Ups and Downs of Computers Science Projects in Primary and Secondary Canadian Schools

Thierry Karsenti
Canada Research Chair
Information and Communication Technologies (ICT) in Education
Université de Montréal, Canada
Case postale 6128, succursale Centre---ville
Montréal (Québec) H3 3J7 Canada

Simon Collin
Université de Montréal, Canada
Case postale 6128, succursale Centre---ville
Montréal (Québec) H3 3J7 Canada

Abstract

The overall objective of this research project was to gain a deeper understanding of the benefits and challenges of using laptops in primary and secondary school in 30 Canadian schools. In all, 2,432 students (grades 3 to 11), 272 teachers, 14 education support staff and three school principals participated in the data collection. Three main data collection instruments were used: survey questionnaires, individual semi-directed interviews, and group interviews. Of the students surveyed, 92% had a computer at home, 63.3% had a cell phone and 67.7% used a portable digital reader such as an MP3 device or iPod. On the other hand, 11% of the students did not have an Internet connection at home, whence the importance of the school, which provides their only opportunity for full Internet access. Overall, the data collected highlights 12 main benefits of using laptops. The preliminary results of this study indicate that the 'one laptop per child' strategy fully contributes to students' academic success at the participating schools. The lesson retained is that, despite the technical and pedagogical challenges, this innovative initiative to provide 'one laptop per child' has produced incontestable gains in both teaching and learning, and for the future social and professional lives of the students involved.

1. Introduction

After a number of discussions with the school board administration and school principals, it was decided to launch a study with the aim of gaining a better understanding of the benefits and challenges of using laptops in primary and secondary schools in the Eastern Townships School Board. This school district won the distinction of being the first in Canada to widely distribute laptops to its students. In the last eight years, the board has handed out around 5,600 laptops, mostly to students in grades 3 to 11. It is also noteworthy that all the teachers, technicians, education support staff and students with learning problems were provided with laptops. This study was therefore the product of an exemplary collaboration between a group of primary and secondary schools and the university research community. The Eastern Townships School Board appeared to provide a highly favourable setting for a study on the benefits and challenges of using laptops in primary and secondary school. In fact, when the 5,600 laptops were distributed to the great majority of the students, the school board advanced from 66th position in the province (out of 70 school boards) in 2003 to 23rd in 2010, a remarkable improvement. It was therefore particularly relevant to seek a deeper understanding of the role of the laptops in the significant improvements made on the examinations set by Quebec's (Canada's) department of education.

2. Objectives

To recap, the overall objective of this study was to better understand the benefits and challenges of using laptops in primary and secondary schools in the Eastern Townships School Board. This overall objective may be broken down into four specific objectives:

1. Determine the access to equipment and technologies by teachers and students at the Eastern Townships School Board;

2.   Identify ICT uses by teachers and students at the Eastern Townships School Board;
3.   Identify the ICT skills of teachers and students at the Eastern Townships School Board;
4.   Identify the impacts of ICT use on teachers and students at the Eastern Townships School Board.

3. Methodology

3.1 Methodological approach: the era of the mixed approach

For over two decades, many researchers have agreed on at least two main methodologies, or major research paradigms, in the education sciences (see Krathwohl, 1998): quantitative and qualitative research. These are considered to be very different, if not diametrically opposed. Adherents of the quantitative approach contend that research in the education sciences must be objective, free of bias and generalizable to other contexts. In contrast, proponents of the qualitative approach (see Lincoln &Guba, 1985) reject the idea of objectification as a sine qua non condition for social sciences research. Indeed, believers in the qualitative approach are convinced that objectification and generalization in the social sciences are at once impossible and undesirable. Qualitative research is instead characterized by an emphasis on induction, rich descriptions, and the like. These two epistemologically contradictory positions have frequently raised what Howe (1988) calls the Quantitative– Qualitative Incompatibility Thesis, which proposes that these two approaches and their data collection methods cannot be reconciled. The need to choose between quantitative and qualitative research has therefore characterized most of the research in education sciences for the last 25 years (see Karsenti &Savoie-Zajc, 2011).

However, this methodological dichotomy has been increasingly brought into question. Why, after all, should the education sciences be limited to one or the other of these two methodological 'solitudes'? Why not strike a compromise that would allow a more thorough accounting for complex realities? From these questions sprang the notion of mixed methods in the humanities and social sciences. This notion follows naturally, and above all pragmatically, from the traditional quantitative *and* qualitative methodologies. A mixed methodology is in effect a methodological eclecticism that enables a strategic combination of qualitative and quantitative data in a coherent and harmonious manner in order to enrich the research results. This mixed approach allows the researcher to borrow from a number of methodologies, both qualitative and quantitative, according to the research objective. A mixed approach infers a kind of methodological pluralism. In addition, a mixed methodology facilitates triangulation of the research results (see section 3.2). Given the methodological and strategic plurality that underpin the mixed-method approach, Johnson andOnwuegbuzie (2004) note that it usually produces superior results to those produced by single-method research designs.

Only recently has the mixed-method approach gained a foothold in the education sciences, even though it has been around for over 20 years and several authors have argued for its utility. Among others, the studies by Mark and Shotland (1987), Reichardt and Gollob (1987), Brewer and Hunter (1989), Caracelli and Greene (1993), Van der Maren (1996), Behrens and Smith (1996), and Krathwohl (1998) point out that these two approaches "are usually opposed, when they could just as well be complementary" (Van der Maren, 1996, p. 189, free translation), and when they could quite simply "provide a more textured and productive view of the social phenomena we seek to understand" (Moss, 1996, p. 22). Krathwohl (1998, p. 618) stresses the importance of combining different methods as a way to better "attack" the research problem. He also insists on the importance for the researcher to be creative in combining diverse methods, in an organized and coherent fashion, to better respond to the research question.

He adds that, "Their only limits are their own imagination and the necessity of presenting their findings convincingly" (p.27). The fact is that choosing any method over another risks losing some benefits and gaining others. On this topic, Brewer and Hunter (1989) propose that "our individual methods may be flawed, but fortunately, the flaws are not identical." They add that "a diversity of imperfections allows us to combine methods, not only to gain their individual strengths but also to compensate for their particular faults and imperfections" (p. 16-17). The benefits of mixed methodologies led Johnson andOnwuegbuzie (2004) to recognize it as a completely separate research paradigm, of equal status to qualitative and quantitative research. Our research project, called the *Benefits and Challenges of using laptops in primary and secondary school: An investigation at the Eastern Townships School Board*, clearly belongs to this new perception of research methodology. The researchers were able to choose, from a broad range of data collection methods, those that were most useful to respond to the research problem and objectives.

3.2 Triangulation as a methodological precaution

According toBogdanandBiklen (1992), research is valid when we know that the data collected by the researcher actually correspond to the subject studied. A current, practical and relevant method to do this is triangulation, or the consideration of research results from diverse perspectives in order to appraise their convergence and confirm their validity. A mixed approach is a highly effective form of triangulation. In this project, it enabled us to triangulate our results by using diversified data collection methods (see section 3.4).

3.3 Participants

So far, 2,432 students (from grades 3 to 11) have participated in one of the data collection steps under this study (see section 3.4), along with 272 teachers, 14 education support staff and three school principals. It is worth noting that almost 78% of the teachers who participated have over six years of teaching experience (see Figure 1).
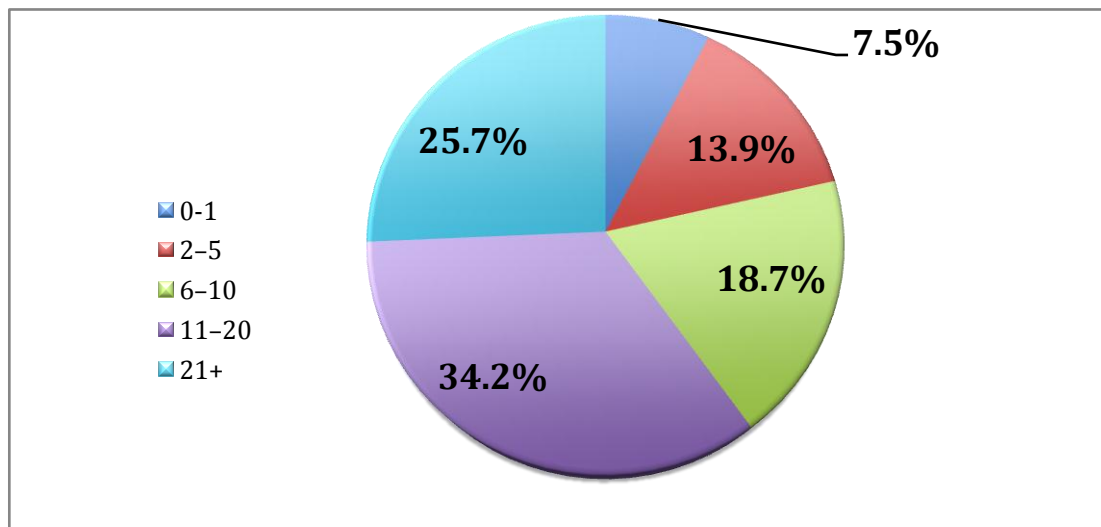

Figure 1. Years of teaching experience among teachers.

3.4   Main data collection instruments

The research project used the four following data collection instruments:
1.   Survey questionnaires
2.   Individual semi-directed interviews
3.   Group interviews
4.   Videotaped observations.

Two versions of the questionnaire were prepared: one for teachers and other education staff, and one for students. Both versions contained five identical sections for teachers and students: general information; access to technologies; use of technologies; technology skills; and the impacts of technologies (benefits and challenges). Another category of questions targeted the teachers and other education staff: the issue of ongoing training in technologies. These questions were developed following a broad literature review of the state of technologies in education. Note also, as pointed out by Krathwohl (1998) and Van der Maren (1996), that the survey questionnaire has the advantage of gathering data on a large number of respondents, and relatively rapidly. This proved highly useful for our research project, because, among others, it enabled a better understanding of the impacts of ICT on a large sample of respondents (almost 2,500 students and over 200 teachers).

The protocols for the individual semi-directed and group interviews of both teachers and students included revisiting five question categories from the questionnaire: general information; access to technologies; use of technologies; technology skills; and the impacts of technologies (benefits and challenges). The issue of ongoing training for teachers was also addressed. From the interviews we gathered the students' and teachers' perceptions of our research objectives. The group interviews were particularly useful in revealing points of consensus and dispute among the participants.

As part of this research project, we also observed classroom situations to gain a deeper understanding of the actual use of laptops in the classrooms, as well as the inherent benefits and challenges. We should point out that the analysis of the videotaped observations is ongoing, and the results will be presented in a subsequent report. The present report focuses on the results of the questionnaires and the individual and group interviews.

3.5 Data processing and analysis

In light of the above-presented arguments, and because the data in this study comprise figures and texts, a quantitative analysis was deemed relevant (for the closed questionnaire responses) as well as the use of qualitative methods (for open-ended questionnaire responses, and transcripts of the individual and group interviews). The qualitative data from the texts (open questionnaire responses and individual and group interview transcripts) were analyzed using a coding system, whereby each text segment (e.g., a sentence) was assigned, as systematically and as rigorously as possible, a semantic category. For example, "Using a laptop in class really helped me improve my French" was assigned to the category, "positive impact of laptops on learning."The qualitative data analysis was inspired by the approaches proposed by L'Écuyer (1990) and Huberman and Miles (1991, 1994). We used a content analysis approach (see Table 2). According toL'Écuyer (1990), content analysis is a "method of classifying or coding diverse aspects of a given material in order to better determine its characteristics and better understand its significance"(p. 9, free translation).

Table 2 General model of the content analysis steps (adapted from L'Écuyer, 1990)

Step	Description
I	Read the gathered data.
II	Define the classification categories for the gathered data.
III	Categorize the gathered data.
IV	Quantify the data.
V	Scientifically describe the case.
VI	Interpret the results described in Step V.

We must stress that L'Écuyer's model is suitable for analyzing not only the interviews, but also the closed questionnaire responses.The qualitative analyses were performed with QDAMinersoftware, which is widely used for qualitative data analysis (see Karsenti, Komis, Depover& Collin, 2011). For the quantitative analysis, SPSS19.0 and LISREL 8.8 were used to obtain descriptive and inferential statistics. Analyses of variance were performed to deepen our understanding of the impacts of ICT on teaching and learning.

4. Main results

The main results of this preliminary analysis are presented under four themes: participants' access to equipment and technology; pedagogical uses of laptops; technology skills that have been or should be developed; and the impacts of laptops on teaching and learning. The results of the quantitative and qualitative analyses are presented together and in complementarity to respond to the research objectives.

4.1 Access and equipment

In terms of access and equipment, let us begin by recalling that the aim of providing one laptop per child is to help overcome a recurrent barrier to the pedagogical integration of ICT: lack of access to computer equipment by teachers and students. In fact, most of the students in grades 3 to 11, all the students with learning problems, all the teachers, and all the education support staff and school principals at the Eastern Townships School Board were given a laptop (for a total of over 5,600 laptops). On top of this, we must emphasize that mobile labs were provided for the remaining students. Access to ICT equipment was also high at home, according to the closed responses on the student questionnaires. Thus, over 92% had a computer at home (see Figure 2). In addition, 63.3% had a cell phone or smartphone (e.g., iPhone, Google phone) and 67.6% used a portable digital reader (e.g., MP3 reader). This indicates that the students who participated in this study were living in a highly technical environment, both in and out of school. Consequently, it can be considered an optimal setting to observe the benefits and challenges of ICT use.
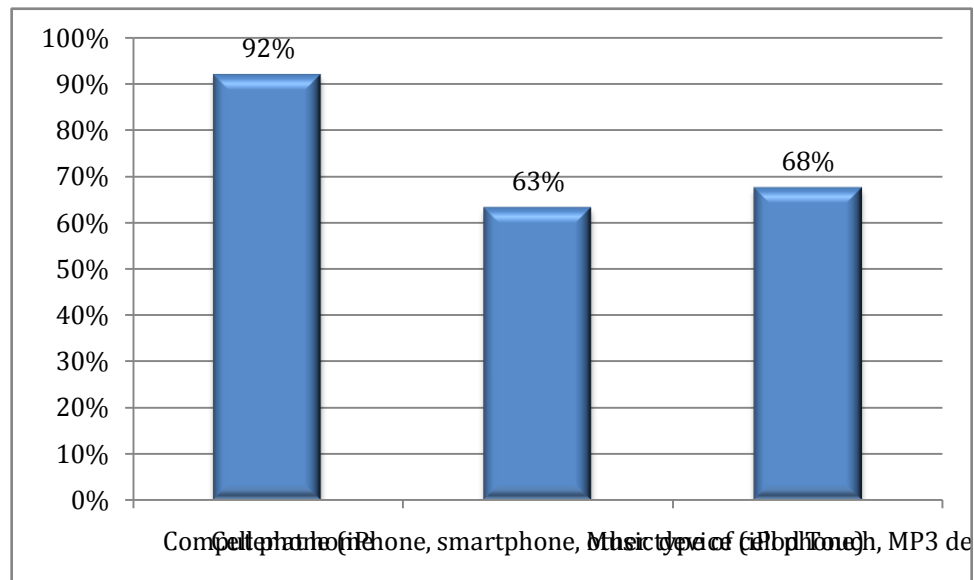
Figure 2.Computer equipment and access by student participants (%).

Furthermore, 67.3% of the students used social networking sites such as Facebook at least once a week at home, suggesting that they have fully embraced the new Web 2.0 technology.In view of their personal technological habits (that is, outside school), it is conceivable that most of the students are full members the 'digital native' generation (McLester,2007; Prensky, 2001).

Nevertheless, this finding needs to be qualified. Because 11% of the students did not have an Internet connection at home, the school was the only place where they could access it. In view of the critical need for computer literacy for the social and professional future of children in the Western world (OECD, 2004, 2008), we may posit that the Eastern Townships School Board, through its laptop program, is going a long way to compensate for the lack of access to computer equipment by 'technologically excluded' youth.

4.2 Pedagogical uses

The results of the interviews and the open-ended questionnaire responses by teachers revealed two types of pedagogical use for laptops: extracurricular (outside the classroom) and schoolwork-related (in the classroom).
Pedagogical use of computers by teachers outside the classroom

Outside the classroom, the most common uses of computers were communicating with colleagues and the administration, and communicating with students, parents, or other education stakeholders in the community.
T[1]. "I use my laptop to connect/share with other teachers."
T. "All my communications with parents are on my laptop."
T. "[I use] email for communication with my students."

Teachers also did a lot of searching for teaching resources. Among others, they could
-     Upgrade or create new teaching practices:
T. "Searching for creative inspiration, to discover new methods of teaching new skills."
T. "The internet allows me to find better methods to use and experiment with in the classroom."
-     Improve and add to their teaching materials:
T. "I look for pictures, diagrams, tables, graphs, etc., for PPT presentation."
T. "I'm using sites that are made especially for teachers (Jardin de Vicky, Educa-tout and l'Envolée)."
-     Less often, to uncover student plagiarism:
T. "[I use my laptop]...*for plagiarism checks…"*

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[1]Throughout this presentation of results, the letter E refers to teachers and the letter S refers to students.

Teachers also used computers outside the classroom to manage their teaching and their students' learning with education platforms or software such as Illuminate or Cyberduck.

Pedagogical uses of computers by students in the classroom

What are students actually doing with their computersin class? This question arises because laptops are sometimes viewed as a source of distraction that actually hinders learning. Nonetheless, the results of the closed questionnaire responses suggest that student use in the classroom is both reasonable and positive. Thus, of the tools, software and sites provided in the possible answers, the most often used are Wikipedia (60.7%, used weekly or monthly) and especially Google (60.5%, used weekly or daily), particularly for finding information on the Internet.

These results suggest that students use computers in class mainly for educational purposes, which is confirmed by the diversity of pedagogical activities reported during the student interviews and in their open questionnaire responses. In fact, students apparently used computers to carry out many learning activities (see Figure 3), which we have grouped into four main categories, as follows :

1. Searching for information, because materials on the Internet are much more numerous, interactive, diversified and current than the available hard copy materials:

S. "We use computers for almost all our projects because they let us do a better search. We don't have to go through books and it's faster than reading a book."
S. "The research lets us learn. With using technologies, we don't have tolook in books, and it's impossible to find one that has all the information you need."

2. Writing, which is easier to do with word processing than by pen and paper:

S. "I like to write stories for my French and English class. I love typing on my computer. I can always add more details and descriptions, and I can erase everything and start over… I feel free to do what I want when I write by computer. When I write by hand, I get bored.**"
T. *"[…] it's obvious, you can erase, add, and the dictionary is directly accessible."*

3. Multimedia projects, which let students express their creativity:

S. "I like to make a video clip, and it shows my creativity."
S. "I used a podcasting program for one of my projects. You have to record a conversation with a famous person and then play it in front of the class."

4. Presentations, using a program such as PowerPoint, which integrates text and images to present information much more interactively and dynamically:

S. "We made an oral presentation, and we had to include images, but not a lot of words."
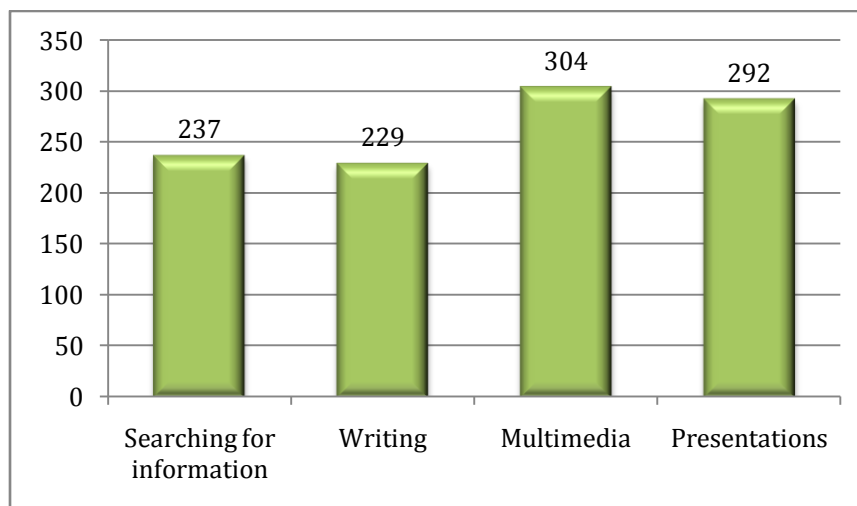S. "We presented it on PowerPoint…"

Figure 3. Pedagogical activities performed with laptops in the classroom as reported by students (real numbers).

The pedagogical activities ranged across all the school subjects. Teachers reported using laptops mostly in language teaching (English, French as a second language), science, mathematics and the social universe (see Figure 4).

T. "I use videos from National Geographic and VodZone in science class, YouTube in language arts and TeacherTube in math. I use the digital projector and Word to demonstrate in language arts. We use favourite Websites in all subjects."
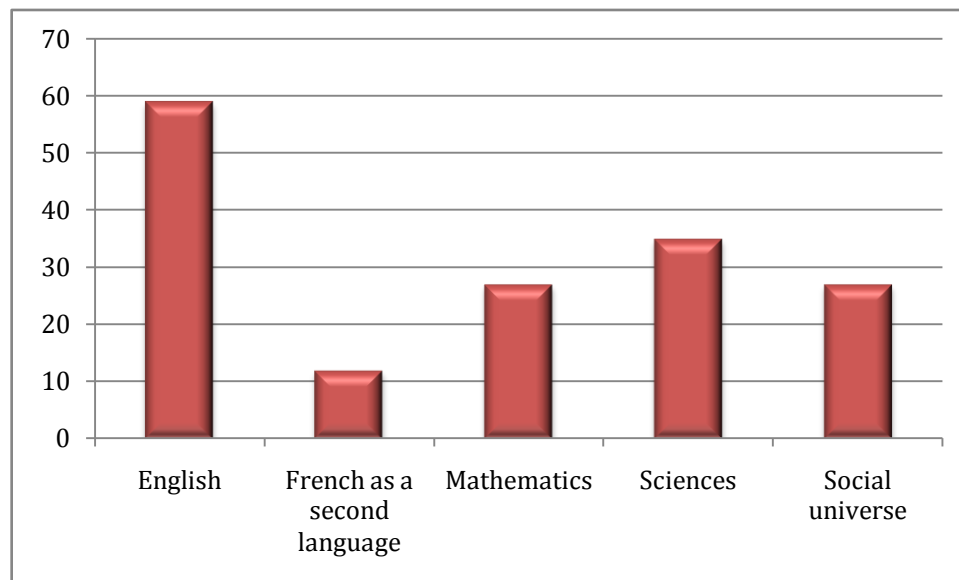

Figure 4.Subjects in which laptops were used, as reported by teachers (real numbers).

The activitiesusing laptops that were mentionedwere usually part of a learning project. These learning projects appear across the results, showing the benefits of combining for a given project a number of skills and subjects to make the experience more meaningful to the students.

The laptops were also used to make day-to-day teaching and learning more interesting and rewarding. For instance, they
-   Help the teacher explain things through the use of presentation software like PowerPointor relevant digital materials:

T. "I use a projector and a computer lab. Using Power Point and Video projections to emphasize specific elements about business topics."

T. "Sometimes I will demonstrate a new sport by showing a slide show, video or YouTube video."
S. "By using technologies, the teacher can give us the exact information […] So we see the real value of what we're learning."
-   Foster discussion and collaboration in class groups:

T. "We use the projector for correcting and grammar activities."
S. "I use it for my morning messages, during all my math classes, for any group project, for showing notes on the smartboard during large group discussions, and many more occasions."

-   Make learning more authentic and meaningful for students:
T. "My students are in the Work-Oriented Training Path, so technology is very useful for job search, navigating government web sites, using Canada411 to find businesses/people, etc."
-   Similarly, increase students' motivation to study:

T.   "I   often   use   technology   to   spark   an   interest   in   my   lesson."
"My students are very 'visual learners' and respond to video/YouTube/PowerPoint presentations."
Given the diversity and transdisciplinarity of laptops in the classroom, we may posit that they contributed to improve the day-to-day education process for the teachers and students who participated in this study.

S. "I would say that the best way to learn is to use technologies."

Does this mean that laptops are used in the classroom only for learning? Well, not quite. If the students could use their laptops as much as they wanted, Facebook would be the second most popular use, after Google. This finding is echoed in the fact that an average of 30.3%, 38.6% and 36.2% of students used Facebook, YouTube or chat programs (e.g., Messenger), respectively, weekly or daily at school. Nevertheless, these results can be qualified. It seems that these software were used less regularly at school than at home, and less than informative software or Websites such as Wikipedia.Therefore, it appears that the laptops were used in the classrooms more for pedagogical than social or recreational purposes.

4.3 Technological skills

The above-mentioned uses appear to be connected with the development of certain skills in the students, beginning with information literacy skills(i.e., the ability to search and evaluate information on the Internet). We found that 60% of students considered themselves advanced or expert at finding the information they needed on the Internet, and 30.7% felt they were at an intermediate level. However, the results are less clear-cut on judging the credibility of sources and ethical issues concerning the use of the information they found. From the teachers' standpoint, the use of laptops is related more to the issue of training in the pedagogical integration of ICT. From the results obtained, the teachers who participated in the study did not seem to have received the ICT training that they needed. In fact, 69.4% of the teachers felt that their training had little or no impact on their teaching practices, versus 30.6% who felt that the impact on their pedagogical use of ICT ranged from slight to major (see Figure 5).
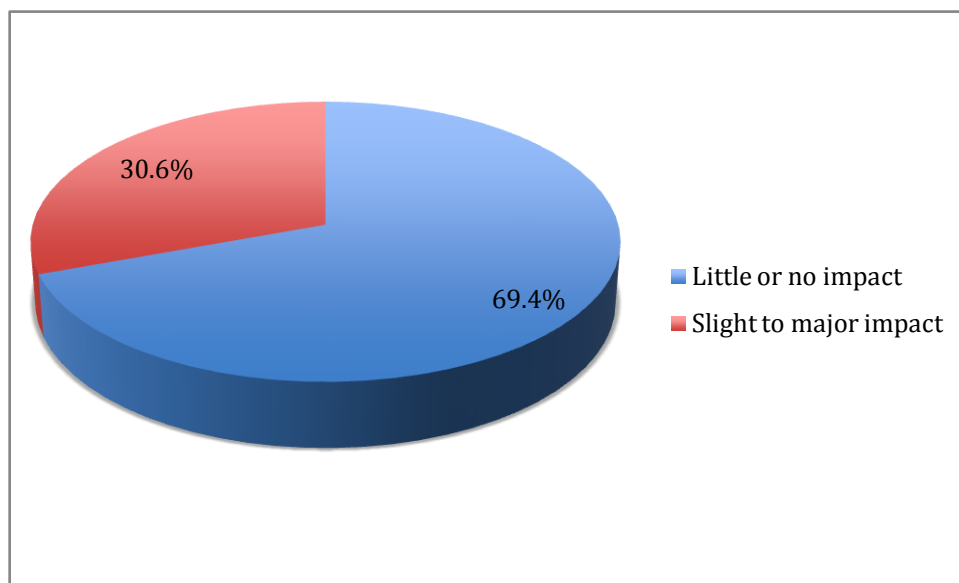

Figure 5.Impact of ICT training on the professional development of teachers who participated in the study (%).

These results, derived from the closed questionnaire responses, are corroborated by the results on the interviews and the open questionnaire responses.

T. "I did not have a useful professional development course."
More precisely, a number of participants reported that some of the suggested activities were not doable in their classrooms, and that their efforts were usually in vain. They also complained that their training was usually too intense, too short or redundant.

T. "I haven't found any to be particularly helpful in that not enough time is given to learning how to use the technology efficiently and effectively enough to take it back to the classroom and use it right away."
Consequently, the professional development of teachers in the pedagogical integration of ICT seemed to be largely trial and error:

T. "I have learned mostly on my own, 'playing around' on my computer and with the various programs."

Among the training needs mentioned by the teachers was the suggestion to better align the training with the realities of teaching and learning. To do so, they recommended that the training

- Include time so that teachers could exchange experiences with their colleagues about ICT activities they had used;
- Be given in small groups of teachers who share something in common (cycle, subject, ICT experience(or)expertise);
  Involve the students, or hold the training in the classroom with the students.

T. "I want to bring students with me, as they are excellent teaching assistants in the classroom."
Thus, training the teachers and students at the same time, and in the classroom, would appear particularly useful.

4.4 The 12 main benefits of laptops

Based on the above-presented results, 12 main benefits of using laptops in the classroom were identified. These benefits are briefly presented in this section and illustrated by one or more extracts from the questionnaires or interviews. The benefits are grouped into four main categories:

- Schoolwork facilitationand improvement
- Psychosocial factors for students' academic success (motivation, autonomy, interaction and attention)
- Access to information, and skills acquisition and development
- Equity, openness to the world, and opportunities for the future.

Schoolwork facilitation

1. Facilitates the work of students and teachers, saves time

The final benefit identified in this study is schoolwork facilitation, for both students and teachers. The responses clearly indicate that technologies save time, enable better work organization, and so on.
T. "We could do projects on it instead of doing it on papers and it would save more time."
T. "A laptop is useful because you can do so much things with it that would help you and save time at school like word documents. When you want to do presentations, instead of doing boring and long posters, you can save time and do it on PowerPoint."
T. "You can do your work easily and you can save time for other things to do."
T. "Laptops save us time and are pretty easy to use, as long as students stay on task there isn't really anything wrong with them. It's also a lot more fun when we use the laptops to express our topics in different ways."
T. "Once procedures are in place, it can save time and give students more autonomy, put them in charge of their learning."
T. "On the computer it is much neater and faster."

2. Increased access to current, high-quality information

A repeatedly cited benefit was information research, which is faster, more efficient and more interesting than what hard-copy materials can offer.
T. "Information at your fingertips."
T. "To enable easy access to a vast amount of information."
T. "The access to vast information when our libraries are very minimal."
T. "Connected to information and to new ideas at the same time."
This benefit is directly related to information literacy skills, as mentioned above in section 4.3 (Technological skills).

Psychosocial factors for students' academic success (motivation, autonomy, interaction and attention)

3. Greater student motivation

One of the primary impacts of using laptops at the Eastern Townships School Board is undoubtedly the greater motivation of the students, which is clearly attributable to the use of laptops in the classroom.
T. "Motivation and provides skills that they will need in the future."
T. "Motivating factor!"
T. "Increased student success and motivation."

T. "ICT offer all kinds of exciting possibilities. These possibilities mean that we can use fresh and innovative teaching practices."
S. "It's also a lot more fun when we use the laptops to express our topics in different ways."
This result has also been reported frequently in the literature on the pedagogical use of ICT.

4. Students pay more attention

In addition to increasing academic motivation, the use of information and communication technologies (i.e., laptops) appears to significantly increase student attentiveness during schoolwork.
T. "It draws you into your work - holds attention."
T. "Kids attention, and serious work!"
T. "Students are much more attentive."

5. Development of student autonomy

The development of student autonomy is another main impact of laptop use.
T. "It can […] give students more autonomy, put them in charge of their learning."
T. "Students become more autonomous."
T. "It helps them to work on their own and to face challenges."

6. Improved interaction between students, teachers and parents

Laptops also foster more communication between teachers, students and their parents.
T. "Communication at your fingertips."
T. "It is easier and faster to communicate."
T. "Technologies allow students to communicate more effectively among each other […] and with their teacher."

These results directly corroborate the above-presented results on students' use of laptops outside the classroom (see section 4.2). The teachers reported greater communication with students and their parents thanks to the laptops.

Learning and skills development

7. Individualized, differentiated learning

Laptops also allow more individualized and differentiated learning, which means students can learn at their own pace.
T. "Individualized instruction opportunities and collaboration."
T. "I find that the students pay more attention and are more interested to what I present in class because it combines several learning styles: visual, oral, tactile. The great thing is that each one can review their material on the computer, and they can do research at their own pace."
T. "The technologies get the children involved, through the visual and oral aspects. This helps reach students who have trouble with the paper format, and it's an excellent way to present the material."

8. Active, interactive and meaningful learning with multimedia support

Laptops can also be used for learning that is more active, interactive and meaningful for the students, particularly due to the abundance and variety of support materials (texts, audio, video, images, etc.).
T. "They like to use it for math and science the most, I think, because there are often interactive sites or teaching clips that they can enjoy."
T. "Allows students to visualize actual events or phenomena that are hard to explain verbally."
T. "Individual creativity..."
T. "Students love using technology. Boys tend to write more when we ask them to do it on a computer."
T. "[The use of ICT] helps students understand what they write in their texts and organize their ideas."
T. "[…] it's obvious, you can erase, add, and the dictionary is directly accessible."

9. Development of ICT skills

The close exposure of youth to ICT when they use a laptop also help them develop ICT skills. We refer here mainly to the development of information literacy skills, or the ability to efficiently search for and find the information they need. The results in section 4.3 suggest that the'one laptop per child' strategy can play a positive role in this respect.

Equity, openness to the world and future opportunities

10. Universal access

Laptops also provide equity of access to technologies, as they facilitate universal access. Recall that almost 11% of the students at the Eastern Townships School Board do not have Internet access at home, and the school is the only place where they can go online. This is all the more important in a world where ICTand ICT expertise are increasingly essential in the daily lives of people in Western societies.

T. *"Accessibility to computer and Internet at all times."*

T. *"Equal access to information and to the world."*

11. Breaking down the barriers between the school and society

Laptops are enormously beneficial in terms of opening up the classroom to society and the world. In so doing, they narrow the gap between societal life and school practices, and make possible a more authentic and meaningful education. This is particularly valuable in rural areas, where some schools in the Eastern Townships School Board are located.

T. *"We are more tied to the world and what the kids are interested in. Students enjoy the computer and the orals are much better when accompanied by PowerPoints or photos."*

T. *"The students know that there is a world outside the classroom walls, one which they have questions and concerns about. The laptop is the wreckingball that removes the walls, allowing all kinds of things (good AND not-so-good) into their lives in a very real way. They are part of the world, and need to discover themselves as they discover the world around them."*

T. *"You are not limited in your learning to your immediate surroundings."*

T. *"Instantaneous access to videos, experts, music and authentic images brings the world into our classroom. The school becomes more meaningful for this generation of students."*

T. *"Technology is here to stay. The students rarely question the value of a task when it involves technology, because it is part of our world and their personal reality. Technology is relevant, and it makes the curriculum relevant for the students. Thanks to technology, I can bring the world into my classroom. We walked among the ruins of Pompey last week, and a few months ago we went to Paris to see the Eiffel Tower."*

T. *"Being able to connect to and collaborate with places outside the classroom opens up our horizons, and it's very motivating."*

12. More opportunities for the future

Besides opening up the classroom to the rest of the world, laptops can alsoprovide more and varied future opportunities for the students.The techno-educativeskills that the students develop will be valuable assets in their future academic and professional careers.

T. *"Students have an opportunity to develop […] skills at a young age, which will help them when looking for future jobs that require computer literacy."*

T. *"Preparing students for the future."*

T. *"The students have access to a world of information at their fingertips and they are being prepared for the world ahead of them."*

4.5 Main challenges of laptops

The results reveal two major challenges: technical and pedagogical.

4.5.1 Technical challenges

The technical challenges mainly involve laptop breakdowns and malfunctions, which can be explained by the sometimes obsolete state of the equipment (over seven years old in certain cases). These technical problems undoubtedly pose obstacles to teaching and learning.

S. "We planned to read some rules about a game in French but the computer failed."

S. "She was trying to show us a video but the power was down so it didn't work."

These results remind us, as if we needed one, that sustainable funding for laptop programs such as the one at the Eastern Townships School Board is critical for project success, and for positive teaching and learning outcomes. The absence of funding policies can only lead to project failure.

4.5.2   Pedagogical challenges

The first pedagogical challenge mentioned by students is related to the use of educational Websites that are not very motivating, particularly for mathematics.

S. "I think it's when they make us go on boring sites like multiplication.com and make us play those boring games."

S. "When they just let us go on the educational games or cool math games, but they were not really fun; they were all bad games that were not really cool; they all had all these bad things like pinball games and that."

S. "Math sites, because it's boring."

This first challenge appears to have given rise to a second: student distraction. In fact, the unappealing nature of certain Websites appears to drive some students to use their laptops for purposes other than education.

S. "The worst way was when some of our teachers teach math or science, they tell us to go on science or math games to learn about how things in those topics work... So as everyone goes on those sites they are just playing fun, FUN games and they don't even have to do anything that we're learning! It's just like free time to do whatever! Then when it comes back to learn again no one is listening and everyone is concentrating on the video games."

However, it noteworthy that this distraction does not appear to be the norm among the students. In other words, most of the students stated that they preferred to use their laptops in class for educational rather than social or recreational purposes, which confirms the results presented in section 4.5.2. In fact, neither students nor teachers particularly enjoyed using their laptops for recreational purposes.

S. "We go on free time, which is fun, but also we could be doing real school work!"

S. "I think the least productive thing our teacher has given us would be the online comic site called Bits trips. Although it was fun we didn't learn anything from it."

S. "When the teacher told us to use GarageBand for no exact reason.

S. When she let us play fake games on the Internet, because we don't learn."

T. Surfing the net for no good reason and without guidelines. Playing games when they have finished their work."

T. "Free time on laptops - mindless games that don't contribute to learning or practice of skills."

It is therefore interesting to note that, contrary to certain preconceptions about the use of ICT in education, the students, like their teachers, seemed to have developed a strongly educational perception of computer use in the classroom, to the point where using their laptop for recreational instead of educational use was considered a waste of time. This 'techno-educative maturity' of the students, in terms of the exclusively educational use of laptops, is most probably related to the frequency with which they used ICT at school. In other words, it is conceivable that the students used ICT in order to do their schoolwork, but did not necessarily appreciate their educational value.

The final challenge concerns ongoing teacher training in the pedagogical use of ICT, as mentioned above (see section 4.3).

5. Conclusion

To recap, this project was the fruit of an exemplary research partnership between the Canada Research Chair on Information and Communication Technologies (ICT) in Education and the Eastern Townships School Board. The school board, under the urging of its visionary Director General, had already determined eight years previously to provide most of its students with laptops to use for their schoolwork.

In this study, which is still ongoing, we aimed to identify the main benefits and challenges of using laptops in primary and secondary school. We administered a large-scale survey questionnaire to students, teachers and other education stakeholders. We also conducted individual and group interviews and performed classroom observations (currently under analysis). In all, 2,432 students and some 280 teachers and other education stakeholders participated in the first study phase. The data gathered to date have enabled us to determine the state of technology access, both at school and at home. We also identified the computer equipment owned by teachers and students at the Eastern Townships School Board. In addition, the survey revealed the pedagogical uses of technologies by teachers and students. We also identified the technological skills of the teachers and students. Most importantly, the gathered data enabled us to identify the main impacts, including the benefits and challenges, of the use of ICT by teachers and students at the Eastern Townships School Board.

We grouped the challenges of using laptops into two general categories: technical and pedagogical. The technical challenges appeared to be more problematic, and were most probably related to the intensive use of information and communication technologies for pedagogical purposes (Karsenti & Collin, 2011). The pedagogical challenges were of various types: some Websites and pedagogical activities that were suitable for ICT use were not very appealing or stimulating for the students, so that they were tempted to use their laptops for fun instead of learning. In this case, ICT can become a source of distraction rather than a tool to encourage learning. The teachers found that the pedagogical challenges were mostly related to the ongoing training they received. The training did not seem to meet their needs, which are quite different from those of their students. Finally, the students, like their teachers, appear to have developed a strongly educational perception of the use of laptops in class. In tangible terms, many students clearly stated that recreational use instead of pedagogical use of their laptops in school would be a waste of time. This 'techno-educative maturity' of the students isan unexpected finding, and could be at least partly explained by the frequency and duration of use of laptops in class.

The benefits identified in this first study phase may be grouped into four main categories, as follows:
- Schoolwork facilitation and improvement
- Psychosocial factors for students' academic success (motivation, autonomy, interaction and attention)
- Access to information, learning and skills development
- Equity, openness to the world, and opportunities for the future.

A total of 12 main benefits of using laptops were identified by the majority of the students and teachers:
1. Facilitation of schoolwork for students and teachers, and consequently time saving
2. Increased access to current, high-quality information
3. Greater student motivation
4. Improved student attentiveness
5. Development of student autonomy
6. Increased interaction between students and between students and their teacher
7. Individualized, differentiated learning
8. Active, interactive and meaningful learning with multimedia support
9. Development of ICT skills
10. Universal access
11. Breakdown of the barriers between the school and society
12. More opportunities for the future.

These benefits, which were mentioned by the vast majority of the respondents, clearly demonstrate that the use of laptops, or the intensive use of information and communication technologies, has a major impact on students' academic success, and potentially on their future academic and socioprofessional careers. A further, particularly interesting finding of this study is the attitude of teachers towards technologies. In fact, the literature on the pedagogical integration of ICT frequently reports that ICT are motivating for students, but are perceived more negatively by teachers, for instance, due to the changes in teaching practices that they imply. It is therefore particularly unusual to find so few teachers with a negative attitude toward technologies. Less than 5% of the teachers at the Eastern Townships School Board were unenthusiastic about using them. The majority, even though they had experienced a few problems, would not go back to their old ways of teaching. Indeed, for both teachers and students, the worst use of the new technologies would be not to use them in class.

Another notable impact was revealed by the results of this study: the 'one laptop per child' strategy appears to have contributed to the development of ICT skills in both students and teachers, particularly information literacy skills.As noted by Karsenti and Dumouchel (2011), technologies have wrought substantial changes in information production and accessibility (see UNESCO, 2005). In today's knowledge society, the primary advantage of ICT is to provide rapid, easy and free access to practically unlimited amounts of information. ICT have become a prerequisite, a mandatory way to access information and consequently produce knowledge and foster learning. We may therefore conclude that the teachers and other education stakeholders at the Eastern Townships School Board have pioneered an exemplary approach and made an outstanding contribution. In light of the results of this preliminary study, we may posit that the implementation of the 'one laptop per child' strategyat the Eastern Townships School Board is a primary factor to explain its leap from 66th position in 2003 to 23rd in 2010 (out of 70 school boards), and why the student dropout rate has plunged from 39.4% in 2004–2005 to 22.7% in 2008–2009.

This progress, which we may at least partly attribute to the 'one laptop per child' strategy, would certainly never have been possible without the complete commitment and outstanding skills of the teachers, the school administrations and other education stakeholders at the Eastern Townships School Board. The official statistics on student graduations in this school board appear consistent with the preliminary results of this study, which enable us to gain a broad overview of the benefits and challenges of using laptops in the classroom. In this respect, we should retain the lesson that, despite the technical and pedagogical challenges, this innovative education initiative represents above all a gain,for both teaching and learning, and for the future social and professional lives of the students who participated.

5.1 Directions for future research

At this point (the research is still ongoing), it is difficult to point out directions for future research. Nevertheless, the findings of this first study phasesuggest the following scientific approaches:

- More systematic studies on the impacts of enriched technology environments, such as at the Eastern Townships School Board, on students' academic success;
- More specifically targeted studies on adaptation processes in teachers and students when making the shift from a traditional class to a laptop class, and vice-versa;
- Studies on the relationships and interactions between students use of laptops in the classroom and at home;
- Longitudinal studies to document the academic and professional paths of students who attended 'one laptop per child' classroomsin order to gain a better understanding of the impact extent of this innovative project.

7. References

Beck, R. C. (2003). *Motivation: Theories and principles*. New York, NY: Prentice Hall.

Behrens, J. T., & Smith, M. L. (1996). Data and data analysis. In D. Berliner & B. Calfee (Eds.), *Handbook of educational psychology* (pp. 945-989). New York, NY: Macmillan.

Bogdan, R. C., & Biklen, S. K. (1992). *Qualitative research for education*. Boston, MA: Allyn and Bacon.

Brewer, J., & Hunter, A. (1989). *Multimethod research: A synthesis of styles*. Newbury Park, CA: Sage.

Caracelli, V. J., & Greene, J. C. (1993). Data analysis strategies for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 15*(2), 195-207.

Centre francophone d'informatisation des organisations. (2009). *Rapport-synthèse sur la génération C*. Montréal, QC: CEFRIO. Retrieved from http://www.cefrio.qc.ca/fr/documents/publications/Rapport-synthese-sur-la-generation-C.html

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Thousand Oaks, CA: Sage.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd Ed.). New York, NY: Macmillan.

Howe, K. R. (1988). Against the quantitative-qualitative incompatibility thesis or dogmas die hard. *Educational Researcher, 17*(8), 10-16.

Huberman, A. M., & Miles, M. B. (1991). *Analyse des données qualitatives. Recueil de nouvelles méthodes*. Bruxelles, Belgique: De Boeck Université.

Huberman, A. M., & Miles, M. B. (1994). Data management and analysis methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 428-444). Thousand Oaks, CA: Sage.

Institut de la statistique du Québec. (2007). *Utilisation d'Internet à domicile à des fins personnelles non commerciales par les individus, selon le type de besoins d'études, de formation ou de travaux scolaires, Québec, Ontario et Canada, 2005*. Retrieved from http://www.stat.gouv.qc.ca/savoir/indicateurs/tic/individus/tic_etude1.html.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Karsenti. T., & Collin, S. (2011). L'enseignement-apprentissage 2.0: la nécessité d'apprivoiser les technologies émergentes en enseignement supérieur. *Revue de la Haute École Pédagogique de Berne, du Jura et de Neuchâtel, 16*, 16-18.

Karsenti, T., & Dumouchel, G. (2011). *Former aux compétences informationnelles au Québec: une mission partagée*. Manuscript submitted for publication.

Karsenti, T., Komis, V., Depover, C., &Collin, S. (2011). La recherche en éducation à l'ère des TIC.In T. Karsenti, T. & L. Savoie-Zajc (Eds.), *La recherche en éducation: étapes et approches* (4th Ed.). Ville Saint-Laurent, QC: Éditions du Renouveau Pédagogique.

Karsenti, T., &Savoie-Zajc, L. (Eds.). (2011). *La recherche en éducation: étapes et approches* (4th Ed.). Ville Saint-Laurent, QC: Éditions du Renouveau Pédagogique.

Krathwohl, D. R. (1998). *Methods of educational and social science research: An integrated approach* (2nd Ed.). New York, NY: Longman.

L'Écuyer, R. (1990). *Méthodologie de l'analyse développementale de contenu. Méthode GPS et concept de soi*. Québec, QQ: Presses de l'Université du Québec.

Lessard-Hébert, M., Goyette, G., & Boutin, G. (1990). *Recherche qualitative: fondements et pratiques*. Montréal, QC: Agence d'ARC.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Mark, M. M., & Shotland, R. L. (1987). Alternative models for the use of multiple methods. *New Directions for Program Evaluation, 35*, 95-100.

McLester, S. (2007). *Technology literacy and the MySpace generation*. Retrieved from http://www.techlearning.com/article/7074

Moss, P. A. (1996). Enlarging the dialogue in educational measurement: Voices from interpretive research traditions. *Educational Researcher, 25*(1), 20-28, 43.

Organisation for Economic Co-operation and Development. (2004). *Completing the foundation for lifelong learning: An OECD survey of upper secondary schools*. Paris, France: OECD.

Organisation for Economic Co-operation and Development. (2008). *New millennium learners: Initial findings on the effect of digital technologies on school-age learners*. Paris, France: OECD.

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the Horizon, 9*(5), 1-6.

Reichardt, C. S., & Gollob, H. F. (1987). Taking uncertainty into account when estimating effects. *New Directions for Program Evaluation, 35*, 7-22.

Sedlack, R. G., & Stanley, J. (1992). *Social research: Theory and methods*. Boston, MA: Allyn and Bacon.

UNESCO. (2005). *Vers les sociétés du savoir*. Paris, France: Éditions UNESCO.

Van der Maren, J.-M. (1996). *Méthodes de recherche pour l'éducation* (2nd Ed.). Montréal, QC: Presses de l'Université de Montréal.