To achieve this quality, use was often made of the same bandwidth (384 kps and more) as that employed in videoconferencing rooms, on (ISDN) lines reserved for this use.

In order to increase the number of the schools able to communicate between each other by videoconference, tests were conducted with fast land-lines, similar to those operating in the schools. During the tests and using videoconferencing software, it proved impossible to maintain for a sufficiently long time the quality of the signal in order to hold a videoconferencing session. The only way of maintaining the quality was with points of fibre optic cable using a private network of the Ca*NET type. It is currently difficult on the public Internet to guarantee reserved bandwidth between each of the videoconference points. This is why with commercial videoconferencing services, digital telephone lines (ISDN) are used to connect these points. For multiple reasons, a satellite link is much better adapted for broadband videoconferencing than is a land-line.

The satellite link tested in this project was the mode most commonly adapted for broadband videoconferencing between schools. At present, as regards broadband videoconferencing in public IP mode, the best solution is that all schools be connected with fibre optic cable on the same Ca*NET type private network. However, for schools, if a satellite link is not able to compete with a fast land-line for Internet navigation, the same cannot be said for videoconferencing. In the case

of the latter, a fast land-line cannot compete with a satellite link for videoconferencing in IP mode, except on a private network.

CONSUMPTION OF BANDWIDTH AND GEOGRAPHIC LOCATION

The analysis of statistical data reveals that the schools in the project which are located in isolated areas made greater use of the satellite link than did schools in less isolated areas. To illustrate the consumption of relative bandwidth of each one of these schools, we will analyze the traffic starting from the data recorded at Telesat, in Ottawa. The schools in distant areas will be identified by an asterisk in all the tables of this section.

The table that follows presents the relative percentage of the traffic sent to the schools. These data were collected over a period of 54 days. It is normal not to arrive at 100 % in the total of the column representing the percentages because, to answer a request from a school, it is necessary to forward it to the Internet, and this request is included in the overall consumption. Moreover, in the tables that follow, only the data relating to the schools are represented, and not all of the sites where data were sent.

Table 5.7: Relative percentage of Internet traffic by site

Sites	Isolated schools	% of total consumption
1		0,2 %
2		0,2 %
3		0,2 %
4		0,2 %
5		0,3 %
6		1,2 %
7		6,0 %
8	*	8,2 %
9		0,3 %
10		0,1 %
11		3,2 %
12	*	35,5 %
13	*	25,8 %

The following table presents the relative percentage of traffic which the sites sent towards a central point located in Ottawa for the same period of time.

Table 5.8 : Relative percentage of Internet traffic by school towards a central site

Sites	Isolated schools	% of total consumption
1		0,0 %
2		0,1 %
3		0,0 %
4		0,0 %
5		0,1 %
6		1,6 %
7		7,5 %
8	*	11,1 %
9		0,1 %
10		0,1 %
11		3,6 %
12	*	26,4 %
13	*	47,3 %

It should be noted with these two tables, that, both in terms of the quantity of data sent and received, these three insolated schools are clearly distinguishable from the others. As this system of satellite Internet connection is intended for them, one can conclude, with the reading of these statistics, that it should undoubtedly be used by schools having a similar profile.

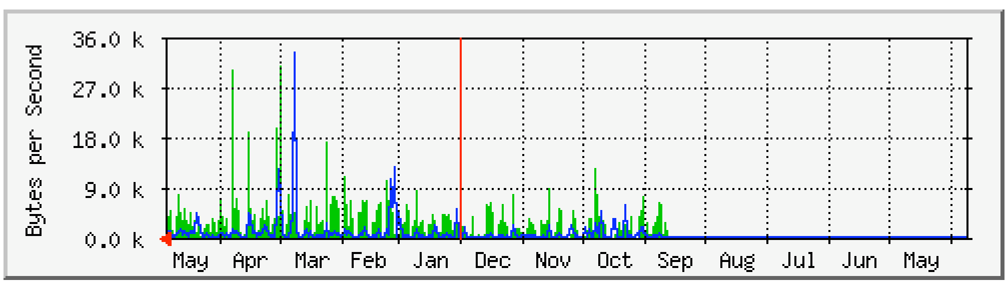
EVOLUTION OF BANDWIDTH CONSUMPTION

Did the schools' consumption of bandwidth increase between the beginning and the end of the project? Unfortunately, the detailed statistical data collected by Telesat and used until now in this report, are available only for the last months of the project. If we want to observe the evolution of bandwidth consumption, from mid-September 2002 through to the end of May 2003, there are only standard data available.

These data have not yet been taken into account in this report for several reasons. They do not fully reflect reality, being based on averages of daily consumption. Considering the average duration of a school day is five to six hours, this will distort the calculations. It is like saying that, in a class of twenty-four pupils, six of them accumulated points, but the eighteen others always had zero. The average will always be weak, then, despite the marks of these six pupils.

In spite of the difficulty in interpreting these data, we can observe that the average consumption of seven schools increased by comparing the period of time involved between September 15, 2002 and December 31, 2002, and that of January 1, 2003 with the end of May 2003. We can observe a case of one school where this increase in consumption clearly increases. The vertical red line separates these two usage periods.

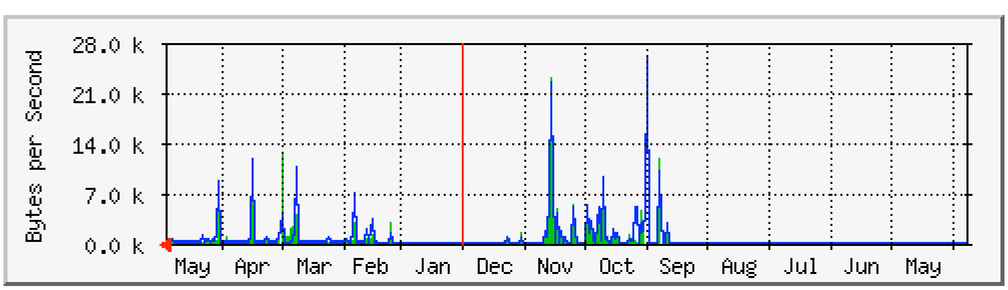
Figure 5.4 Evolution of Bandwidth Consumption



DECREASE IN BANDWIDTH CONSUMPTION

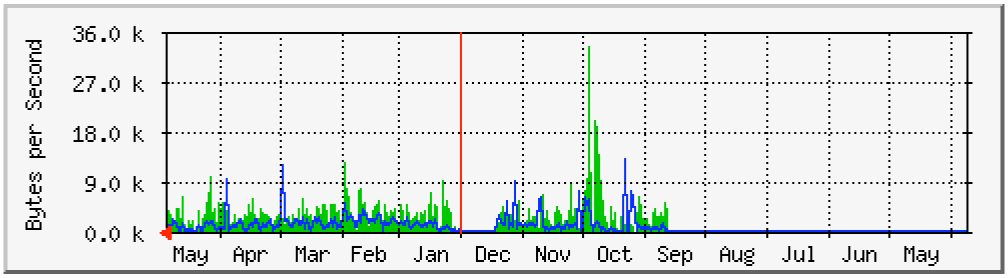
In three other cases, consumption decreased between the first period (on the right of the graph) and the second. The graph that follows illustrates this tendency.

Figure 5.5 : Decrease in bandwidth consumption



In the three other cases, the average consumption appears stable throughout the project. We can observe, here and there in these figures, some peaks in consumption; but it generally corresponds to videoconferencing projects. In the following figure, we can observe peak demand at the end of October.

Figure 5.6 : Peak demands for bandwidth



LOW CONSUMPTION OF BANDWIDTH AND VIDEOCONFERENCING

A simple mention of the word "IP videoconference" with a network administrator typically generates concern because of the high bandwidth requirements of such types of Internet use. Add to that the fact that each session consumes 384 Kbs, for transmission and reception, the administrator's concerns are confirmed. What does 384kbs represent exactly?

384Kbs is that bandwidth which was used for video-conferencing in this project. School users were invited to use videoconferencing as much as they wanted. The principal difficulty, in analyzing the statistical data related to bandwidth consumption, lies in the nature of the H.323 protocol which was used. This protocol uses random ports each time. Fortunately, these are UDP ports, and few Internet applications in schools use these ports. Concretely, the consumption of bandwidth during videoconferencing is slightly inferior to what one observes (see UDP) in the following table (Table 5.9). Videoconferencing consumption was 8% of the total UDP consumption. By comparing consumption in bandwidth of the total of UDP ports with TCP ports, one is assured of obtaining a relative consumption which will be higher than that used by videoconferencing.

The table below presents the respective consumption of TCP and UDP ports for the total of the schools in the project, over a period of 86 days beginning March 4, 2003.

Table 5.9: Global Protocol Distribution

Protocol	Data	Percentage		
IP	133.5 GB (100.0%)	**TCP**	113.6 GB	
		UDP	12.4 GB	
		ICMP	70.4 MB	

Once again, it can be observed that even if one incites users to videoconference, there is a negligible impact on the total consumption of bandwidth. Moreover, this table does not reflect reality, because eight of the thirteen sites used only videoconferencing with UDP and made no real use of TCP. This has the effect of artificially inflating UDP traffic relative to overall traffic.

The table below presents the relative impact on bandwidth of use of this videoconferencing software by the school which used it most. The data are spread over a 45 day period, beginning on April 15, 2003.

Table 5.10: Protocol Distribution

Protocol	Data Sent		Data Rcvd	
TCP	2.7 GB		10.6 GB	
UDP	187.2 MB		425.9 MB	
ICMP	3.5 MB		1021.4 KB	

The relative impact on the total consumption of bandwidth is also of little importance, even given that this school is a significant user of videoconferencing. Its consumption of other Internet applications is also larger.

In light of these figures, it is notable that even in cases where teachers were encouraged to use videoconferencing, there was relatively little impact on the total consumption of bandwidth even though this application consumes considerable amounts of bandwidth. This lack of impact is due to the characteristics of integration of use in teaching and learning. Unlike integration of web browsing, videoconferencing could not be integrated as often and as easily into classroom activities. To hold a videoconference, one needs to have planned the activity with another group. The two groups must carry out the activity at the same time. It is significantly more difficult to organize synchronous than asynchronous activities. This is why an approach to learning based on an individual activity, such as use of a browser will remain for some time more popular than a collaborative activity. There is little need for concern related to bandwidth even in cases where collaborative exchanges with videoconferencing are encouraged.

USE OF VIDEO

Taking into account certain technical aspects, this section on statistics related to use of educational video needs to be treated differently from other parts of this report. First, the technical environment needs to be briefly described.

In each school, a video server was installed. A Sun server was used for this purpose with the Callisto software. This server made it possible to offer users video on demand. This service resembles that offered by Vidéotron and Bell, with "ExpressVu", with fewer time constraints. The only requirement for the teacher was to order the film 24 hours in advance. The video server allowed storage of up to nearly 50 hours of recordings. It was necessary to find supplies of video at low cost and, preferably, free for schools.

Tele-Quebec already had in its reserve more than 1,600 videos that could be used for educational purposes. The video was already classified according to teaching levels (primary, secondary), by discipline and by age groups. Thanks to an agreement with Tele-Quebec, it was possible, for the schools in the pilot to use this video repository for free for the duration of the project. Unfortunately, it was not possible to conclude a similar agreement with other organizations in order to be able to provide access to large amount of content in English. Given this situation, use of the video service for educational purposes was limited almost exclusively to the Quebec schools participating in the project.

Even if it was the Quebec schools that benefited primarily from this service, this situation does not affect the statistical data used to this point in this report. All the satellite traffic related to the transfer of these videos in the schools has not been included in the statistical data used. When a video was ordered by a teacher, it was automatically sent at the same time, during the night, to the thirteen sites in the project, by a mode of transmission resembling the distribution of the satellite television.

Once the video had been transferred to the video server of the school, this visual document was available for viewing by streaming to all computers in the school. In theory, this video server can serve several stations simultaneously on condition that the local area network is able to support this load. As these films are in MPEG1 format during this reading in transit, each station consumes a bandwidth of 1.5 Mbs. If all of the components of the network of the school are not certified to 100 Mbs, one easily reaches a saturation of the bandwidth by using only some stations to view these video documents. Several problems of this nature were encountered in the schools.

If one had wanted to know the total number of viewings, it would have been necessary to be regularly connected to the video server of each one of these schools so as to collect statistics. As the agreement with Tele-Quebec specified that the downloaded videos were to be erased after a certain time, it was difficult to have exact statistics concerning the number of viewings.

According to Tele-Quebec, which agreed to provide statistics, the total number of videos ordered by each Quebec school is presented in the table below. Consistent with the aim of preserving the anonymity of the schools, they will once again be identified from 1 to 5, and this classification will not have any relation to the preceding ones not will it be related to the schools referenced alphabetically (School a, School b, etc.)

Table 5.11: Number of videos ordered per school

School	Number of videos ordered
1	92
2	42
3	15
4	7
5	16

In the statistics provided by Tele-Quebec, it is specified that several schools ordered the same video more than once. This situation occurred 36 times. Several reasons can explain this situation. Taking into account the mode of transmission, the file could have been damaged, or the teacher had not checked whether the document was already on the school's server, or the document had been erased because the period of time during which one could legally preserve this file had passed.

ANALYSIS OF SOME OF TELESAT'S CHOICES

In addition to the results sought in a trial such as this, there are often secondary, unintended outcomes. In this case, certain choices made in this experimental framework provide us with interesting statistical data. Let us examine the consequences of two of these choices more closely. The first choice is that of not employing Web-page filters. The second is the opening of all the communication ports on the videoconferencing workstation allowing the use of any software that makes use of the TPC/IP protocol to communicate.

Absence of Web page filters

Telesat always refused to establish Web page filters to block offensive sites. Installing filters did not form part of the objectives of the pilot project, because it would have required too much effort and the choice of criteria concerning the sites and/or the pages to be excluded would undoubtedly have varied from one school establishment to another given that the schools belong to differing organizations and are situated in different provinces.

We should remember that only five of the schools in the project used Telesat's satellite link for Internet navigation. It is thus relevant to examine the statistics of Web use of these schools.

Let us look first at the total use made of the Web by these schools as illustrated in the next table (Table 5:12). In order to obtain comparable data between these schools of different sizes, two measuring units were retained: the number of requests per pupil and the number of bits transferred by students. Once again, with an aim of retaining the anonymity of the schools, they will be placed in this table, from the largest consumer to the lowest.

Table 5.12: Use made of the web by schools

School	Requests/student	Bits/student
1	4 408	25 774
2	3 526	10 161
3	2 102	9 748
4	1 350	5 145
5	199	917

It is notable once again that there are differences between these schools. Taking into account the method of calculation retained, very low figures generally indicate that students did little Web browsing.

In spite of the absence of Web page filters, we can note the absence of pornographic sites and others of the same kind in the list of the sites most visited by these schools. Here now are the ten most popular sites for some of these schools.

Table 5.13: Ten most popular sites for school 1

Most Popular Sites				
	Organization	**Hits**	**% of Total**	**User Sessions**
1	Site housed at the district office	37216	3.37%	1467
2	Http://us.i1.yimg.com	22339	2.02%	969
3	Http://banner.hlserver.com	114652	10.4%	923
4	Http://us.a1.yimg.com	8345	0.75%	834
5	Http://login.yahoo.com	3260	0.29%	639
6	Http://www.yahoo.com	2369	0.21%	620
7	Http://us.js1.yimg.com	7487	0.67%	612
8	Http://view.atdmt.com	1470	0.13%	570
9	Http://global.msads.net	5664	0.51%	558
10	Http://rad.msn.com	4985	0.45%	511
Subtotal for Sites Above		**207787**	**18.85%**	**7703**
Total for Log File		**1102173**	**100%**	**3841**

Table 5.14: Ten most popular sites for school 2

Most Popular Sites				
	Organization	**Hits**	**% of To**	**User Sessi**
1	Site housed at the district office	276065	52.89%	997
2	Http://www.statistique.tv	2372	0.45%	898
3	School district mail server	4031	0.77%	318
4	Http://www.google.ca	3539	0.67%	283
5	Http://ad.doubleclick.net	1686	0.32%	250
6	Http://www.hotmail.com	394	0.07%	227
7	Http://loginnet.passport.com	418	0.08%	215
8	Http://login.passport.net	783	0.15%	204
9	Http://global.msads.net	976	0.18%	193
10	Http://cb.msn.com	483	0.09%	193
Subtotal for Sites Above		**290747**	**55.7%**	**3778**
Total for Log File		**521903**	**100%**	**1834**

Table 5.15: Ten most popular sites for school 3

Most Popular Sites				
	Organization	**Hits**	**% of Total**	**User Sessions**
1	Site of the province of this school	58480	9.69%	1476
2	Http://windowsupdate.microsoft.com	7364	1.22%	993
3	Http://global.msads.net	5391	0.89%	723
4	Http://c.msn.com	1539	0.25%	655
5	Http://view.atdmt.com	1805	0.29%	631
6	Http://rad.msn.com	6281	1.04%	617
7	Http://www.passportimages.com	1281	0.21%	593
8	Http://spd.atdmt.com	1249	0.2%	576
9	Http://msimg.com	6214	1.03%	571
10	Http://www.hotmail.msn.com	1584	0.26%	536
Subtotal for Sites Above		**91188**	**15.11%**	**7371**
Total for Log File		**603285**	**100%**	**2223**

Table 5.16: Ten most popular sites for school 4

Most Popular Sites				
	Organization	Hits	% of To	User Sessi
1	Http://www.google.ca	13386	2%	862
2	Http://c.msn.com	1143	0.17%	481
3	Http://www.passportimages.com	1064	0.15%	481
4	Http://global.msads.net	3435	0.51%	458
5	Http://windowsupdate.microsoft.com	3050	0.45%	452
6	Http://msimg.com	3873	0.58%	430
7	Http://loginnet.passport.com	933	0.13%	410
8	Http://www.google.com	1029	0.15%	404
9	Http://login.passport.net	1871	0.28%	403
10	Http://go.msn.com	1237	0.18%	399
Subtotal for Sites Above		**31021**	**4.65%**	**4780**
Total for Log File		**667103**	**100%**	**1863**

Table 5.17: Ten most popular sites for school 5

Most Popular Sites				
	Organization	Hits	% of To	User Sessi
1	Http://www.google.ca	1107	2.77%	161
2	Http://global.msads.net	845	2.11%	142
3	Http://windowsupdate.microsoft.com	490	1.22%	131
4	Http://c.msn.com	247	0.61%	119
5	Http://rad.msn.com	836	2.09%	118
6	Http://loginnet.passport.com	218	0.54%	115
7	Http://login.passport.net	442	1.1%	111
8	Http://www.passportimages.com	214	0.53%	106
9	Http://www.hotmail.msn.com	200	0.5%	105
10	Http://cb.msn.com	235	0.58%	102
Subtotal for Sites Above		**4834**	**12.11%**	**1210**
Total for Log File		**39907**	**100%**	**470**

It would be possible to compare the most visited pages and the files most downloaded for each one of these schools, but one would come to the same conclusion: the absence in this list of sites that one generally prohibits in a school. Even if the sampling is weak, one can conclude that excellent monitoring is carried out by the teachers of these schools.

All exit ports open

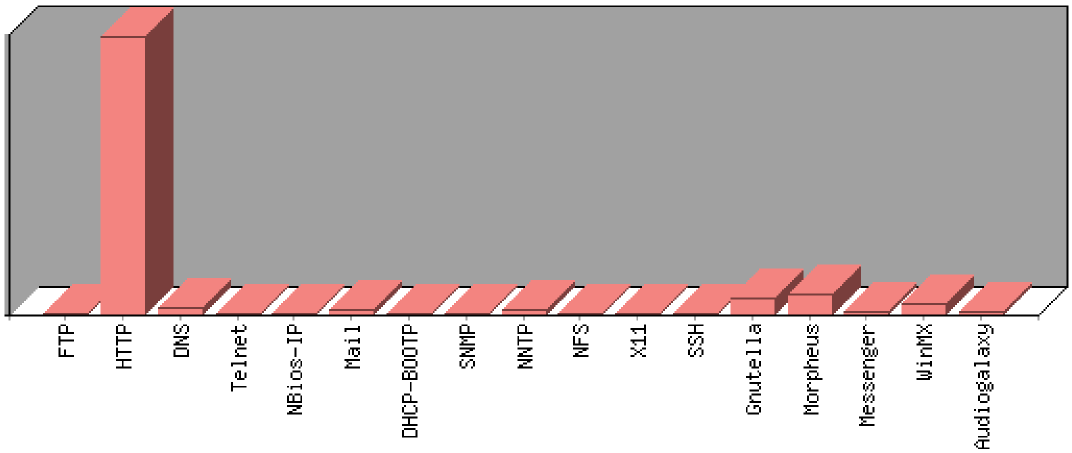
The use of the automatic translation of IP addresses is not a very current practice in the school world. It allows, via private IP addressing, the use in a transparent way of almost all Internet-related software. Concretely, that means the opening of all the ports of communication to the Internet. People regard this practice as dangerous from a security perspective and it is viewed as leaving the system open to excessive consumption of bandwidth. For various reasons, Telesat chose to use the automatic translation of IP addresses in this project, so as to allow use of a vast range of software and in particular software related to videoconferencing. The videoconferencing software used the H.323 standard which required opening of nearly all of the ports. This use of automatic translation is doubly interesting because it allows us to measure the impact on security and on consumption of bandwidth.

In relation to security, any problem of this nature was reported throughout the project, by both Telesat and the schools. For the project and for security reasons, Telesat supervised patterns of bandwidth consumption of the schools. The screening software "Netsaint" was also used to ensure the opening of all of the ports as well as for detecting faults in the integrity of the software using these ports.

It is interesting to observe the use made by the schools of the bandwidth offered. Generally banished software, like "Gnutella" and "Morpheus", was used in two schools. This software makes it possible for users to download files of all kinds and, often, to exchange "MP3" files. These are two popular and well-known pieces of software heavily used by young people.

The following figure illustrates the total impact on bandwidth of use of this software over one 86 day period, beginning March 4, 2003.

Figure 5.7: Total impact on bandwidth of use of file-sharing software



It can be observed that use of the automatic translation, combined with the opening of all ports including those connected to the file-sharing software had relatively very little impact on the total consumption of bandwidth. This graph is particularly revealing in terms of the Internet applications which consume the most bandwidth. The category "HTTP" of this histogram should be even more significant, because only five sites out of thirteen navigated with this satellite link. These data confirm those obtained in a school district which used automatic translation, while keeping open its ports of communication.

This presentation and discussion of the choices made by Telesat concludes the consideration of the findings related to technical aspects of the trial. The following chapter presents and discusses the educational findings.

CHAPTER 6
PRESENTATION AND DISCUSSION OF EDUCATIONAL FINDINGS

The goal of the leading partners in conducting the multimedia satellite trials was twofold: to test broadband access using the equipment provided, and to test the relevance and feasibility of the following pedagogical objectives:

- To make use of new digital media (video, telecollaboration tools);
- To engage in collaborative projects;
- To provide opportunities for teachers to become familiar with the material provided by Telesat and partners, including access to digital video databases;
- To develop new research tools using digital video data;
- To encourage schools to produce video-supported educational resources.

The findings hereafter reported are those concerning all schools together[10]. They are organized in accordance with the conceptual framework presented in an earlier section of this report. They are also organized according to the four dimensions (learner access, supportive context, educational usefulness, value-added) regrouping the specific questions addressed in this evaluation. Detailed descriptions by school are available in the provincial case studies.

LEARNER ACCESS

The installations were carried out in several stages. During the first stage, the material for satellite communication was installed; this stage ended with a videoconference with Telesat, in Ottawa. A brief training session was given to school personnel. Each school had equipment for Internet and videoconference use. Some schools required the authorization of Telesat to connect some other work stations to this satellite link. This first stage of installation was finished, for all the sites except one, in the spring of 2002. During the subsequent stages, the FreeBSD server was installed in order to accelerate TCP/IP with SCPS, the cache for the Web pages and the video server. The last phase of installation involved connecting all school work stations to this

[10] The fourth Ontario site – a school board resource centre that intended to rotate visiting classes through their facility in order to use the Telesat videoconferencing equipment – had working equipment, but it was never used as the desired arrangements for usage proved too difficult to implement.

satellite link. In cases where the school had a satisfactory land Internet link, this last stage was accomplished only once the school wished it.

For eight of the twelve schools, the equipment functioned properly throughout the duration of the project, and the schools were able to make use of the connection and its capabilities throughout the entire period. Three other schools reported experiencing technical difficulties that prevented them from taking full advantage of the connection and equipment for periods of approximately three months in the Fall of 2002. For one school there were often power failures and interruptions. In August 2002, a technical team went to the site in order to resolve certain problems and to change a network component. During the next year, following announced technical problems, checks were carried out remotely and a team returned to the spot to observe that all was functioning normally. In the Fall of 2002, it was necessary to reconfigure the video server following a power failure. The following table offers a synthesis of the availability of broadband access in the pilot schools:

Table 6.1: Comparative levels of learner access to broadband by school

School	**Learner access**
	Limited-- High
School A	x
School B	x
School C	X
School D	x
School E	x
School F	x
School G	x
School H	x
School I	x
School J	x
School K	x
School L	x

Was the system easy to use?

Schools reported experiencing minor technical difficulties when participating in videoconferences with the satellite connection. Students at one school were very enthusiastic about their tutoring work, but did not gloss over the problems they encountered. They found the videoconferencing system easy to learn and use (one boy had had some prior experience with it and taught his partner the procedures involved). These difficulties consisted primarily of audio and video feed delays. Problems were rectified either through collaboration between individuals and schools, or through seeking technical advice from a local expert or Telesat. Testing the equipment before a broadband-based educational activity was found to be a useful practice. Local technicians assisted in equipment setup and debugging, and helped with special arrangements such as setting up the videoconferencing system in the gym for the Robotics Challenge held in Ontario. Telesat's assistance (debugging or troubleshooting: for instance, to reposition the satellite when the signal was lost) was most effective and appreciated by all participants.

Other elements that limited the ease of use and, therefore, the learners' access to satellite-based activities were the number and location of the connected computer(s) in the school. These computers were not always in the classrooms where teachers and students regularly meet. Several teachers noted that a major limitation on broadband availability during the trial was imposed by the lack of mobility of the videoconferencing equipment. A second limitation of the equipment as it was delivered to schools is that it did not include any large monitor or data projector for displaying a videoconference to a group of students larger than five or six, which made it very difficult to use effectively with a large class.

What was the perceived impression of the performance of the system for Internet access, videoconferencing, and video streaming/serving?

Based on the results presented in Chapter 5, we can conclude that all the schools that had another broadband connection than the one provided by the satellite-based system made little use of the latter for Internet access.

As regards videoconferencing, all schools used the software provided by the project to interact with other learning institutions. Basic adjustments that over time became routine, were made to the videoconferencing system and allowed participants to see the system as rather reliable, and performance was perceived as good enough to encourage them to plan more videoconferencing activities. Difficulties experienced when scheduling videoconferencing activities were unrelated to the equipment or connection, and consisted primarily of scheduling conflicts with collaborating schools and teachers.

Connections to CA*Net allowed more collaborative activities to occur (e.g., interaction with university-based action-research team members).

Video streaming/serving was underused. The availability of this type of activity did not meet project's expectations. Only one video bank from an external partner (TeleQuebec) was made available[11] (See Chapter 5 for statistical data). Besides Quebec schools, the three Ontario schools and two Newfoundland schools signed an agreement with Tele-Quebec. Schools could keep videos for 90 days, and download them as often as they wanted. The difficulty in getting a video server limited interested schools' capacity to create and share videos. The lack of English video for access resulted in no significant use of video downloading in Ontario schools.

***What were the other applications for which the system was used*?**

Students and teachers in Newfoundland made use of the software Vclass™ to engage in synchronous text-based communication using two-way audio, whiteboard and direct messaging. Two schools in Quebec attempted to use another videoconferencing system (iVisit), but remained with the videoconferencing application provided by the MSTP. Two Ontario schools made regular use of the whiteboard and remote application-sharing software included with the teleconferencing equipment in their videoconference-based tutorial sessions.

What were the benefits with the applications used over broadband?

All pilot schools enjoyed the advantages of the satellite-based system, but differed in their perspectives regarding its reliability. All participating schools in Newfoundland found it reliable, while schools in Ontario and Quebec found it to be less so. It is clear, however, from participants' comments that all pilot schools appreciated the platform provided to schools by the project, and took advantage of it. Schools that were at a lesser degree of readiness for broadband use at the onset of the project could have gained more benefits if another year of service had been added to the one-year trials, as it was originally envisioned.

Where were school expectations met?

The MSTP project brought high-speed communications to schools in a way that met their expectations, and beyond. However, it must be noted that the installation and operation of multimedia equipment in all 12 schools was delayed. And adjustments needed to be made until the following month of November for two Newfoundland schools, and two Quebec schools. A late change in which a northern Ontario was participating in the trial meant that the school involved did not come fully online with Telesat until the fall of 2002. At the fourth site – located in a school board resource centre – the equipment was functional, but the expectations were not met as efforts were not undertaken by the board to bring classes from other schools into the trial activities using the facilities available at this site.

In short, technical as well as administrative challenges had to be met, in order for pilot schools to offer access to learners during the trial period.

SUPPORTIVE CONTEXT

Support was an important dimension of the trials. Leading partners were aware of its importance. However, support was needed in many ways, and in many cases one or more forms of support remained an issue throughout the trials. The following table indicates that support was of various levels for the pilot schools.

Table 6.2: Levels of support for pilot schools

School	Low support-----------------------------High support
School A	x
School B	x
School C	x
School D	x
School E	x
School F	x
School G	x
School H	x
School I	x
School J	x
School K	x
School L	x

Who were the supporters, or "champions," who fostered technological innovation, or those who provided technical or pedagogical support, guidance, or advice, to schools?

[11] There was also Magic Lantern, but costs were high and it would have been necessary to classify the material with respect to curricula.

At the onset of the project, leading partners were Telesat, SchoolNet, and CRC[12]. They soon found provincial, school district, and local champions as partners. Pilot schools also had their share of leaders in terms of technology adoption. External partners offered an impressive variety of supports to pilot schools, but internal support was also provided. Together, leading (external and internal) partners offered two-dimensional supports, ones that ranged from basic training onsite in the use of the software to online professional development, from onsite trouble shooting to online collaborative activities. At each school, there were at least one or two people (school principal, teacher, and/or technology teacher) who supported the trials and fostered technological innovation. However, some pilot schools had a higher level of readiness than others for undertaking the trials. Nevertheless, they all needed technical support, but some schools were more ready than others for pedagogical support, including online advanced professional development.

What forms of support were available for broadband use and have they been sufficient? What, if any, what were the related problems?

Support took the three following forms: administrative, technical and pedagogical. There was support specifically geared to using the broadband technology, and support related to the use of ICTs in more general terms for schools with low capacity in this regard. And support was provided onsite or online (phone, e-mail messages, and videoconferencing).

Administrative support

School districts were consulted at the onset of MSTP on terms and conditions of their participation (goals, benefits, timing and duration and evaluation of trial). Telesat and SchoolNet expected that schools and their school boards would contribute resources and/or dollars to the project. Response, if any, was unequal. Except in two or three cases, there was little indication of engagement in the project on the part of school districts. Newfoundland (CDLI and Stem~Net made in-kind contributions) and Quebec provincial partners (MEQ and MCC) contributed funding and resources whereas in Ontario one school district was involved at a level far above average, arranging for

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[12] CRC did the installation in agreement with Telesat, and provided basic technical training.

teacher teams to receive summer funding for unit development and providing considerable central office support.

Administrative support for teachers to engage in innovative teaching was also required. School principals demonstrated interest in the project and a willingness to make it succeed, but often delegated responsibility to volunteer teacher(s) (e.g., all Ontario schools, and, 4 out of 5 Quebec schools). Better distribution of technology knowledge among the staff, and ICT integration to the curriculum were issues for them. Time management was also an issue. Because there was little or no funding for teacher time release, available onsite and online support could not be used to its full advantage, except for a few days at the end of the trials[13]. Delays in funding availability severely limited the impact that the facilitative support had on trial outcome, as most of the facilitations had to be undertaken towards the end of the school year.

Technical support

As was indicated in a previous section of this chapter, Telesat and CRC provided basic technical support. Moreover, there was funding from provincial sources (Newfoundland and Quebec) or resources from school districts (in Ontario and elsewhere) to assist with basic technology training in the use of the satellite-based system (Internet access, videoconferencing, and video streaming/serving). The technology training provided a sufficient basis for schools that had engaged for some time in capacity building with regard to the use of ICT, as in the case of the pilot schools already part of the Network for Innovative Schools (NIS). For the schools with low capacity basic training remained an issue throughout the trials. At one school, for example, it was not until onsite training was provided by Telesat staff in December 2002 that the school champion felt comfortable enough to proceed with developing and implementing a project.

However, even in the most advanced schools, the use of the applications provided by the satellite-based system was performed by a few if not by one person only. Those who knew more about technology were often involved. For instance, in Ontario, the two teachers who had the least technical problems using the videoconferencing equipment, and who were able to employ it successfully, were both teaching computer technology courses. All three broadband applications required

[13] Funding to this end came from the action-research evaluation budget.

specific knowledge in order to become familiar with the equipment (videoconferencing and video streaming/serving) or to adapt one's expectations with regard to the functioning of a satellite link as opposed to a land-line. (See Chapter 5)

Even if project participants did not have at their disposal 24/7 support, the support personnel involved in the project did not count their hours. Personnel were always available to solve a problem and to ensure that equipment was functional in the evening and on weekends. The person in charge at Telesat, Mr. Fred Markauser, and the members of his team were available by email at almost any time when a problem was reported to them. As in any pilot project, technical problems occurred, but these people were always there to try to find solutions. Several teachers commented on the high quality of phone support provided by Jon at the Telesat centre in Ottawa.

Pedagogical support

Beyond receiving basic training in the use of the satellite-based system[14], participating teachers offered either onsite or online pedagogical support to one another. On the one hand, school principals noted that professional development activities were far from sufficient in preparing staff for exploiting broadband's potential. On the other hand, some teachers showed leadership and resourcefulness in engaging in just-in-time consultation with colleagues.

SchoolNet provided support through the NIS and Grass Roots programs. (Half of the participating schools were part of NIS.) A good number of participating teachers, especially in Newfoundland and Quebec, got funding from the GrassRoots program.

The planning and implementation of educational activities in collaboration with partners like the CRC, Stem~Net, the Canadian Space Agency, and GRICS included online pedagogical support to pilot schools' participating teachers and one face-to-face training day in two schools. Two teachers participated in one school, and all teachers in another school. The videoconferencing projects in which the Canadian Space Agency participated occurred early in the trials; the first session took place on May 2, 2002.

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[14] The web site (www.telesat.ca/schooltrials/website/) provided essential information on the trials, including corporate and educational partners. It was also the place for schools to share their learning activities in a public manner. Michelle Mayer, CRC project coordinator, commented in this regard: "It's a tool for sharing information – a link among the schools to see what other schools are doing and also to find ways to collaborate. It's also good for teachers to see the lessons learned by other teachers during the trials." The website included a web board where students and teachers could post comments and information.

Moreover, members of the action-research evaluation team provided some pedagogical support. Support was not only geared to broadband-based activities. It related to a number of pedagogical issues around integrating ICTs into the curriculum. Furthermore, during the last weeks of the trials, support regarding the sustainability of new pedagogical practices was offered to interested participants.

In short, there was external support, and more so for schools with a better capacity in the use of ICTs. Schools with low capacity made some modest efforts to participate in the trials, but often lacked the support resources to participate effectively.

EDUCATIONAL USEFULNESS

The project was instrumental in providing both a context and support that encouraged teachers to apply learner-centred and collaborative approaches. Both of these approaches are highly recommended by advances in cognitive science (Bransford et al., 1999). That is to say that the constructivist approach was reflected in many of the learning activities in which teachers engaged students. This approach has gained much visibility in education, and is reflected in school provincial curricula.

From teacher-centred to learner-centred

Less direct instruction was carried out when engaging students in broadband-based activities. As indicated in the table below, the majority of the activities planned and carried out by teachers show characteristics of constructivist and collaborative learning situations, with very little emphasis on simple transmission of content.

Table 6.3: Analysis of teaching approaches by school

School	Teacher
	Transmission ----------------------------------Facilitation
School A	x
School B	x
School C	x
School D	x
School E	x
School F	x
School G	x
School H	x
School I	x
School J	x
School K	x
School L	x

Videoconferencing supported the full range of teaching approaches, from transmission of information to facilitation of peer-to-peer learning. All videoconferencing activities were of a collaborative nature in the sense that they all required at least minimal collaboration between pilot sites or with other partners for planning and coordination. Some activities engaged students in collaborative learning. Where it was accessible and used, video streaming/serving was appreciated for beginning or enhancing an educational activity. In the schools that had no land-line, satellite-based Internet access (or Web access) became a lever for inquiry in the classroom (one school) or a new source of information (four schools). Broadband-based activities were of various types, and none received negative evaluation from participants. There were unfulfilled expectations, but no comments regarding the inadequacy of some activities.

What specific types of teaching activities involving broadband have taken place?

Collaborative activities could all be conducted using the two-way high speed connection over satellite. Although attempts may have been more successful in one occasion or in one context than another, the following classification of possible activities is presented:

HIGH-INTERACTIVE / LOW VISIBILITY BROADBAND ACTIVITIES

Project-based collaborative learning

- **Planning collaborative projects.** Teachers and students engaged in planning projects of various nature using email, chat, discussion forums, and videoconferencing system. They built on innovative practices already in place.

- **Information sharing.** Students shared information about a number of topics (e.g., their region) combining the creation of web pages with the videoconferencing system. For instance, students at one school participated in the Parks Canada "Ecopal" project and shared information about national parks in their area.

- **Information seeking.** Students asked questions to people from outside their local area using mostly e-mail.

- **Storytelling.** Students told stories about their local communities on the Web and using the videoconferencing system. In the “Our Local Marvel” project, students inquired into a local natural wonder, and delivered results to students from other schools during videoconference sessions. In one school, short video clips captured the atmosphere of community locations. Another school showcased the virtuosity involved in its Inuit sports.

- **Problem solving.** Students shared design and research tasks. In one school, for instance, students worked in problem-solving groups with Dr. Berinstain and teachers during the “Mission to Mars” activity. The designs for the kite-building collaboration developed at one school, and the programming challenge planned for by another school, also incorporated extensive collaborative design and problem-solving activities.

- **Creating learning materials.** School websites contain many publications: a full range of engaging K - 12 science projects, GrassRoots projects, video clips of guest speakers -- reusable videos of the presentations, creating content that could be used throughout the school, and shared with other schools. In one school, teachers are compiling a cache of French language videos for use in second-language instruction. In another school, teachers and students filmed demonstrations and visits of guest speakers to be shared with other schools and stored on the school's server for future use. Students at this school also taped their literature fair presentations for sharing with other schools. They participated in Heritage and science fairs virtually. Yet, in another students edited images using multimedia applications, and added captions to the pictures in French, thereby constructing content for their studies of French language and grammar. A set of replicable school projects for elementary gifted students was produced, a kindergarten project using talking books, and many others.

Collaborative teaching

- **Exchanging educational resources.** Teachers sent and received multimedia files and other resources.
- **Planning to teach collaboratively.** In collaborative teaching, pre- and post reflection on action is necessary. Teachers who used the videoconferencing system to adjoin their classrooms had to plan their teaching activities, and coordinate their activities. Post-reflection considered how their students were learning and upcoming activities. More often than not, coordination was needed with technology personnel before and during an activity. Teachers interested in broadband-supported collaborative teaching also wanted a greater number of school teachers to explore potential collaborations with, and more flexible school scheduling.
- **Giving lectures to students from another’s teacher classroom.** For instance, the Hormisdas-Gamelin Secondary School in Buckingham, Québec, just across the river from Ottawa, had the bandwidth necessary to use the videoconferencing system for offering violin lessons to elementary-level students from a northern school.

- **Teaching mother tongue to peers.** An Anglophone school and a Francophone school engaged in interactive second language teaching. A French immersion school also had a second-language project. However, this project’s videoconferences, while very generative and authentic on one level, encountered language difficulties that impeded meaningful conceptual exchange and collaborative learning.

- **Offering and taking distance education courses.** Teachers from the Centre for Distance Learning and Innovation in Newfoundland used an online collaborative environment to deliver educational content, and to act as instructors, moderators, and monitors of student progress in distance education courses. Teachers from one school engaged in monitoring the work of students taking online courses.

- **Peer tutoring/mentoring.** During the "Mission to Mars" virtual event, senior high school students mentored grade 6 students. There was also the Web page peer tutoring project between two Ontario schools, in which students at one school tutored students from the other school in Web page creation. The tutors had to engage in considerable amount of collaborative experimenting and problem solving to respond effectively to the younger students' queries. The participating students at one of these schools shared their newly-minted expertise with other students in their class, acting as mentors to them.

- **Providing expertise or service.** People from the local community, another school or organization acted as mentors, coaches, or providers of expert advice. Science experts helped with science fair projects. Consultation with a guidance counselor has been made easier in the case of one school.

LOW-INTERACTIVE BROADBAND ACTIVITIES

- **Direct teaching in one's classroom using video-on-demand.** High quality educational video programs downloaded for local storage and playback on demand were used in a few schools.
- **Researching and locating educational resources.** The Internet was tapped as a reservoir of resources for students to conduct online research, and complete a variety of projects.
- **Listening to and communicating with a guest lecturer.** Canadian astronauts Steve MacLean and Marc Garneau were guest speakers. Their audiences were made up of students from elementary and high schools from across Canada. However, some teachers and students were disappointed: students had prepared questions for the astronaut but had little opportunity to ask them.

HIGH-INTERACTIVE BROADBAND ACTIVITIES

- **Hosting a virtual visitor.** Dialogues with online guests were conducted with whole classrooms and also with the school's teachers participating in the trials.

- **Learning online with special teachers.** Learning activities characterized by a high level of interactivity between a teacher and students wanting to learn from him or her **--** practicing music, discussing with a technology experts, reflecting with a university professor.

HIGH VISIBILITY BROADBAND ACTIVITIES

- **Participation in a grand-event virtual classroom.** Projects planned and implemented by a partner or partners with high expertise in a domain. For instance, a special learning event was co-hosted by the Communication Research

Centre (CRC), the National Research Council (NRC) and the Canadian Space Agency (CSA). A number of schools from across Canada participated. The pedagogical focus, specifically designed into the event, was “student problem-solving and building scientific knowledge together about space with an expert mentor”. Explanations and demonstrations were built around concepts inherent in the topic “Structure in Space”. Students engaged in problem-solving activities.

- **Participation in existing e-learning programs and networks.** One school participated in The CANARIE Music Grid e-learning project, which is researching distance music education using broadband technology and which built on the infrastructure developed during the Learn-Canada project. Another school provided connectivity to a school that was participating in the École éloignée en réseau project in Quebec. Both engaged in collaborative activities.

From absorption to the creation of content

There were some appropriate interactive learning material and learnware available in the trials, and there were also, in Newfoundland, distance education courses available, but more often than not teachers engaged students in constructing content. Students got to present their projects, and in the process transmitted content, as, for instance, in the high-visibility projects such as the ones of the Canadian Space Agency. In another instance, junior-high school Social Studies students constructed and exchanged content when studying other communities throughout their province, and with their peers in a school in New Mexico. In another school, technology and broadcast journalism students watched grade three students at another school.

Table 6.4: Analysis of approaches to content by school

School	Content
	Pre-organized-------------------------------Constructed
School A	x
School B	x
School C	x
School D	x
School E	x
School F	x
School G	x
School H	x
School I	x
School J	x
School K	x
School L	x

As mentioned earlier, doing projects between pilot schools resulted in content creation. But the risk was that the content of the learning, while constructed rather than predetermined, would be superficial (e.g., at one school, due to the communication difficulties encountered), and so could not be rated highly.

How do these activities differ from current activities? Were broadband-based activities integrated into the provincial curriculum?

Compared to what is often observed in classrooms, the tasks that were performed by teachers and students were less commonly of the demonstration type, and less single-stage tasks or multi-stage broken into single-stage tasks were found than is typical. The need for students to complete whole tasks by themselves (associated with the Knowledge Age) rather than single-stage tasks (as common in the Industrial Age) is on the rise, and who does the thinking between the tasks becomes a critical question (see Skilton-Sylvester, 2003, p. 13).

Teachers, however, felt the pressure to integrate the ICTs and broadband-based activities into their provincial curricula. There were few exceptions. For instance, one school district is keenly supportive of technology-enhanced hands-on learning. “We believe that technology is a valuable educational tool,” they explain, “one which can enhance student learning at all levels and expand the scope of the curriculum in many innovative ways.” The school district’s enthusiastic support was reflected in the participating school’s beliefs about student-centred learning, published on the school’s Web site. The school’s beliefs include working together with students “as a team”, “encouraging students to become independent and motivated learners” and “meeting challenges and in meeting others in their challenges”. The grade 6 class at that school studied robotics. Working in small teams, students were expected to invent, build and program a computerized robot out of LEGO to solve a challenge. Later in the year they competed in the province-wide Robotics Challenge, along with several other classes in the school district.

There were also teachers for whom it was difficult to find the time to fit broadband related activities into their curriculum, and daily teaching. Some expressed interest in the broadband-based activities, and others did not.

VALUE-ADDED

Enhanced connectivity

Did the project provide a platform for schools to enjoy the advantages of high-speed access?

Teachers and students from the schools in one province both expressed high levels of satisfaction with ease-of-use, and with the speed with which they could access resources and accomplish educational tasks while using the satellite connection: “Speed is the big advantage we see today with broadband,” said one school respondent. Another school noted that the FTP capacity of the large bandwidth was the feature they considered the most important, and it enabled them to carry out collaborative projects with two of the other provincial schools. Teachers from another school also noted that the connection had enabled a wide range of opportunities, and had provided access to a variety of resources, that would have otherwise been impossible given the school’s remote location. For example, students were able to enter into provincial and national competitions in broadcast journalism, robotics, and other sciences. Students were also able to avail of access to expert mentors.

Schools in another province were also satisfied with the connectivity level, especially those in the most remote areas. The three schools that had or could have in the short term a land rather than a satellite link kept comparing performances or hearing from people who were comparing performances to the advantage of the former for Internet access. In the third province, all participating schools had land-line access to the Internet at satisfactory speeds; but they all valued the additional capacity that the satellite system brought to them for videoconferencing. The short time lags that this transmission mode introduced into conversations was noted as an inconvenience, but not a major impediment to its use. Overall, for videoconferencing with schools within the network or with learning institutions that had CA*NET 4, the connectivity level was found to be very good by all twelve schools. (See Chapter 5.)

Have school experiences with broadband meshed with their initial expectations?

Access to faster and more reliable Internet connections enables more efficient use of teaching and learning time, and all schools that saw their Internet access augmented by the satellite link were grateful. With regard to video streaming/serving, locating digital video resources to add to a school video cache proved to be a daunting task, as did experiments with establishing school-wide network connections to distribute such access to the classroom. Regarding videoconferencing, the potential for videoconferencing to facilitate exciting and beneficial exchanges in the future was uncovered, and the majority of participating teachers expressed the view that they would like to see more such exchanges integrated into teaching and learning experiences. However, there was considerable disappointment expressed at some schools over an inability to find other schools to collaborate with on carefully planned projects, projects that as a result were never implemented.

Emerging school-to-school collaboration

***Did the system provide connection over the Internet to the World Wide Web to other learning institutions*?**

Most of the collaborative activities in which students participated were conducted as a result of the recognition of the value and authority of experts, and of formal educational initiatives such as the SchoolNet GrassRoots program and special projects organized by the leading partners (CRC, and GRICS in Quebec). Overall, pilot schools' capacity to network was enhanced: students had opportunities to know other students, and teachers to plan, coordinate and conduct learning activities. Two teachers from one school described how they had been involved on many occasions in videoconference meetings with teachers from other schools. They had used those meetings to discuss ideas with their remotely located peers, to organize activities, and to find solutions to technical challenges. Teachers from a few schools noted that they had worked with teachers from other schools in this way, and that those meetings had been very beneficial. They described how they had exchanged useful ideas, and helped one another to prepare for activities such as videoconferences, and to sort out technical difficulties that they were having.

While none of the pilot schools implemented any large amounts of formal professional development programs dealing with the use of the connection, a majority of participating teachers mentioned that they had worked collaboratively with colleagues throughout the year to improve their skills. That collaboration most often took the form of working together to generate ideas for using the connection with their classes, to plan and coordinate activities such as videoconferences, and to find solutions to technical problems they were experiencing. For instance, teachers from one school described how they had often held one-on-one or small group professional development sessions, in which they would share their expertise with their colleagues, and teach each other how to use various features of the connection. However, in the majority of the pilot schools, only one or two teachers were involved in MSTP.

The connection to higher learning institutions was offered by the action research team, and experienced by most pilot schools in the context of research and/or facilitation activities.

MSTP was a lever for innovative teaching. The majority of the teachers involved in broadband activities used pedagogical approaches that focused on student-centered and student-driven learning, and techniques that emphasized collaboration between students, classes, and schools. For the most part, participating teachers relied on collaboration with their colleagues, assistance from Telesat, and the efforts of teachers who emerged as leaders in school efforts to integrate technology, learn how to use the equipment, and develop innovative teaching and learning activities.

Moreover, one teacher argued that broadband had been an eye-opener for many teachers at his school, and that he knows of at least six teachers who were now planning on pursuing graduate studies via the Internet.

To what extent did teachers work with colleagues from within their school or from another school in joint planning or curriculum development for broadband use*?*

The MSTP provided opportunities for school staff to collaborate within each pilot school, and between pilot schools. For example, one teacher claimed that he saw it as important to bring cross-curricular collaboration into the school. As a result, the teacher explained how he began to take a cross-curricular approach with his junior-high school technology classes. He explained that through his approach to teaching technology, students would first “get the capabilities,” and then use them to complete work for other courses. Participating teachers commented that the connection had provided them with valuable opportunities to interact with colleagues from their province, and also with a few from different cultures. However, there was evident frustration on the part of several teachers due to the difficulties encountered in finding partners at other schools with which to collaborate.

Was provincial and national inter-school communication important and useful for teachers and students, and if so, was the system in place used for that purpose? What obstacles were encountered?

Such communication was found to be interesting, but more often than not it was not found important enough given the efforts that were required. Several projects were either planned for or anticipated, but only a minority of them were implemented, due to time pressures and difficulties in finding other broadband-enabled classes outside the school to partner with on projects. The identification of relevant learning objectives was also an issue and so were the obstacles encountered or remaining in the way of such communication. As noted above, teachers raised concerns about the difficulty in making contact with other schools, or third parties, interested in participating in collaborative activities such as videoconferences. It was difficult for them to coordinate scheduling for such activities, particularly with their colleagues from schools in other provinces. The potential for such collaboration was easier to see at the district or provincial level. But such coordination will require time. It was suggested that it might be useful to either have someone oversee the coordination of collaboration between schools, or have someone responsible for generating ideas for collaboration, and contacting schools and teachers that might be interested, in order to coordinate such efforts.

The greater speed, scope and, above all, the enhanced reliability of the new technology have encouraged more teachers and school principals to invest in technology. By being linked to other schools and learning networks, pilot school participating staff and students became aware of a new range of possibilities for teaching and learning. As they shared information among themselves and with trial managers about their learning experience, they built capacity in broadband-based activities. However, in high school, teachers have a complex curriculum to cover within a short time frame. Many teachers would like to implement ICTs within the subject areas they teach. However, they may feel they have little teaching time to spare (after covering the content of their courses) for taking on ICTs or broadband activities.

Learning outcomes

Teachers and staff were trained in using new technology for teaching and learning, especially broadband applications. The opportunity to engage students in collaborative projects with other schools across the country was seen as an excellent way to expand student perspective while developing new project management skills. It also provided new opportunities for peer tutoring and shared learning which enhanced student mastery of complex tasks that involved problem solving. Participation in the MSTP also provided a range of alternatives for the professional development of teachers. Even in those instances where the implementation of planned projects was not possible, the development efforts undertaken by staff expanded their appreciation of the potential broadband held for supporting collaborative and constructivist learning.

Has the use of broadband affected teaching practices and approaches in your school more generally? In what ways?

There was no evidence from either teacher reports or in cursory observation that the broadband activities undertaken at the participating schools had had any lasting impact on school teaching practices. Given the limited extent and length of the trial, it would seem unreasonable to expect significant transference of teaching strategies to other contexts. Within those classes engaged in broadband projects in Ontario, the teaching strategies typically employed were already quite generative and constructivist in their orientation. In the other two provinces, there was some evidence of capacity building in the design and conduct of more constructivist learning activities.

Did students benefit from the use of ICT? In what ways? Have they benefited from having access to broadband? How?

There was at least one teacher comfortable with the satellite-based system in each pilot school, and in almost all cases other teachers also experienced and conducted broadband-based activities. Therefore, certain students in each school had opportunities to experience high-speed access to Internet and video conferencing. Some of them may have been in contact with off-site pedagogical resources and/or they may have downloaded files or developed web sites or pages. Some of them had opportunities to exchange with students from other pilot schools, and even to engage in collaborative projects. Identified benefits that tend to influence students' relationships to their learning environment, which are in turn related to school success, are the following ones:

- **Increased student motivation was a clearly identified benefit at all sites.** Teachers know that student engagement is key to learning. Newfoundland students anticipated participating in videoconferences with far more enthusiasm than any of the other activities facilitated by the connection. Teachers noted that students tended to be on their best behavior when participating in videoconference exchanges. The students participating in inter-school peer tutoring in Ontario were able to work largely without teacher supervision and still remain consistently focused on their tasks. In one northern Quebec school, students' interest in broadband-based activities was often mentioned in the interviews and students themselves expressed a greater liking for school.

- **Engagement in authentic activities and projects.** This is another key learning condition. For instance, in one Newfoundland school primary grade students were very excited about being able to present their accomplishments to older students from another school, and the younger students were amazed by the multimedia products that their older peers created as a result of those presentations. The authenticity of the learning experience could be very high. Another example: the students providing the tutoring at an Ontario school needed to master content quickly to serve a real purpose—"teaching others."

- **Opportunities to participate in events on provincial and national scales.** Such events are often not accessible to students in remote schools. Teachers valued opportunities for students to interact with their peers from around their province, and from different cultures. They valued the exposure students were given to other regions and cultures in Canada.

Research tends to show that digital technologies enhance student motivation, satisfaction and engagement (Owston & Wideman, 1997). Declining student interest in school is noticed as early as in Grade six. In the United States, the states of Maine and Michigan recently justified their laptop programs in terms of raising student interest. "Engagement in school is an important academic outcome in its own right" affirmed Furrer and Skinner (2003, p. 159) in their study of the effects of students' relatedness to peers. The MSTP, however, lacked the density, range, and similitude of activities that would be required in order to evaluate the effects of the program on students' academic results, except for the ICT skills of those who had substantive and significant access to the applications made available:

ICT skills

- **Acquaintance with broadband-based applications**. Some students played a rather passive role but others had opportunities to access the Internet, and even operated the videoconferencing system and associated data and application-sharing tools on a recurring basis.

- **Students' ability to learn online.** To be able to search the Web for themes and questions of interest and to be able to publish their ideas "so others outside the school benefit from them" represented an advantage for participants. To trust one's capacity to find relevant information on the Web is important. In order to build such self-confidence, successful experience is needed. A teacher from one school noted that he was amazed by what students could now accomplish in one school year because of the speed and reliability of the Internet connection.

Providing that access to broadband becomes a regular feature of remote rural schools, changes in vocabulary skills could eventually be measured (pre/post), and observations could be made as regards reading comprehension, self-concept (social & academic), higher-order thinking skills, problem-solving skills, and writing skills.

What new possibilities for teaching do you envisage as a result of the provision of broadband that have not happened yet at this school? Which do you think are the strongest possibilities?

ICTs can be integrated across disciplines: "A lot of the subjects taught in school," one teacher pointed out, "share many of the same outcomes. Using ICTs to cover many of these across disciplines could free up more teacher time to incorporate ICTs in individual subject areas to benefit student learning."

Another teacher pointed that the arrival of reliable, high speed Web access has meant access to a wealth of current, curriculum-relevant materials. Now, with videoconferencing, as one teacher explains, "Outside expertise now can come into the school, through on-line visits and talks."

The range of planned projects that were not implemented provides a direct indication of the possibilities teachers foresaw for broadband that had not yet happened. These projects incorporated collaborative problem solving and knowledge building activities that were both generative and authentic (authentic in that they were instrumental to the successful completion of valued tasks, such as the mapping of local topography by kite-mounted cameras).

Were there any negative consequences of broadband use for any of the students?

Only one was identified: A concern was expressed by a teacher at a school that his female students had lower levels of participation in tutorial interactions with another school, and that this needed to be addressed somehow in future projects.

Chapter 7

CONCLUSIONS, LESSONS LEARNED, AND RECOMMENDATIONS

The project's technical goal was to test broadband access using multimedia equipment as a means of preparing for the upcoming availability of the new satellite AnikF2. Schools had the technical capability, some for a few months and others for a year (May 2002-May 31st, 2003), to conduct video-conferencing, take advantage to broadband access to Internet, and download, produce and distribute video files. At the pedagogical level, the goal was to test the relevance and feasibility of the use of new digital media (video, telecollaboration tools), broadband-based collaborative projects, access to digital video databases, and school production of video-supported educational resources. In addition, the development of new research tools using digital video data was envisioned. This chapter presents the research team's conclusions about the trial outcomes with reference to the above goals. It summarizes the lessons learned and provides recommendations for further broadband development in K-12 education.

Conclusion 1

At the technical level, the project goal was minimally met.

Leading partners wanted leading-edge use of broadband. Pilot schools wanted better connectivity levels or to expand their range of use for that connectivity. Their level of connectivity increased (internet access, videoconference, and file transfer). As a result, more is now known about what is required at the technical level for broadband connectivity to become part of rural remote schools' infrastructure. This conclusion is based on the broadly defined criteria for success applied (see the conceptual framework), given the exploratory nature of the multimedia trials.

However, the MSTP was not without shortcomings. The selection criteria of pilot schools restricted the range of results. Most significant data were provided by remote schools. With a few exceptions, those schools also showed greatest interest in the multimedia trials. As the willingness of the teachers to experiment with new ways of teaching as well as their capacity to do so are very important mediators of success, these should have been taken into better consideration. The importance of these criteria (location, motivation, and competence) was overlooked.

Lesson learned 1

The target population for access to broadband connectivity through a satellite link is the remote schools of Canada, and equality of opportunity is the educational principle at stake.

Access to broadband connectivity through a satellite link is required in Canada in order to provide access for any school in the country regardless of its location. One must keep mind, however, that over 80 per cent of the Canadian population has access to broadband technology, through a land-line. The findings of this evaluation clearly demonstrate that schools are most likely to prefer a land-line than a satellite link for Internet access. Therefore, the rural communities across Canada that are currently without access to broadband or will remain without such access constitute the target population for access to broadband connectivity through a satellite link. According to the quantitative data of this study, three of four of the most remote schools used the satellite link more than all other sites, and the fourth remote school had a land-line, unlike the other three. They used it to access off-site educational resources (people and materials, including interactive courses and websites). But this is a narrow market for satellite access providers, and there are issues related to availability and cost.

Given the importance of the principle of equality of opportunity in education systems, schools must to be able to access the Internet, and especially the World Wide Web. The more they become aware of the realities and constraints facing the country's most remote schools in regards to connectivity, educators committed to this principle, including the Canadian Education Association (CEA), are likely to be grateful to satellite companies that face the challenges of providing access to these schools. The latter must be encouraged, if not pressured, to keep providing access to rural schools at a price schools can afford. Otherwise, learners in such areas will be deprived of opportunities to participate in the "new paradigm of work" (Tapscott, 1999; Skilton-Sylvester, 2003). Therefore, recommendation one is made to Federal Ministries (Industry Canada, HRDC, and Heritage Canada) and Pan-Canadian organizations such as the Canadian School Board Association, the Canadian Teacher Federation, the Canadian Association of School Administrators, and the Canadian Association of Principals) that are in a position to recognize the necessity of satellite access for broadband connectivity:

Recommendation 1

The availability of a satellite link for remote rural schools is of primary importance for achieving equality of opportunity in the 21st Century. The needs of the most remote rural schools in this regard have to be voiced, recognized, and acted upon.

Conclusion 2

At the pedagogical level, schools' and leading partners' expectations were met, but within limits.

All twelve pilot schools built their networking capacities as they engaged in broadband activities, especially Internet access, videoconferencing, and/or file downloading. Access to the Web was the primary use of broadband, and time saving was the most noticeable element of satisfaction for remote schools that could not have a land-line. But for those who had experienced a land-line in their pilot school, or elsewhere and who knew that the particular pilot school with which they were associated, could get one, the satellite link was too slow for Web access. For teachers who engaged or wanted to engage in collaborative activities with other schoolteachers through videoconferencing, the circle of potential collaborators (12 schools) was too small for successfully pursuing authentic and other curriculum-related activities.

Leading partners were aware that technical or institutional barriers would need to be removed in order to make this system as attractive and useful as possible. Another important limit was the fact that, in most pilot schools, videoconferencing and faster access to the Web interested only a limited number of teachers. In at least 4 schools, a teacher acted almost alone, and did more than one job at a time when supporting the participation of a few other teachers. For all other teachers, logistics and overhead were issues: for the majority of the pilot schools' teachers, trust in the reliability of the system and in their own capacities as well as time management were 'in play'. This came as no surprise as researchers into the use of technology know that, in schools as in other contexts, trust in technology is a critical element in its use. People tend to opt for the simplest support solution. Though the satellite-based system was robust, there were routine tests and adjustments required when doing videoconferencing. Teachers are easily dissuaded from using technologies if it involves any 'fuss'. As one ICT coordinator noted, teachers need to be able to quickly and effortlessly use the system with assured reliability; he and others felt that the systems used in the trial were not yet at that level of maturity.

Lesson learned 2

Capacity building in the use of broadband is as important as connectivity itself, and this requires organizational change through proximal collaborations.

Amongst the most remote schools, the one that was the exception with regard to the use of the satellite link (as quantitatively demonstrated), had little capacity in the use of ICTs. Qualitative data analysis showed that teachers were building confidence in the use of the Internet. More generally speaking, the trials helped develop teachers' perception that broadband may be reliable. A few schools that were without technology implementation plans began to develop one. In schools where better basic capacity in the use of ICTs existed, more advanced uses of broadband were observed. These included project-based collaborative learning, collaborative teaching, peer tutoring and mentoring, and active participation in grand broadband-based events or province- and Canada-wide activities. Teachers, school principals, local champions, and researchers had glimpses into how organizational change and broadband-based activity are intertwined. Collaborative teaching and learning took on new positive meanings for participants. These related to how work "production" in school is organized (e.g., coordination of adjoined classrooms for collaborative teaching as in the violin course; collaborative project implementation as in the peer tutoring project between two schools, how work organization may change with broadband (e.g., more team work within and between schools), and how educational resources are developed and shared (e.g., more homegrown and shared educational resources).

Teacher leaders in these new practices evolved their views of a broadband-enabled school and of its activities during the trials. And their school principals were supportive and, at times, so too were school district personnel. Applying the principle of proximity from social psychology, serious adoption of broadband-based activities are more likely to involve schools from the same school district or province. Some communication and collaboration with schools from other school districts, provinces and countries were successfully brought to being during the trials, but these special projects, while being of high interest from a cultural perspective, driving interest and being highly motivating for students, remained sporadic, and a good number of planned projects were not implemented. Therefore, the major challenge to the proper use of broadband to enhance and transform teaching and learning lies more within education organizations and systems. Recommendation two addresses this challenge

Recommendation 2

The window of opportunity for collaborative teaching and learning supported by broadband must be seized first at the classroom, school, and school district levels before higher-level linkages are attempted.

Conclusion 3

The MSTP had greater immediate impact on teaching and learning practices when access was high and when support was high, including professional development support.

The need for technical support cannot be underestimated. When computers or the network do not function properly on a regular basis, they become an additional stress factor for teachers, who are then less encouraged to innovate in their pedagogical practice. In the MSTP, most of the technical problems that were encountered were not a matter of the satellite link. Transmission problems were easily identifiable and quickly solved. This was not the case for glitches located within pilot schools such as the following problems: an electric power bar which is shut off, a disconnected cable, a server stopped following a power failure, etc.

We sometimes observed response times that were much too long but which could have resulted as much from the network of the school as from the satellite link. These problems turned out to be much more difficult to identify. It was often necessary to go to the site to identify the nature of the problem and, meanwhile, the service was not available to teachers. In a school where there was a person ready to regulate and/or identify the majority of these problems, the degree of satisfaction was greater. A teacher having the required knowledge could fulfill this role. It would thus be appropriate, in the future, when the installation is finished, to devote one day to the training of a teacher of the school so that he/she can solve problems of this type. At the time of this training, the principal problems to be solved should be simulated so that the teacher can learn to regulate them and/or identify them quickly. It would be more than desirable that the trainer be available throughout the project to help these teachers in the schools. One of the schools in the project had a person in this role and this helped the other teachers considerably. It was possible to observe in the statistics that the teachers of this school made more use of the satellite link.

Pilot schools that already had developed capacity in the integration of ICTs and manifested a sense of purpose in engaging in such innovative activities were more inclined to see the affordances provided by the project. Participating school personnel could make better sense of the difficulties inherent in the technology. Broadband-based activities tended to generate more excitement in pilot schools that had been engaged in opening up the world of new learning opportunities provided by ICTs. In all cases, however, bandwidth turned out to be much appreciated.

Lesson learned 3

Capacity building and collaboration take time, and clarity of purpose is essential

Being innovative is hardly considered enough when it comes to student learning and contrived education. Fads come and go. But for educators to rest on their laurels given the challenges and issues related to student motivation and the global economy is too conservative a path. New technology (connectivity, hardware and software) is being deployed in schools for reasons pertaining to innovation instead of reproduction. Conservative thinking and habits and safe learning paths must co-habit with new work arrangements and learning activity as capacity building in the proper use of new technology is undertaken and results evaluated. The MSTP lasted only a year. Yet it resulted in an important number of trials; benefits were identified; and directions pointed to by teachers, school principals and even students in response to the year of experimentation. Among these directions, the creation of locally produced educational resources and inter-school collaboration stand out. The latter leads to the third recommendation and the former to the fourth.

Throughout the broadband trials, there were teachers who did not count their time, but there were others who indicated that time had been an issue when it came to implementing projects they had planned or would have liked to plan. The development, sustainability and scalability of successful broadband-based practices require time management. Of course a worthwhile purpose is needed here as well to justify such expenditure. Equality of opportunity, school improvement and reduction of school dropout are likely candidates, offering rationales for a serious investigation into the possibilities of broadband-based activity for teaching and learning purposes. Therefore, the third recommendation is addressed to school and school district administrators who have authority over personnel that may be involved in exploring and documenting broadband-based collaborative activity as part of their professional task:

Recommendation 3

Broadband-activity implementation plans must include provisions for teacher time reallocation as well as connectivity fees.

Conclusion 4

Teachers that engaged the most in broadband-based activities were proactive in their professional development and contributed to the learning of their colleagues.

Those teachers that helped one another solve broadband implementation and use problems demonstrated autonomy in learning, but they comprised a very small percentage of staff in most of the pilot schools. They learned from each other's experience. They demonstrated resourcefulness in the projects they planned and/or implemented. They often took advantage of the GrassRoots Program. Those teachers were energized and energizing. They did not wait for others to take charge, but they participated in the high-visibility activities initiated by partners. They came to better understand the practicalities of outreaching. They are on their way to gain visibility themselves as they and their students shape and build their school websites with local storage of Web objects.

Still, more communication and sharing between the partners of the MSTP would have been required for greater impact. Roles and responsibilities were not well defined in a number of cases. Moreover, from the start of the project, it would have been important to have statistics on the evolution of use of broadband. It would have offered useful feedback to participants, allowing them to better regulate their activities.

Other teachers and their students also benefited. They gained confidence in the reliability of satellite connectivity, and received technical and pedagogical support. Confidence and support are two important factors that are associated with success in a number of studies (e.g., Sherry, Jesse, & Billig, 2002; see also http://www.cosn.org/initiatives/cto/cto_meeting_notes.htm).

As broadband connectivity becomes more widely available in remote schools, a greater number of teachers are likely to get acquainted with satellite-based professional development. Distance education courses are already being offered and taken. And peer learning is more possible than ever before.

Lesson learned 4

Informal learning played an important role, and it is a form of professional development that needs to be understood and integrated more strategically into school practice.

Distance was reduced as teachers communicated among themselves or with the Telesat support person, emailing, exchanging files, or engaging in videoconference sessions. Within their school, most of them also played a leading role, and more teachers got interested and/or participated in the trials as a result of their enthusiasm and leadership.

Informal professional development gained in substance and visibility as a few teachers rose to the challenge of mentoring one another in teaching and learning approaches discovered and developed through using this technology. However, such professional development gets little recognition and formal learning is still what counts when it comes to teacher salary. In the Internet era, many more opportunities for informal learning become available. But informal learning is awaiting recognition in educational organizations and elsewhere. Therefore, the fourth recommendation is addressed to educational administrators:

Recommendation 4

Ways of fostering creative relationships between informal and formal learning are needed including recognition of teacher participation in one another's learning and in informal learning.

Conclusion 5

A large variety of broadband-based activities were experimented with, but time was too short for new routines to take hold and see structural changes emerge in the network of pilot schools.

The classification of activities presented in the preceding chapter is impressive. However, there was only a year for remote schools to take advantage of rarely accessible teachers (e.g., a violin teacher, a university professor). The potential is there, and awaiting … The same is true for large-scale projects initiated from the outside. The MSTP featured projects in which leading partners played an important role. The possibility that other research and development teams (in informatics and in other subject areas) may be interested is real, and would be welcomed. It would provide those teams direct contact with the school reality. But this is not an easy task for teachers when their classroom must evolve in a shared rhythm with the classrooms of other participating schools. Still, such collaborations tend to be beneficial to participants.

There were indications that school principals were valuing teacher collaboration and that community building did occur in some pilot schools, but existing processes were often not aligned with such an orientation. Teacher culture is rather individualistic, and education systems are hierarchical structures. Broadband use increases opportunities for communication, production of educational materials, work coordination, and collaborative teaching and learning. Though the activities implemented showed signs that new collaborative practices were being experimented in at pilot schools and between a few schools, structural shifts that would define the collaboration as a whole that was taking place did not clearly emerge. One potential model for such collaboration was seen in the Newfoundland schools where teachers found solutions to technical problems together. Another model was seen in a participating board in Ontario, which found funding for teacher teams to develop broadband-enhanced unit plans over the summer. The Quebec school that was instrumental in another's school participation in the project, *L'école éloignée en réseau*, by providing electronic connectivity and teacher leadership offered another model.

Lesson learned 5

Time is needed for new routines to take hold within and between schools.

One-year trials do not provide enough time: the removal of the satellite link in May 2003 led to a missed opportunity in this regard. It is likely that a trial lasting one or two years longer, which is standard procedure for larger trials, would have allowed for the collection of more complete data which in turn would have made possible the identification of longitudinal patterns in the implementation process, as the implementation could have been followed to a more mature stage. More high-visibility and broadly-based projects could have occurred, and more teachers would have gotten the basic training or found motivation to participate in the trials.

However, all schools in the current trial raised their existing level of connectivity. Leading partners had defined before hand that value-added (VA) must exceed existing level of connectivity and ICT/Internet use. However, in most cases, networking with other schools was still not part of the school culture. School principals tended to conceive of value-added in terms of capacity building for their stand-alone school. Enhanced possibilities for interaction with other education centers were perceived, but their practical fit was still seen as a challenge that had not been properly met. Therefore, the fifth recommendation is addressed to leading partners that provide the resources for such projects to take place:

Recommendation 5

For better value-added outcomes similar trials should be extended so as to run for three years. Teacher comfort and commitment levels need time to develop as does the development of an effectively collaborating teacher community.

Conclusion 6

The trial's notable learning results were more process than content oriented.

Broadband-based learning activities were scattered throughout the MSTP. The most interesting processes reported are outlined below. These matched processes observed in other studies:

- Teachers pointed to student motivation and engagement in the broadband-based activities as a major outcome. This is a result often pointed to in the literature on the benefits of ICT use (see the ImpaCT2 study in the UK).
- Students taking "holistic task responsibility" (see also Skilton-Sylvester, 2003; Granger et. al., 2002) when engaged in learning projects; etc.).

- Students engaged in projects that establish a new correspondence between the work that they do in schools and the work that they are expected to do as adults (see also Lipman, 2002; Reynolds, Sinatra, & Jetton, 1996).
- Oral communication skills improved as pointed out by teachers who used the videoconferencing system more than the average. (See also Harris, 2003.)
- Several teachers took a less directive role in the classroom during the trial's projects, instead of functioning as a coach or facilitator when needed. Students functioned more fully as autonomous learners, even when collaborating with peers (for example in the Web page creation tutoring project). (See also Kozma, 2003.)

However, the overall lack of density of use of broadband rendered irrelevant any assessment of substantive learning over the course of the trials.

Lesson learned 6

Density of use is the next-level criterion in the study of remote schools' capacity to generate and process information in new and diversified interactions.

Broadband enabled projects, properly designed, seem to offer the potential to enhance student motivation and foster more autonomous learning, while at the same time building collaborative skills. However, such activities were scattered throughout the year, and so was their impact on learning outcomes. Only three pilot schools, and all were NIS schools, had half of their teachers or more involved in the trials.

Even if the technology was not quite there yet in terms of ease of use, the pedagogical capacity to plan and conduct broadband-based activities was found to be the functions of only a few teachers. In order to better assess whether such technology can make a difference in student learning and achievement, a more robust relationship between treatment (broadband-based activities) and result (learning outcomes) will need to be established. Any large-scale study is likely a few years away. Meanwhile, multiple case studies could presently be conducted now of remote schools that have the capacity to self-improve by offering all their students a better range of learning activities. Therefore, the sixth recommendation is addressed to schoolteachers:

Recommendation 6

The potential of satellite connectivity for enhancing education needs to be explored more systematically and over a longer time frame to confirm these initial findings. Further study is recommended.

Conclusion 7

All schools are engaged in some self-sustainability process regarding broadband-based activity

It was found that pilot schools were beginning to think of broadband connectivity in more strategic terms. Some were in the process of developing a more substantial or complete technology implementation plan. One of the school boards involved in Ontario, for example, was implementing a broadband Wide Area Network amongst its elementary schools specifically for videoconferencing and media streaming purposes. None of the pilot schools wanted to go back to low bandwidth connectivity (Direct PC or 56K modem). All had made or were making efforts for getting a broadband connection on a more permanent basis.

As mentioned above, a greater number of interested teachers in each pilot school will be needed for sustainability. A number of teachers wondered about curriculum integration of broadband-based activities. As pointed out by Doug Walker, an observer of the trials: "The biggest obstacle to rapid adoption of interactive multi-point broadband-facilitated collaborative education is, as usual, lack of time - the old ways take up all the time of students and teachers. There's currently no place for this new technology and its new ideas to fit in naturally."

Lesson learned 7

Early-stage collaborative ventures between schools such as discovering one another's community won't suffice to maintain interest in broadband-based activities.

While the project was implemented in advanced ways by a few teachers, this was not the situation in the majority of cases. The way new technology might be woven into the real life and real time experiences of teachers and students at work is at stake here. And so is the vision of a network-enabled school, and that of a network of broadband-enabled remote schools.

The value-added of new broadband technologies will depend on the real needs of the schools, the real time behaviors and interactions of practitioners in the school (and possibly at home or elsewhere). At this current stage of availability and adoption, partners in the trials could only get glimpses of how school change may occur when networked classrooms, schools, and school districts take advantage of broadband.

For such change to occur, mechanisms are needed to ensure collaboration within schools and coordination between schools. Too often during the MSTP, school schedules made collaborations difficult, if not beyond one teacher's reach. Therefore, the seventh recommendation is addressed to all those likely to be planning future applications of broadband connectivity between remote schools:

Recommendation 7

Future plans should include the identification of a school district and/or provincial coordinator who would help 1) make the connections between remote schools for "high-interactivity / low-visibility" learning activities and projects, and 2) plan high-visibility learning projects in which remote schools will participate alongside other schools.

Conclusion

This completes the conclusions, lessons learned, and recommendations. The MSTP was a step forward in the deployment of the network phenomenon in Canada. As planned, pedagogical and social possibilities were explored in the trials. Identification was made of the organizational, structural and cultural limitations facing schools and classrooms accessing Anik E2 for multimedia use, especially for use with digital video. Not only did this pilot project provide opportunities to learn about the requirements and shortcomings of satellite networks in school settings, it also afforded the opportunity to uncover the behaviors of school personnel and students related to the use of virtual educational resources, and to explore the potential consequences of broadband deployment with respect to teacher and students' virtual social mobility.

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APPENDICES

Appendix A
Description of participating schools by province

Newfoundland

Fatima Academy, St. Bride's, NL

Fatima Academy is a K-12 school with 213 students. It is a rural school in the Avalon West School District in the province of Newfoundland and Labrador. The school is located in St. Bride's (population 473) on the Cape Shore. It is approximately 170km from St. John's and 125km from the district office in Bay Roberts. Fatima serves students from St. Brides, Ship Cove, Patrick's Cove Angel's Cove, Cuslett, Point Lance and Branch. The nearest larger town is Placentia (population 4 426), located 46km away. The area is famous for the Cape St. Mary's Ecological Reserve.

Fatima Academy now has approximately 60 computers on the school network. The computers are located in the school's learning resources center, classrooms, technology laboratory, science laboratory, art room, staff room, guidance office and main office areas. The network is used by teachers, students, school administrators, and the school guidance councilor.

Glovertown Academy, Glovertown, NL

Glovertown Academy is a K-12 school with 484 students in the Lewisporte/Gander School District in the province of Newfoundland and Labrador. The school is located in Glovertown (population 2 163) and also serves Traytown, Culls Harbour, Charlottetown and Terra Nova. It is located approximately 57km from the district offices in Gander, and 276km from St. John's. Glovertown is located on the East Coast of Newfoundland, near Terra Nova National Park.

Glovertown Academy now has 80 computers on the school network that rely on the Telesat satellite connection. The computers are accessible by students, teachers and school administrators, and are located in classrooms, two computer laboratories and the school resource center. A video-conferencing system on the satellite connection is located in one of the school's computer laboratories.

Roncalli Central High School, Port Saunders, NL

Roncalli Central High School is a Grade 7-12 school with 173 students in the Northern Peninsula/Labrador South School District. It is located in Port Saunders (population 812) on the Northern Peninsula, and it serves students from Port aux Choix, Hawke's Bay, River of Ponds and Eddie's Cove West. Roncalli is located approximately 230km from Corner Brook, and about 800km by road from St. John's.

Roncalli Central High School presently has 60 computers on the school network and connected to the satellite. 30 computers are located in a school computer laboratory, with 10 computers located in classrooms, 10 computers in a technology laboratory, 5 computers in a science lab, and 5 computers in school offices and the staffroom. All computer systems on the satellite connection are accessible to students and teachers with the exception of those computers located in the administrative offices.

St. Paul's Intermediate School, Gander, NL

St. Paul's Intermediate School is a Grade 7-9 school in the Lewisporte/Gander District. The school is located in Gander (population 9 651), and it also serves students from the much smaller town of Benton. The school is located approximately 330km from St. John's, and is located in the same town as the District offices.

St. Paul's Intermediate School currently has 130 computers. The computers are located in 2 computer laboratories, 19 classrooms, teacher offices, the staffroom, the school learning resources center, the administrative offices, and a video-conferencing room. Teachers, students and administrators at St. Paul's have access to the computer network. Internet access is not facilitated using the satellite connection. One computer in the video-conferencing room is linked to the satellite connection. Two computers in classrooms and one in an office were linked to the satellite connection on an experimental basis.

Ontario

Bayside Secondary School

Bayside Secondary School is a grade 8-12 school located in a small town in southern Ontario about 200 km east of Toronto; the nearest major town is Belleville, which lies to the northeast. With an enrolment of about 750 students, it offers both academic and technical programs. There are 180 computers at the school on a 100Kbps LAN. The videoconferencing equipment is set up in an alcove in a computer lab, where a small group of students can use it without disturbing a class in progress in the main part of the lab. At one point the school was looking at ways to connect the Telesat system and video server to the network for cross-school access, but it never did so. The school has an external 1.5Mbps frame relay connection to the Board offices which provides Internet access. In the past year, four full computer labs with 30 computers each have been established in the school. The network is used by teachers, students and school administrators.

Pelican Falls First Nations

Established in 1990 on the site of a former residential school in a small town about 300km northwest of Thunder Bay in northern Ontario, this private high school is housed in a building built in 2000. Approximately 200 students attend the school; most are members of First Nations communities, and a substantial number board in the town over the school year. In order to allow these students to spend as much time in their home communities as possible the school days are longer but the school year shorter at Pelican Falls than is typical in Ontario, with the school year ending in mid-May.

The school has a main computer lab containing 32 computers, and there are an additional six computers in the library. All are on a LAN, and have access to the Internet through the school board network—access that is described by the computer technology teacher as very fast and reliable. The Telesat videoconferencing equipment is located in the main lab; all conference viewing is done through a computer monitor attached to the Vcon conferencing system.

Kente Public School

Kente Public School is a kindergarten to grade eight school situated in rural southern Ontario about 200 km east of Toronto. It currently has an enrolment of about 336 students. Presently, there are about 90 computers on site, with about 25 situated in a lab, three in every classroom, and several more in the library and the science room. They are on an internal 100 Mbps network and have a 512Kbps frame relay connection to the school board offices for Internet access. The school runs a cross-grade gifted and enriched science and technology program for selected students from grades 5/6 and 7/8, with each group of students meeting for two half-days per week with the enrichment teacher.

Over 30 new Pentium 4 computers came into the school in the fall of 2002. Some of these replaced outmoded equipment, so that nothing older than Pentium III units is now being used for teaching purposes. The enrichment classroom was given priority access to an adjacent resource lab with seven of these computers, and there are three other computers in the enrichment classroom. A video editing work station supplied by Telesat was brought into the school, which the enrichment classes used heavily. There was also a plan this year to connect the satellite station to the school network and put the videoconferencing workstation on a trolley so that the high speed Internet link and videoconferencing equipment could be used in any class in the school, but this never occurred. The satellite workstation is located in the corner of a multipurpose room with a number of computers in it.

Quebec

Ecole Saint-Damase

Cette école, localisée au 45° 31' Nord, 73° 01' Ouest, est une école primaire de quelque 250 élèves. L'école disposait au départ de 53 ordinateurs Mac et de trois serveurs Mac. Leur connexion Internet était un lien par ondes radio en cascade avec une autre école. Le réseau interne comprenait deux commutateurs également en cascade. Les ordinateurs étaient tous dans les classes et non dans un laboratoire (de 1 à 5 ordinateur(s) par local de classe). En cours de projet, la qualité de leur lien Internet s'est grandement améliorée après avoir enlevé une cascade à leur connexion par ondes radio et après avoir ajouté une liaison modem câble. Une dizaines d'enseignants forme l'équipe professorale.

École St. Agathe

Localisée au 46° 03' Nord, 74° 17' Ouest, cette école, primaire et secondaire, de Sainte-Agathe-des-Monts, compte quelque 330 élèves. L'école compte 22 enseignants, soit 10 au niveau primaire et 12 au niveau secondaire. L'école déclarait disposer de 71 ordinateurs reliés à Internet par une connexion ADSL. Lors de leur sélection pour ce projet, cette école ne disposait pas d'un lien Internet semblable. Un seul ordinateur, installé dans le laboratoire d'informatique, était branché à la connexion satellite et équipé de l'équipement nécessaire pour la réalisation d'activités de vidéoconférence.

École Hamelin

Située à Wotton, près de Sherbrooke, cette école primaire compte quelque 150 élèves. L'école compte 8 enseignants, à raison d'un par niveau scolaire. Elle disposait de 51 ordinateurs et d'un lien Direct PC. Des ordinateurs étaient disponibles dans chaque classe et dans un laboratoire. Tout le réseau, à l'exception du poste de travail de la secrétaire, a été relié au lien satellite. (Le réseau de l'école de Saint-Camille s'est également ajouté en cours de projet.)

École Ulluriaq

Cette école primaire et secondaire, localisée à Kangiqsualujjuaq (George River), est située au 58° 41' Nord, 65° 57' Ouest. L'école compte école de 250 élèves et un personnel enseignant composé de 25 enseignants, soit 14 enseignants au niveau primaire, 6 au niveau secondaire les autres étant des spécialistes.L'école est équipée de 50 ordinateurs, tous connectés au satellite. Des connexions externes incluaient les bureaux de la municipalité (10 ordinateurs) et deux accès publics autres. Avant l'intallation du lien satellite l'école était reliée par un lien DirectPC.

École Secondaire Otapi

Située à Manawan, 47° 12' Nord, 74° 23' Ouest, cette école de 200 élèves comptait 40 ordinateurs. Cette école ne disposait d'aucun lien Internet. Tous les ordinateurs ont été reliés au lien satellite. Il y a une vingtaine d'enseignants dans cette école secondaire.

Appendix B
Contacts and general information on schools by province

NEWFOUNDLAND

Coordinator:

Frank Shapleigh, Training Officer, STEM~Net
5 Gander Bay Road
Gander, Newfoundland
709-256-2489
frank@stemnet.nf.ca

Roncalli Central High School

Location
PO Box 119
Port Saunders, NF, A0K 4H0
50° 39' North, 57° 18' West
709-861-3624

Contacts
Don Tulk
dtulk@stemnet.nf.ca
Aurele Beaupre
abeaupre@nf.sympatico.ca

Additional information
- Grades 7-12
- 287 students
- 60 computers, all connected to satellite
-Links - School Website
- Community Images

St. Paul's Intermediate

Location
5 Gander Bay Road
Gander, NF, A1V 1W1
48° 57' North, 54° 37' West
709-256-8404

Contacts
Aiden Drover (prime)
adrover@stemnet.nf.ca
Herb Pack (backup)
hpack@stemnet.nf.ca

Additional information
- Grades 7-9
- 374 students
- 80 computers
- Internet access through Cisco UBR905 cable modem.
(Average speed in ~500 Kb, out ~200 Kb)
Links - School Website
- Community Images

Fatima Academy

Location
General Delivery
St. Bride's, NF, A0B 2Z0
46° 55' North, 54° 10' West
(709)337-2500

Contacts
David Welshman (prime)
dwelshman@awsb.k12.nf.ca
Gordon Pike (backup)
gapike@stemnet.nf.ca

Additional Information
- Grades K-12
- 224 students
- 50 computers, all connected to satellite
Links - School Website
- Community Images

Glovertown Academy

Location
PO Box 100
Glovertown, NF, A0G 2L0
48° 41' North, 54° 02' West
709-533-2443

Contacts
Derek Blackwood
dblackwo@stemnet.nf.ca
Glen Winsor
gwinsor@stemnet.nf.ca

Additional Information
- Grades K-12
- 494 students
- 70 computers, all connected to satellite

ONTARIO

Hastings and Prince Edward District School Board
156 Ann St., Belleville, Ont. K8N 1N9

Coordinator:

Bob Foster
Co-ordinator – Elementary Computers Across the Curriculum
bfoster@hpedsb.on.ca
(613)966-9491 ext. 2219

<u>Kente Public School</u>

Location
264 County Road 19
Ameliasburgh, ON, K0K 1A0
44° 4.097' North, 77° 25.247' West
(613)962-7533

Contacts
Nikki Roy
nroy@hpedsb.on.ca
Principal: Heather Seres

Additional Information
- Grades JK-8
- 336 students
- 60 computers, all connected to satellite
- External Network: 512K Relay to Board
- LAN: 100 Mbps infrastructure

Links - School Website

<u>Bayside Secondary School</u>

Location
1247 Old Highway 2
Quinte West, ON, K8N 5M6
44° 7.532' North, 77° 28.609' West
(613)966-2922

Contacts
Brent Seres
Bseres@hpedsb.on.ca
Principal: Maureen Allen

Additional Information
- Grades 8-13
- 757 students
- 180 computers, all connected to satellite
- External Network: 1.5 Mbps Frame Relay to Board
- LAN: 100 Mbps infrastructure

Links - School Website

HPEDSB Education Centre

Location
156 Ann Street
Belleville, ON, K8N 1N9
44° 7.773' North, 77° 22.600' West
613-966-9491

Contacts
Doug Callaghan
dcallaghan@hpedsb.on.ca
Bob Foster
bfoster@hpedsb.on.ca

Additional Information
- Grades JK-13
- 120 computers, all connected to satellite
- External Network: 512K/1.5 Mbps Frame Relay to all elementary/secondary schools,5 Mbps to Internet
- LAN: 100 Mbps infrastructure

Links - Website

First Nations Schools

Pelican Falls First Nations High School

Location
Sioux Lookout, ON
(807)737-1110
Fax (807)737-1449

Contacts
Solomon Kakagamic
skakagamic@nnec.on.ca
Principal: Wayne Mercer

QUEBEC

Coordinator:

Sonia Sehili
sonia.sehili@rtsq.qc.ca
514-251-3700 ext. 3913
General support: soutien-rtsq@grics.qc.ca

<u>St. Agathe Academy</u>

Location
26, rue Napoléon
Sainte-Agathe-des-Monts, Québec J8C 1Z3
46° 03' North, 74° 17' West
Téléphone: 819-326-2563
Télécopieur: 819-326-7563

Contacts
John Richard
jrichard@swlauriersb.qc.ca
Johanne Vallerand
Jvallerand@swlauriersb.qc.ca
Principal: Johanne Vallerand

Additional Information
- Grades K-12
- 330 students
- 71 computers, all connected to satellite
Links - School Website
- Community Images

<u>Ecole Saint-Damase</u>

Location
18 rue Saint-Joseph
Saint-Damase, Québec J0H 1J0
45° 31' North, 73° 01' West
Téléphone: 450-797-3873
Télécopieur: 450-797-3658

Contacts
Sylvain Bédard
Sylvain.bedard@prologue.qc.ca
Sophie Lussier
Sophie.lussier@prologue.qc.ca
Principal: Caroline Robert

Additional Information
- Grades K-6 (maternelle à 6e)
- 249 élèves
- 53 Ordinateurs Mac et 3 serveurs Mac
- Antenne de type wavelan
Links - School Website
- Community Images

Ecole Hamelin

Location
École Hamelin 405
rue Mgr L'Heureux
Wotton, Québec J0A 1N0
Téléphone: 819-828-2682
Télécopieur: 819-828-0445

Contacts
Lyne Clément
Lyne.pierre@sympatico.ca
Paul Benoit
Paulbenoit50@hotmail.com
Principal: Jean-Marie Dubois

Additional Information
-Grades K-6 (maternelle à 6e)
- 148 élèves
- 51 Ordinateurs, lien DirectPC
- 1 hub principale et un secondaire avec des ordinateurs dans chaque classe et un laboratoire tous PC (hub secondaire pour le lab)
Links - School Website
- Community Images

Ecole Ulluriaq

Location
Ecole Ulluriaq
Kangiqsualujjuaq (George River), Québec
58° 41' North, 65° 57' West
Téléphone: 819-337-5250
Télécopieur: 819-337-5354

Contacts
Alain Rochefort
Arochefort@nunavik.net
Nelson Lamoureux
Nelson_lamoureux@kativik.qc.ca
Principal: Jean Leduc

Additional Information
- Grades K-12
- 250 élèves
- 50 Computers, all connected to satellite
- External connections include the municipal office (10 computers), and two additional public access points in the near future.

Links - School Website
- Community Images

<u>Ecole Secondaire Otapi</u>

Location
470 rue Otapi
Manouane, Québec, J0K 1M0
47° 12' North, 74° 23' West
Téléphone: 819-971-1379
Télécopieur: 819-971-1266/8848

Contacts
Eric Labbé
Labbe.eric@videotron.ca

Additional Information
- 200 students
- 40 computers

Links - School Website
- Community Images

Appendix C

Example of best practice for the Satellite Multimedia Trials : Ulluriaq School

It's lunch time. For most students from Ulluriaq School, it's time to go home to eat. But for the nine students in the violin program, the situation is different. They have to rush home and eat quickly because in less than an hour, their weekly virtual violin lesson will begin.

Students during virtual violin class

First, they take out their instrument and sit in front of the camera. Soon, the image of their virtual violin mentor will appear on the white wall in front of them. This special class is delivered to them by videoconference. The students are in Northern Quebec and their violin mentor is more than 1000 km away in a High School in Buckingham, Quebec. Yet with the satellite broadband connectivity, these students are now able to learn to play the violin.

The image from Buckingham

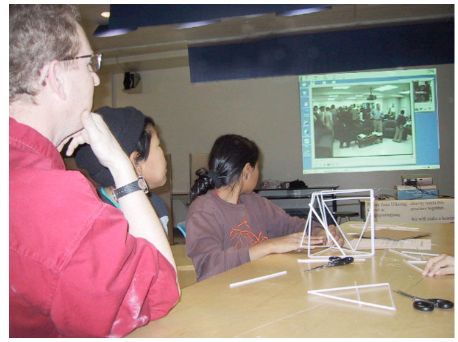
Ulluriaq School is located in Kangiqsualujjuaq, Nunavik, Quebec, an Inuit community with a population of 750. This K-12 school has 250 students with a staff of approximately 25 teachers. The school team's main challenge is to keep the students in school by offering interesting activities. Here, technologies are at the center of the school's pedagogical plan. And it works!

Participating in Telesat's Satellite Multimedia Trials for Schools project during the 2002-2003 school year, Ulluriaq School has set itself apart from other schools by the great variety and number of activities realised using the satellite broadband connectivity. With their interest, dynamic spirit and skills, the staff has played a crucial role to make this a real success out of this experimental bandwidth. The activities taking advantage of the broadband connection ranged from videoconference and email exchanges to web surfing. Here is their success story.

Improved Connectivity

In the spring of 2002, Telesat's equipment is installed at Ulluriaq School. Thanks to the Satellite Multimedia Trials project, Ulluriaq School will reap the benefits of a broadband satellite connection including high resolution videoconferencing capabilities. Typically, schools in Nunavik have inadequate Internet access. Often Web browsing is slow enough that teachers decide not to use it with students. The installation of this new equipment was the starting point for Ulluriaq School's "Connecting Cultures" project to get under way.

Throughout the 2002-2003 school year, more than a dozen different classroom activities have integrated the use of videoconference. Among these, let's mention the virtual violin class program, the Structures in Space workshop with astronaut Steve Maclean, many direct exchanges with classes from Quebec schools, from other provinces and even from other countries. Videoconference also allowed teachers to participate in workshops on the integration of ICTs in the classroom, to exchange with members of the research team and with numerous people from Telesat and the CRC involved in the project.



Structures In Space workshop

The virtual violin program shows very well the advantages of a broadband connection in providing access to resources rarely available in a remote region such as Nunavik. Part of the Canarie MusicGrid project, the virtual violin program took place from November 2002 until to May 2003 and involved one weekly lesson using the broadband connection. The nine students from Kangiqsualujjuaq ranged from grade 4 to grade 7; they were accompanied by a teacher at Ulluriaq School and benefited via videoconference from the teaching of an expert violin mentor who taught them from Buckingham, more than 1000 km South of Kangiqsualujjuaq. With image and sound from the videoconference system, their mentor could teach the group the necessary skills to play violin. Yes, there were some technical difficulties to overcome and a few lessons could not take place at the planned date and time. But in the end, the students' violin skills became quite impressive for first year learners and they developed a good relationship with their mentor. The program concluded its 2002-2003 activities with the presentation of a concert at Ulluriaq School for the parents and for partners in the program who were present through a multi-point videoconference. This program was a resounding success and will continue.

The broadband connection also allowed Kangiqsualujjuaq students to exchange and get to know students from across the country and even from other countries. For example, in the project "Local Marvels", organised by Ulluriaq School's pedagogical counsellor, grade 7 students presented a marvel from Kangiqsualujjuaq, the arctic charr, to students from three other schools in Newfoundland and Quebec. The activities in this project started with exchanges of emails and multimedia presentations to finish in style with a videoconference involving the four schools simultaneously during which students exchanged questions and answers about their local marvel. The grade 6 French group used videoconference to explain the Nunavik ecosystem. With the use of a webquest created by their teacher, students from this group presented the results of their research to younger students from another school during a videoconference session.

Many more projects were realised during the year. With the improved Internet connectivity, a majority of students accessed a variety of information sources on a weekly or daily basis and communicated with their peers by email on a regular basis. From common agreement of the school administration and the teaching staff, the broadband connection allowed students to benefit in many ways from network-based applications. These projects have helped to motivate students and keep them interested in their work at school. They have discovered ways of life of people from across the world and have proudly shown to others the Inuit culture. Students have learned or improved their technological and pedagogical skills. Many teachers have pointed out that second language oral and written skills of students have improved as a result their participation in activities involving exchanges by email or by videoconference. But it's not only students who have benefited from the broadband connection. Teachers gained access to professional development opportunities and to a greater variety of pedagogical resources. For example, in the fall 2002, six teachers participated by videoconference in the "Colloque de la Société GRICS", a conference held in Montreal on the integration of ICTs in the classroom. Many teachers have also used videoconference or email to collaborate with peers and have used the resources on the Web to enhance their teaching.

To complete this extraordinary year, many groups of students, under the guidance of their teachers, presented their work on the Web. Each group created a few Web pages around a common theme, exchanges involving the cultures of Nunavik and elsewhere. The result is an impressive Website, entitled "Connecting Cultures", produced for the SchoolNet Grassroots program.

The Road to Success

Ulluriaq School's success during the Satellite Multimedia Trials project is primarily due to a long-term commitment to technologies. The staff has succeeded over the years in integrating technologies in the classroom because of these important factors: their interest in technologies and the benefits they bring, their efforts to acquire equipment and training, the collaborative culture that exists among them and the local support they receive locally in their school.

The Need to Break the Isolation for a School in a Remote Location

Living in a remote region means having limited access to resources taken for granted by city dwellers. Access to information and communications networks lessens the isolation by having resources available on the Web and by opening students' minds to the world through easier communication. The satellite broadband connection has significantly improved the quality of Internet access compared to the technologies previously used at Ulluriaq School. Without having to deal with slow Internet access and an unstable system, teachers have regained confidence in the Internet and have used it more and more as the year went by. In an environment where most students drop out of school years before graduating from high school, teachers must find creative means to keep students interested. According to the school's principal as well as to many teachers and students, technologies in school and network access plays an important role in motivating students. This also explains the enthusiasm shown by the staff throughout the project.

Taking the Initiative

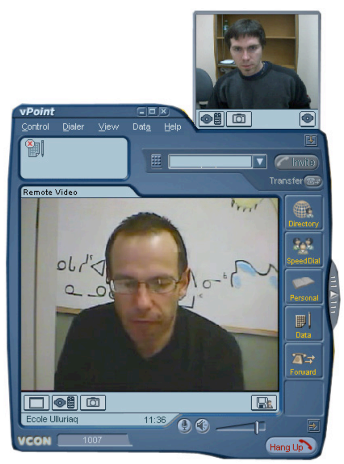
When using technologies, being enthusiastic is just not enough. The technical skills of the staff at Ulluriaq School is a key element in their success during the Satellite Multimedia Trials project. Since the mid 90s, local workshops in technologies have been common place in this school. Backed by the support of the administration, a small group of teachers led the way in integrating ICTs in the classroom. They shared their expertise with their peers, organised fundraising activities and submitted project proposals in order to get the necessary equipment for their students to be able to learn with the help of computers.

"Learning how to use computers is not a goal in itself for us. The computer is an excellent tool to do projects in class and make school more attractive." (...) Networked computers are part of the daily routine at Ulluriaq School and are "an important motivating factor for the students" according the school's principal. They believe that integration of technologies should take place where students spend most of their time, the classroom. The use of technologies in the school has become a matter of interest for every member of the staff. Year after year, according to this logic, new equipment goes mostly to the classrooms where it is always accessible to students and teachers. Most teachers at Ulluriaq School use the computer on a regular basis and a core group among them use the computer as their tool of choice to let their students carry out a variety of ambitious projects.

The school is equipped with over 50 computers, all connected to the school network and to the Internet via the satellite access. Most of these computers are located in the classrooms while some are still in the lab. Eight portable computers equipped with wireless capabilities serve as a mobile computer lab. The school network has also been extended in the village to serve the municipal office including a public Internet access point. Students and school staff also have access to peripherals such as digital still cameras, digital video cameras and two multimedia projectors. In 2000, the school's accomplishments were recognised by SchoolNet when Ulluriaq School became part of the Network of Innovative Schools.

Collaboration and Network Culture

The collaboration and network culture existing among the staff of Ulluriaq School has also contributed to the success of the Satellite Multimedia Trials project. In the school, teachers collaborate and help each others. Having only limited access to human and pedagogical resources, teachers often rely on each others for technical support, exchange of ideas and teaching material. This proved an important asset in a project where schools were asked to organise activities while using technologies. Constantly solicited by various partners in the project, including Telesat, the government agencies and the research team, Ulluriaq School's staff not only responded favourably to many of the proposed activites but even initiated projects of their own with the participation of other schools. The school used the support offered by the partners in the project and developed, through numerous successful exchanges, working relationships that will outlast the project.



An exchange with a member of the research team

The network culture already present at Ulluriaq School facilitated the realisation of exchange projects. Many teachers already worked on similar activities with their students so it was a simple matter of integrating the new technologies introduced in the Satellite Multimedia Trials project to well-known activities.

Local technical and pedagogical support

Local technical and pedagogical support was a key element that enabled the school to take advantage of the opportunity to use the network at their disposal. After years of efforts from the school staff to acquire the equipment and build up their technical skills, the school board has acknowledged the special situation of Ulluriaq School by providing budget for a full-time non-teaching professional based at the school. The objective is to support the teaching staff technically and pedagogically as well as to help teachers from schools in neighbouring villages. This "IT coach" has proven to be an indispensable constituent in the Satellite Multimedia Trials at Ulluriaq School. Administration and teachers have identified the major role played by the IT coach whose functions were the following: to ensure the equipment functioned properly,to suggest activities to teachers, to co-ordinate the different aspects of the project, to pre-test the videoconference equipment before each activity while the teachers were with their students and to assist teachers in using the technical equipment themselves. Freed of the task of solving major technical difficulties, teachers dedicated most of their time to their students instead of to the resolution of technical problems. Teachers were less hesitant to use the computers on the network knowing that the system would work when they needed it. Many teachers are convinced there would have been fewer projects carried out without the support of their IT coach. With the frequent help teachers provide each others and the support from their local counsellor, Ulluriaq School school has created a support model many schools would envy.

Conclusion

During the Satellite Multimedia Trials for Schools, Ulluriaq School has shown with success, by carrying out many activities, how a school in a remote region can benefit from a broadband connection. Access to online resources, exposure to the rest of the world, opportunity to develop technical and academic skills are advantages that the school staff have pointed out. However, this example of success was not created overnight. Many years of efforts, dedication and commitment have been invested at Ulluriaq School to put in place the necessary requirements to the integration of technologies in a wide area network.

A few links on the Web

Ulluriaq School Website
http://www.kativik.qc.ca/ulluriaq/
"Connecting Cultures" Website, a SchoolNet Grassroots project from Ulluriaq School
http://www.kativik.qc.ca/ulluriaq/cultures/

Kativik School Board - Music Grid: Orchestral Maneuvers in the North
http://www.kativik.qc.ca/php/modules.php?name=News&file=article&sid=65

Story from the Nunavut weekly Nunatsiaq News – Let the music flow
http://www.nunatsiaq.com/archives/30606/news/features/30606_02.html