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**AN OBSERVATIONAL STUDY ON THE CLASSROOM USE
OF INFORMATION AND COMMUNICATION TECHNOLOGY**

**by
Shelley Martin**

**A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of**

Master of Arts

Department of Sociology and Anthropology

**Carleton University
Ottawa, Ontario
August 26, 1996**

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**The undersigned recommend to the Faculty of Graduate Studies
and Research acceptance of the thesis**

**AN OBSERVATIONAL STUDY ON THE CLASSROOM USE
OF INFORMATION AND COMMUNICATION TECHNOLOGY**

submitted by Shelley Martin

**in partial fulfilment of the requirements for
the degree of Master of Arts**

Thesis Supervisor

Chair, Department of Sociology and Anthropology

Carleton University

August 26, 1996

ABSTRACT

This thesis describes a study designed to address gaps in the current knowledge and understanding of the classroom use of information and communication technologies. Taking a micro-level approach, the project involved the observation, recording, and analysis of events and behaviours in a single Grade 4 classroom in which students engaged in Internet-based activities. The results indicate that both gender and pre-existing cultural capital (in the guise of prior home experience with the Internet) have an impact on children's classroom use of information technologies. Equality of access to the technology is given special consideration; this work endeavours to delineate a variety of factors, beyond the physical presence of a computer in the classroom, that influence children's ability to obtain hands-on, productive engagement with the technology while working on an educationally relevant task.

ACKNOWLEDGMENTS

My greatest appreciation goes to the teacher who permitted my research to take place in her classroom; without her interest and enthusiasm, this work could not have gone forward. My sincere thanks are also extended to the school principal who approved the project, and to the 30 delightful children who cheerfully went about their classroom computing activities as I sat and observed them.

Heartfelt thanks are due to my advisor, Stephen Richer, for planting the seed of the idea for this thesis, and for his guidance, constant encouragement, and unflagging patience. Thanks also to my committee member, Charlie Gordon, for his valuable advice and insights. I am indebted to John de Vries for providing thoughtful comments that helped me fine-tune the focus of my thesis proposal, and to Terry Nosanchuk for his advice as I developed my analytical approach. A very special thank you goes to Marianna McVey, whose interest in and support of this project was invaluable.

My family deserves more thanks than I can ever possibly express. While it is true that the life of a graduate student can be highly stressful, it is equally true that living with a student can be a difficult task; I am enormously grateful to Gerard, Kiowa, Travis, and Drew for their boundless patience and understanding, and for continuing to love me in spite of everything.

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CHAPTER ONE

INTRODUCTION

The educational use of computers as tools for communication and information retrieval is currently receiving considerable attention. This is an exciting new application of classroom equipment that has the potential to provide children with skills in the use of information and communication technology (ICT), and many experts advocate its widespread introduction into our schools. Numerous analysts assert that ICT skills are currently, and will continue to be, absolutely essential for the workplace, and that those students who are not trained in information technology will eventually be at a marked disadvantage in the labour market. Further, some authors argue that the ability to manipulate ICT will have benefits that extend far beyond the workplace; individuals who are familiar with these new technologies will maximize their personal capacity to participate fully in our modern information-based society.

While the reputed benefits of using computers for information retrieval and communication are provocative, there are notable gaps in our understanding of this use of technology in schools; we actually know very little about what happens in classrooms in which children engage in ICT-based activities. The literature contains some accounts of classroom ICT projects, but this material is typically hortatory in nature and neglects to examine the phenomenon with a critical eye. The current literature also appears to assume that all children in a classroom will have equal opportunity to engage with the

equipment, but the reality of a student-to-computer ratio that can run as high as 35:1 casts doubt on this assumption. With, as is typical in classrooms, only one machine available for ICT activities, hands-on computer time must be rationed, this reality engenders the potential for some children to be marginalized or completely excluded.

The literature on other computer use in schools provides ample evidence that the use of such technology tends to be differentiated along class, race and gender lines, and is heavily influenced by the presence or absence of computers in the home. Published reports of the educational use of ICT, however, neglect to consider any of the factors that may influence children's access to the equipment. If familiarity with ICT is so beneficial to children, it is important that ALL students have the opportunity to engage with the technology on a hands-on basis - and it is imperative that we study this phenomenon to determine if access is truly equal.

This work describes the results of an observational study, which was designed to address some of the gaps in our current understanding of the educational use of information technology by providing a rich description of what transpired in a single classroom during ICT activities. Taking a micro-level approach, the study involved the observation and analysis of dynamics and behaviours in a Grade 4 classroom in which students worked on ICT projects, and focused on the impact of gender and home use of the technology. Although concerns about differentiated access according to race or class are at least as important as concerns about disparities between males and females, the single-classroom case study design, and the homogeneous composition of

the only available sample, precluded any class- or race-based comparisons. The study also involved a re-conceptualization of the notion of access to computers by moving beyond simplistic counts of computer-to-student ratios to take into account classroom management techniques and other factors that influence the ability of students to engage with the technology in educationally relevant ways.

Access to ICT in the Information Age

Following the shift in the Western economic system from manufacturing to the production of information, the late 1980s and 1990s have witnessed an explosion in the development and implementation of new computer technologies designed to facilitate electronic communication and the transmission of information. Businesses, governments, and individuals have invested massive amounts of money in computer and communication technologies, software programs and training; by some estimates, as much as 40% of current investment in plant and equipment in the United States is in computers and communication technology (Edwards, 1995; Kirkup, 1992), and a similar emphasis on telecommunications technologies is occurring in Canada (Silva & Cartwright, 1995).

Many analysts insist that the need to compete in the highly competitive and knowledge-intensive global markets currently requires, and will continue to require, a sophisticated workforce trained in the use of information and communication technologies (Fisher, Rubenson, & Schuetze, 1994; Mahmood & Hirt, 1995). Along with this forecast of labour market requirements comes

the assertion that individuals who lack knowledge of ICT will be at a marked disadvantage when seeking employment and promotion in a highly competitive job market (Bailey & Cotlar, 1994; Clarke, 1990; Collis, 1991; Dyrli, 1993; Emihovich, 1992; Fetler, 1985; Fredman, 1990; Hawkridge, 1989; Laszlo & Castro, 1995; Nelson & Watson, 1991; Pelgrum & Plomp, 1991; Pool, Blanchard & Hale 1995; Royal Commission on Learning, 1994; SchoolNet, 1996b).

Given these forecasts about the importance and necessity of establishing a labour force that is familiar with and competent in the use of ICT, it is not surprising to discover that many experts call for schools to assume a central role in the provision of ICT training. For example, Riel (1990) states that it is essential, from an economic perspective, for schools to teach students how to use information and communication technologies. Hunter, Bagley & Bagley (1993) call for middle school administrators to acknowledge their responsibility in preparing students to meet the requirements of the workplace of the information age. Similarly, Bailey & Cotlar (1994), Coates & Jarratt (1993), Everett & Ahern (1994) and Walker (1995) recommend that schools take a highly active role in exposing students to the information and telecommunication technology that they will need to take part in the workforce. The recent Ontario study by the Royal Commission on Learning (RCOL) describes computer literacy, including familiarity with ITC, as a foundation workplace skill; the RCOL recommends that the Ontario Ministry of Education and Training encourage integration of ITC into classrooms, beginning in the earliest grades (RCOL, 1994).

While there is much literature urging schools to provide the basics in computer literacy, including training in ICT, in order to give our children the skill-set required for the workplace, it is important to note that not all analysts agree with this educational focus. Sutton (1991) argues that it may not be essential for students to learn about new technologies in school because the equipment and software that they use will be obsolete by the time they graduate, and on-the-job training will provide them with the necessary skills. I would, however, agree with Chen (1986), who provides evidence that experience leads to a confident attitude toward technology, which in turn facilitates mastery of newer software and hardware. Further, given the current climate of high unemployment, corporate and government downsizing, and the fact that many employment ads call for at least some experience with computers and ICT, it seems reasonable, and perhaps imperative, to expect that the schools should be introducing students to the newest computer, communications, and information technologies.

Another dissenting opinion is expressed by Apple (1988), who warns that by virtue of the current emphasis on introducing computer technology into school curricula, "we are in the midst of one of those many educational bandwagons that governments, industry, and others so like to ride" (p. 151). He calls for educators to take a critical look at the current and future needs of the workforce, noting that high-tech industries comprise less than 15% of the work force in Western industrialized countries, with only about 25% of the jobs within the high-tech industries requiring significant knowledge of technology; far more jobs exist in clerical and service sectors than in high technology

occupations. In addition, the automation and routinization of job tasks made possible by modern technology has resulted in, and will continue to result in, widespread deskilling in jobs, and significant reductions in the total number of jobs available (Apple, 1988). Given these projections for future labour markets, the current emphasis on introducing computer technology in the schools is, in Apple's view, an *over-emphasis*. He asserts that "before we give the schools over to the requirements of the new technology and the corporation, we must be very certain that it will benefit all of us, not mostly those who already possess economic and cultural power" (Apple, 1988, p. 160). He also cautions that a continuing focus on computer and ICT literacy in schools may exacerbate existing labour-force differences along class, race and gender lines.

While Apple's comments are thought-provoking, it is debatable that only a small number of high-technology occupations will require a familiarity with computer and information technology. Apple's critique is based on an overly narrow definition of computer technology and a highly specialized set of skills centred around computer programming. It is true that programming skills are required by only a small fraction of the current and future labour force, but I would argue that knowledge of other ICT applications *will* be a requirement for many other occupations, including those of secretary, office clerk, elementary school teacher, nurse, and truck driver, that Apple says *do not* require competencies in new technologies.

Apple's critique is also flawed in its implicit assumption that the only possible reason to promote ICT and computer literacy in the schools is to prepare students for the future labour market. One need only look around to

see that ICT applications abound in our lives far beyond the workplace: public library catalogues are accessible only via a computer and keyboard, telephone and banking systems are computerized, email is becoming a widely-accepted means for interpersonal communication, and a vast range of information, from daily news to employment information to leisure-related material, is available electronically via the Internet and the World Wide Web.¹ Some analysts argue that the ability to access such information will bestow upon the individual significant benefits that will maximize his or her capacity to achieve personal aspirations and to participate fully in modern society (Clarke, 1990; Fetler, 1985; Hunter et al., 1993; Sutton, 1991). This perspective is summarized most eloquently by Martinez (1994):

Access to and proficiency in the manipulation of information, especially through electronic technologies, defines in part the citizen of the modern democratic state....Given the centrality of computers to information flow, computer literacy may become the *de facto* prerequisite for citizenship in the next century....The distinction between those who have facility with information technologies (and access to them) and those who do not will become as distinct functionally as the difference between those who can read and those who cannot. (p. 395)

Just as Martinez points to access to information technology as crucial for individuals to fully realize their potential in the society of the current and future information age, the notion of access to equipment is often stressed in discussions of educational computing. It is clear that those who address this issue consider it to be highly important, because lack of access inevitably

¹ The Internet is, simply put, a worldwide network of computer networks. The World Wide Web is often referred to as the "killer application" of the Internet. It provides the user with a graphical, magazine-style interface to the Internet, including text, pictures, and even sound and video.

translates into less experience and less knowledge (Schubert, 1986). Some discussions of access in the educational context attempt to measure it by calculating the percentage of schools having computers, or the numbers of computers in a school, where the interest lies primarily in comparing rich vs. poor neighbourhoods or white vs. black school districts (Bonner, 1986). Other treatments of access measure it via the student-to-computer ratio, and assume that a ratio of 10:1 provides more access than a ratio of 25:1. Still other discussions of access focus on a formula for "student access hours" based on the number of students in a school, the number of computers in the school, and the number of instructional hours per week (Slovacek, 1992).

I agree with Becker (1992) and Maddux (1994), who argue that such simplistic definitions of access are seriously flawed because they assume, incorrectly, that equal access to computers is assured by simply placing the equipment into the schools and the classrooms. Given what we know about boys dominating computer labs and elbowing girls out of the way in classroom-based computing exercises (Beynon, 1993; Beynon & Mackay, 1993; Clarke, 1990; Culley, 1993; Jacobson, 1994; Kirkup, 1992; Moses, 1993), it is clearly not reasonable to suggest that the mere presence of computers in a school guarantees access of any kind - equal or otherwise - for all students of both genders. These measures are a reflection of opportunity or availability, and not a reflection of access.

While availability of computers is, of course, an essential condition to educational access, a better definition of access would be one that takes into account what Maddux (1994) calls "practical availability to something that is

educationally beneficial" (p. 38). Maddux asserts that discussions of computer access should include examination of classroom management techniques, as well as investigations of the ability of teachers and students to engage with the technology in educationally relevant ways. I agree with Maddux's position, and I would add to his argument by defining access as those periods when a student has hands-on and productive engagement with the computer technology while working on an educational task. It is this definition that informs all discussions of classroom access to information and communication technologies in this paper. The current study will attempt to delineate a number of factors, beyond the simple physical presence of equipment, that can impact on children's classroom access to ICT.

It is clear that, when analysts describe access to and proficiency with information technologies as essential for full participation in modern society, they view facility with ICT as a form of cultural capital in the theoretical context outlined by Pierre Bourdieu (1986 and 1974). While theories of economics consider only a single form of capital, Bourdieu suggests that there are two other distinct forms of capital -- cultural and social -- that can translate indirectly into economic capital and hence into money and property. Cultural capital in the objectified state includes books, instruments, and machines, and is linked to cultural capital in the embodied state -- cultural competence in the individual -- through the processes of inculcation and assimilation. According to Bourdieu (1986), an individual cannot obtain cultural capital second-hand, but rather must invest (deliberately or unconsciously) personal time in its acquisition.

While the transmission of cultural capital can, and does, occur in an educational setting (Apple, 1982), the degree to which children obtain such cultural capital is strongly influenced by the home environment, and the extent to which parents provide them with cultural events and goods -- books, museums, computers, and so forth (Bellamy, 1994; Looker, 1994; White, 1987). Once acquired, any specific cultural competence can bestow advantages to the individual, just as the lack of a specific cultural competence can result in disadvantages. Those students who are able to begin acquiring specific cultural capital, such as facility with ICT, within the family domain will have greater opportunity for success at school compared to their less fortunate peers who begin to acquire these cultural competencies only within the school setting. As Bourdieu (1986) notes, "being able to read in a world of illiterates derives a scarcity value from its position in the distribution of cultural capital and yields profits of distinction for its owner" (pg. 245). (I would add that being able to manipulate ICT in a group of computer novices also yields benefits to the individual.) Further, such benefits are cumulative, because initial cultural competence opens up options for the individual and permits him or her to build on pre-existing capital while others are only beginning to acquire the rudiments of such capital (Bourdieu, 1974; White, 1987). Those children who enter school with pre-existing knowledge of computers and ICT may very well obtain benefits that impact positively on their future participation in the labour force, as well as on their everyday lives in the information age. I would suggest that any investigation of the manner in which

schools transmit cultural capital in the form of access to ICT must examine the impact of home-based acquisition of such knowledge.

Information and Communication Technologies in the Classroom

It is encouraging to note that some analysts and educators insist that schools have a responsibility to teach ICT because in so doing, they will prepare students for both workforce demands *and* the demands of every-day life in the Information Age (Hunter et al, 1993; Fetler, 1985; RCOL, 1995; Riel, 1990). It is also encouraging to discover that many schools are, indeed, beginning to introduce their students to the newest information and communication technologies.

Teachers and students are increasingly making use of ICT to engage with the wider world outside the classroom. Computerized ICT can facilitate ambitious learning activities in which children can correspond with others around the world; collaborate on school projects with classes in far-flung locations; pose questions to, and receive answers from, experts in a wide range of disciplines; and access a variety of sources of up-to-date, on-line electronic information (Brienne & Goldman, 1989; Ruchanan, 1995; Cutler-Landsman & Wzresinski, 1994; Gray, 1995; Hanson, 1994; Julyan, 1989; Kurshan, 1990; Levin, Rogers, Waugh & Smith, 1989; Riel, 1990; Rieseberg, 1995; Roblyer, 1992; West, 1993). In order for these adventures to occur, classroom computers are being connected to the outside world in a variety of ways. For example, commercial Internet providers such as Prodigy, CompuServ and

America On-Line have special interest areas designed for children and their teachers, and National Geographic sponsors a network geared toward science projects (Julyan, 1989). Many school boards, typically in partnerships with government and industry, are implementing networks designed to facilitate teacher and student use of ICT by providing a means to connect learning activities to a wide variety of relevant electronic resources.

The governments of several Canadian provinces have adopted comprehensive initiatives geared toward introducing teachers and students to the Internet and the Web (Alberta Department of Education, 1996; B.C. Ministry of Education, Skills, and Training, 1995; Manitoba Information Highway Advisory Council, 1996; New Brunswick Department of Education, 1995; Nova Scotia Department of Education and Culture, 1996; Ontario Ministry of Education and Training, 1995 & 1996; Prince Edward Island Department of Education, 1995). In Canada we also have a particularly ambitious national ICT initiative in the form of Canada's SchoolNet, a joint effort of the federal and provincial governments and industry.

SchoolNet arranges for schools to be connected to the Internet, underwriting costs where necessary, and promotes a variety of educational links on its gopher server² and Web site. Four thousand schools were wired and registered users of SchoolNet services during its initial phase, when 300

² Gopher is a tool that searches the electronic world for documents made available for public access by information providers (typically, universities, governments, and businesses). Gopher servers are points of access that Internet users can visit (electronically, of course) to retrieve the information stored there. Gopher servers are commonly referred to as gophers, which admittedly causes some confusion between the concepts of gopher-the-tool and gopher-the-location (not to mention gopher-the-animal!).

schools had been expected to connect to the network. This staggering response led to a renewed goal to provide Internet access to all 16,500 Canadian public schools by 1998. The federal government has committed substantial amounts of money to this project, including \$1.6 million for the 1994-95 school year (SchoolNet, 1995b).

Recently, SchoolNet's plan to connect all Canadian schools received an enormous boost in the form of a partnership between governments and Stentor. The partners are committed to providing high-speed access to the Internet for all Canadian schools, including those in rural and remote areas, by the end of the 1996-97 school year; the total cost of this initiative is estimated at \$16 million, of which \$4 million will be contributed by the federal government (Hull, Day & Spendlove, 1996). Once the program is completed, Canada will be the first country in the world to connect all of its schools to the Internet, and, according to Industry Minister John Manley (quoted in Hull et al, 1996, p. 1), "[these] efforts are moving Canada to the forefront of the OECD countries in harnessing the power of telecommunications to build skills for a more innovative economy."

As well as pushing forward the plans to connect all Canadian schools, SchoolNet administrators have also devoted considerable energy to the development of a high-quality educational Web site that contains a broad array of information on a wide range of subject matters, with a welcome focus on Canadian content. SchoolNet also sponsors programs geared to encouraging teachers and students to actually use the available electronic resources.

While the reputed benefits of using ICT are provocative, and SchoolNet's accomplishments are most impressive, there are notable gaps in our understanding of this use of technology in the classroom. There does not, as yet, appear to have been sufficient investigation geared toward detailing precisely how and by whom ICT is used in the classroom. This technology is expensive, and it is typical for a school to have only a handful of computers equipped for ICT activities (Riel, 1990; Robinson, 1993; Waugh & Levin, 1989). If instruction in and familiarity with ICT is so beneficial to students, it is important that *all* students engage with the technology on a hands-on basis. Without equality of access, not all children will benefit, and there is a very real danger that only select groups of children will acquire the ICT skills that translate into future benefits in the workplace and everyday life. Recalling Apple's comment that a continuing focus on computer and ICT literacy in schools may heighten existing labour-force differences along gender lines, and given that there is a chasm between the number of males and females currently tapping into on-line services and information for recreational purposes (Akst, 1994; Kome, 1995; Shade, 1993; Truong, 1993; We, 1993), it seems particularly important that school-based ICT initiatives be evaluated to ensure that girls, as well as boys, are getting hands-on access to the technology.

There is a small body of literature that provides some (albeit limited) description of the processes and outcomes of ICT projects in the classroom. SchoolNet's Web site contains information about its GrassRoots Projects Program, which encourages Canadian teachers to create and run small, curriculum specific, Internet-based classroom projects (SchoolNet, 1996c), and

provides a forum for teachers to advertise and evaluate their Internet projects (SchoolNet, 1996a).

Evaluation reports accessible on this Web page are typically pedagogical in tone, as one would expect; they tend to provide information about how GrassRoots projects were integrated into classroom activities, details about the component activities (Internet-based and other) of a project, and comments about overall learning outcomes. A number of teachers stated that Internet-based projects involved unexpectedly and unacceptably long time-lines, and required a huge commitment from teachers in order to learn the component ICT-based skills before involving the students. Frequent mention is made of the fact that such projects are highly motivating to children and generate a great deal of excitement (SchoolNet, 1996a).³ No final report provides any information about how the activities were parceled out among participating children; one teacher, however, reported that her project, The International CyberFair, was an extra-curricular activity with participation by invitation only according to giftedness in mathematics; half of the chosen children had previous experience with Web page design. This particular study is a blatant example of a project in which benefits accrue to children with a pre-existing supply of cultural capital, while other students are completely excluded; it does, fortunately, appear to be an atypical example among a set of projects that took place during regular classroom schedules.

³ For example, teachers who submitted reports for the "Birds in Marshes in Spring," "Blue Print Earth," "Discovering Canada," and "Internet Weather Projects" all noted that children were enthusiastic and highly motivated.

Even within the CyberFair project, it is not clear whether or all students were able to have hands-on ICT experience, or whether or not there were differences in participation according to gender. This shortcoming in project evaluation is also inherent in many other published reports of classroom ICT activities.

Robinson (1993) describes an e-mail project in which an elementary school class solved an adventure mystery written by a class of high school students. This project, according to participating teachers, resulted in the students sharpening their skills in math, science, creative writing, and problem solving. Teachers also credit the "motivating power of the e-mail messages" (Robinson, 1993, p. 116) with maintaining students' interest at high levels for the 6-month duration of the project. Finally, teachers noted that the demands of the project stimulated a great deal of collaborative work. Unfortunately, while information was gathered concerning collaboration *between* the schools, no observations were made about the nature of the involvement and collaboration among students *within* each classroom, nor is there any mention of differential experiences according to gender or prior experience. Further, it is unclear whether or not all students in both classes actually engaged with the computer technology on a hands-on basis.

Brienne and Goldman (1989) report on an initiative in which several sixth-grade classes in different New York City schools collaborated on a weather project. Groups of students collected data on temperature, air pressure, wind speed, precipitation and weather conditions; each group used a computer to enter the results into a database that was shared among the

classes and accessible over a local-area network. Students also used e-mail to communicate their results to classes in far-flung locations such as Boston and Hawaii. Participating teachers identified numerous positive outcomes of this project, including the benefits to students of doing hands-on work that modelled the work of real scientists, and the usefulness of learning how to use e-mail to contact experts in the outside world and to communicate findings to a wider audience. No mention is made, however, of the dynamics within the student groups, nor is there any indication whether or not all students had hands-on experience with e-mail. In one school, in fact, students stored their e-mail messages in a central database, and a teacher transmitted the messages. It is difficult to accept the authors' conclusion that these students acquired skills in telecommunication technology, since their teacher handled many of the practical computer aspects of the project.

Walker (1995) describes another weather project, designed and run by a class of students in Carp, Ontario, in which students from 24 schools in Australia, Canada, and the United States used SchoolNet resources to gather data and analyze its significance. While Walker notes that participating students were fascinated with traveling the world electronically, and that certain students at his school were trained to be Internet researchers, he fails to include a discussion about equal access to the technology and whether or not there were differences in enthusiasm or participation according to gender.

Julyan (1994) gives an account of a nation-wide project about pets, initiated by a fourth-grade class in Massachusetts and including input from hundreds of schools, in which the National Geographic Kids Network

information technologies were used to gather data together and to communicate results among participating schools. Teachers noted the interesting finding that *"all their students -- not just those previously interested in science -- were eager to participate"* (Julyan, 1994, p. 35; emphasis original). This observation begs elaboration: were *all* students equally interested in *all* components of the project? Again, this discussion is lacking in that it fails to state whether or not all students had practical experience with the communications technology.

A number of other items in the literature report on 'successful' classroom ICT projects similar to those outlined above (Brienne & Goldman, 1989; Harris, 1994; Harris, 1995; Kelly & Weibe, 1994; Riel, 1990; Riel, 1992; Roblyer, 1992; Roth, 1992; Sayers, 1991; Watson, 1993; West, 1993). All the projects described by these authors were considered successful because they appeared to stimulate learning, generated enthusiasm in the students, and introduced children to computer and telecommunications technologies. Each of these accounts of ITC projects, however, suffers from a failure to attend to issues of classroom dynamics and equal access to the technology, and none makes any mention of gender.

A comprehensive search of the literature on the use of classroom ICT uncovered only a single item that addressed the issue of gender. Hanson (1994) describes the experiences of a group of students, eleven males and four females, that connected to the Internet via equipment at their Calgary, Alberta high school. The students themselves noted that there seemed to be no difference in abilities according to gender, but bemoaned the fact that despite

their best efforts, they were unable to recruit more girls to join the project. The four participating female students had reflected on this phenomenon, and noted that the experience at their school seemed to be very typical of the gendered use of the Internet. They attributed this disparity to the fact that females appear to be intimidated by the "higher" technology which is traditionally a male bastion.

Although there is a gap in the literature related to the issue of gender and the educational use of ICT, there is some (but again, very limited) critical evaluation of this educational phenomenon. Maddux (1989 and 1994) concedes that ICT is an educational tool with a great deal of potential, but points to the existence of a number of significant problems (including cost; requirements for maintenance and repair; a lack of coherent structure, stability, and documentation; the changeability of online information; issues of quality control and inappropriate materials; and a lack of clear-cut links to the curriculum) that need resolution before ICT can live up to its potential. Riel (1990) cautions that, because of the high costs associated with technological innovations like ICT, there is a need for comprehensive evaluative studies that measure the effect of these projects on student learning. Mitchell-Powell (1995) concurs that high costs are an important concern, and also outlines a number of problems (including variables in cultural response patterns, and limitations due to language differences) that can inhere to email and newsgroup projects intended to facilitate cross-cultural exchanges. Waugh, Levin & Smith (1994) caution teachers that seemingly exciting online projects can stall due to a lack

of suitable partners, perhaps caused by poor timing or inadequate online advertising.

From the review of the literature on information and communication technologies in the schools, it is clear that there is some critical material arising from a pedagogical perspective, but none from a sociological perspective. The concerns about costs, relevance to the curriculum, and shortcomings inherent in some online activities are important, but also important are larger issues of access to and use of the technology by all children, especially girls.

Gender Differences in Educational Computing

The literature abounds with statistics and case studies attesting to the fact that the use and study of computers in schools is differentiated along gender lines. According to some researchers, girls and boys are roughly equal in interest and skill in the primary grades (Edwards, 1995), while other research has found that gender differences in interest and attitudes are apparent as early as the pre-school and kindergarten years (Beeson & Williams, 1985; Sadker & Sadker, 1994). By the third or fourth grades, boys tend to demonstrate a markedly greater willingness than girls to engage with computer technology (Beynon & Mackay, 1993; Nelson & Watson, 1991). In classroom situations in which both sexes are participating in computing classes, boys have been observed physically intimidating girls (even resorting to shoving them away from computer keyboards), dominating discussions, and claiming for themselves as much as 70% of the hands-on computer activities

(Beynon, 1993; Beynon & Mackay, 1993; Clarke, 1990; Culley, 1993; DuBois & Schubert, 1986; Fredman, 1990; Jacobson, 1994; Kirkup, 1992; Moses, 1993; Schubert, 1986).

As children progress through elementary school to high school, and enrollment in computing classes becomes optional, there is a large disparity in participation between the sexes, with up to twice as many boys as girls opting to register in non-compulsory computing courses (Clarke, 1990; Edwards, 1995; Moses, 1993; Nelson & Watson, 1991). Differences in attitudes accompany the differences in enrollment, with boys far more likely to display positive attitudes about computer technology, computing activities, and the relevance of computer training to future jobs (Nelson & Watson, 1991). The disparity between male and female participation in high school computing classes becomes even more marked at the university and college level (Clarke, 1990; DeRemer, 1989; Edwards, 1995; Kirkup, 1992; Morse & Daiute, 1992; Moses, 1993;). Not surprisingly, this imbalance is accompanied by a similar imbalance in jobs in the computing industry, with men far more likely to occupy higher-status and higher-paying jobs such as programmer, systems analyst, and technician, and women more likely to occupy lower status, lower-paying data entry and keyboarding jobs (Bohlin, 1993; Clarke, 1990; Kirkup, 1992). Further, there is a growing body of evidence indicating that women are far less likely than men to use computers to connect to the Internet and the Web for recreational and information-gathering purposes (Akst, 1994; Kome, 1995; Shade, 1993; Truong, 1993; We, 1993).

This evidence is alarming; because failure to participate in elective computer courses in grade school, high school and university limit women from entering higher-status jobs in the computer industry, it is self-evident that failure to develop ICT skills at school will also limit women's job opportunities. Since job market forecasts suggest that knowledge of current ICT will be essential for a wide range of jobs across many occupations (including but not limited to jobs in the computing industry), a pattern of female non-participation in classroom ICT activities will likely have far greater repercussions for women's future labour force activities than will female non-participation in computer programming courses. In addition, the tendency for women to stay away from Internet and Web applications such as listservs, newsgroups, and information sources suggests that, as our society becomes more dependent upon electronic transmission of information, women will suffer disadvantages in their everyday lives as well.

The observed disparity between male and female participation in educational computing activities has been attributed to the interaction of a variety of factors. Clearly, being shoved away from a computer by an over-zealous boy is likely to taint a girl's attitude about computer work -- although one can only hope that this sort of event is the exception rather than the rule. Previous research has suggested that factors such as sex-biased software (Clarke, 1990; Frenkel, 1990; Koch, 1994; Nelson & Watson, 1991), lack of female role models (Akst, 1994; Clarke, 1990; Edwards, 1995; Koch, 1994), and gender-biased attitudes and behaviours of teachers (DuBois & Schubert,

1986; Koch, 1994; Nelson & Watson, 1991; Sutton, 1991) impact negatively on girls' willingness to engage with computer technology.

Gender bias in the computer game market is another factor thought to be a major contributor to girls' lack of interest in and access to computer technology (Clarke, 1990; Edwards, 1995; Koch, 1994; Kirkup, 1992; Sanders, 1995). Computer games tend to contain violence, competition, and stereotypical representations of males and females; typically, such games are highly appealing to boys and alienating to girls. Some experts suggest that playing games is an important use of computers, because "games introduce children to the basic technology. Kids who play the games have an advantage over those who don't" (Koch, 1994, p. 3).

Many children are first introduced to computer games at home, and the home environment has been found to be an important source of inequity in computer use. As Wajcman (1991) notes, "recent evidence on the gender gap in access to computers ... at home, supports the idea that our culture has already defined computers as a pre-eminently male machine" (p. 150). A number of studies examining home computer use have found significant disparities in computer use and ownership between males and females. Research findings indicate that, when a computer is placed in the home by parents, the intended users are the household's male children, and the father is likely to be the principal adult helper (Schubert, 1986). Parents are far more likely to encourage computer use by their sons -- than by their daughters, and tend to explain to their sons -- but not to their daughters -- the educational and career benefits of learning how to use computers (Nelson & Watson, 1991).

Given this parental dynamic, it is not surprising to find that, among children who have a home computer, boys typically report almost twice as many hours of computer use per week as is reported by girls (Chen, 1986), and far fewer girls than boys describe themselves as the most frequent computer user in their home (Clarke, 1990). This situation is very troubling, since research has shown that proficiency with computers in general (Apple, 1988; White 1987), and with ICT in particular (Martinez, 1994), is strongly related to experience with computers at home.

Another factor described as having a major negative impact on girls' involvement in educational computing is its association with math and science, which extends girls' "math anxiety" into the realm of computers (Clarke, 1990; DeRemer, 1989; Eastman & Krendl, 1987; Fetler, 1985; Koch, 1995; Wiburg, 1995; Sutton, 1991). When computers were first introduced into schools, they were used exclusively in computer programming and mathematics classes, and the machinery was located in math departments. Almost inevitably, "computer science and related computer experiences were established as a male-dominated field within the educational system" (Nelson & Watson, 1991, p. 347). In recent years, however, computers have moved out of the mathematics and science labs into the classrooms, where they are being integrated into subject areas across the curriculum. No longer viewed exclusively as machines to learn *about* and to program, computers are increasingly being redefined as tools that contribute to and facilitate a variety of learning activities.

The literature contains some encouraging evidence indicating that female students are more receptive to activities (such as those included in ICT exercises) in which computers are used as educational tools than they are to programming activities. Koch (1994) notes that, while boys prefer to tinker with the equipment, "girls usually want to accomplish a task when they sit down at a computer" (p. 5); an emphasis on programming is more appealing to boys, while a focus on practical applications is more inviting to girls. Akst (1994) suggests that females attach a value to computing when it is a means to end, not an end unto itself. Further support for the notion that girls prefer to use computers for practical, non-math applications is provided by a number of other studies and analyses (Clarke, 1990; Collis, 1991; Edwards, 1995; Frenkel, 1990; Jacobson, 1994; Lockheed, 1985; Nelson & Watson, 1991; Schubert, 1986; Sutton, 1991; Turkle, 1984). Since ICT activities are practical in nature (in that they encompass online searches for information, electronic communication with experts and other students in distant locations, and collaborative learning projects across the curriculum), the research highlighting girls' preference for using computers-as-tools would suggest that we might expect girls to be receptive to classroom exercises involving computerized information and communication technology.

As well as indicating that girls may be receptive to ICT because of its practical orientation, the literature highlights the fact that another potential aspect of ICT work may cause it to be inviting to female students. While earlier educational computing activities took place in computer labs with one student per machine, the newest applications involve the placement of small numbers

of computers in regular classrooms, where their use is integrated across a variety of subjects areas. Even in classrooms having more than one computer, it is typical that only a single machine is networked or equipped with a modem and telephone line and thus available for ICT activities. Clearly, with only a single machine equipped to allow ICT exercises in classrooms of twenty to thirty children, hands-on access to the computer must be rationed and, perhaps, shared.

There is an existing body of research on collaborative and competitive learning, rooted in the writings of Allport and Dewey from the early 1900s and the 1950s, which demonstrates that "female students as a group tend to achieve better in classrooms where learning activities are structured as cooperative ventures" (Streitmatter, 1994, p. 97). More recent research into educational computing provides evidence that girls prefer computer activities that require cooperative, collaborative interaction among pairs or groups of *female* students (Beynon, 1993; Clarke, 1990; Collis, 1991; Culley, 1993; Fisher, 1993; Fredman, 1990; Kirkup, 1992; Koch, 1994; Light, 1993; Moses, 1993; Neilsen, 1985; Nelson & Watson, 1991). When teachers conducting ICT projects structure the computer components as collaborative work, and permit girls to work in same-sex groups, we would expect to find relatively high levels of interest and performance among the female students. Again, however, the literature has not yet explored this dimension of the classroom use of ICT.

Given the claims made for the workplace-related and personal benefits of familiarity with ICT, and the large amounts of public money being directed to

networking initiatives such as Canada's SchoolNet, it is astonishing to find the literature so lacking in critical evaluation of this use of computer technology in the school system. It is particularly curious that the literature describing classroom use of ITC is virtually silent on the issue of differences in access according to gender, given the existing body of evidence indicating that other classroom usage of computers is differentiated by gender. Further, we know almost nothing about who the children are that are actually using ICT in the schools and the classrooms -- and there are many questions that require investigation.

SchoolNet's objective to wire all 16,500 schools in Canada is admirable, but if, as is often the case, there is only one "Internetworked" computer in a school, is it reasonable to assume that electronic resources and familiarity with ICT are being made available to *all* students? If hands-on access to the technology is limited due to enormous student-to-equipment ratios, how do teachers determine which students will get practical experience? What are the dynamics of behaviours and interactions in classrooms in which students are participating in an ICT project? Do all children in such classrooms have access to hands-on experiences with the equipment? Do students who develop ICT skills at home have an advantage at school over those who do not have the technology in their home? Are boys more likely than girls to be provided with ICT tools at home and encouraged by their parents to learn about this use of technology? Are there differences in the manner in which boys and girls engage with ICT? What are some of the factors that impact upon children's productive engagement with the technology?

I believe that these are important questions, each pointing to a need for research into and critique of the phenomenon of ICT in the classroom. The current study attempts to provide answers to some of these gaps in our knowledge and understanding of the educational use of information and communication technologies.

CHAPTER TWO

METHOD

The literature review and ensuing questions point to a variety of possibilities for research, some of which would involve quantitative techniques, and others requiring a qualitative approach. The more I considered my set of questions, the more I became convinced that a micro-level, observational study was the most appropriate place to begin investigation of the phenomenon of ICT use in the classroom. While other researchers might wish to focus on examining teachers' and administrators' responses to a survey asking about student access to and use of ICT, I was more interested in exploring research questions in a naturalistic setting. The fact is that we know almost nothing about the classroom use of ICT, and it does not seem reasonable to attempt survey research without first arriving at some understanding of "what's happening" in the classroom, based on an observational research design.

There is support in the literature for the adoption of a naturalistic, observational approach to the study of educational computing. Morse & Daiute (1992), for example, suggest that quantitative research into gender differences in classroom computing is seriously lacking in its failure to address the computing context. While surveys designed to measure attitudes, aptitudes, and use may provide some useful results and conclusions, the all-too-common lack of attention to the computing context ignores the fact that behaviour linked to gender can be highly sensitive to the particular situation. Morse and Daiute argue that a qualitative, observational, and contextual emphasis is likely to be more explanatory; they also call for additional qualitative research

into newer computing technologies and initiatives that are not part of math and programming. Other researchers, such as Kay (1992), Sutton (1991), and Mercer and Scrimshaw (1993), also support the adoption of naturalistic techniques in order to address the key research issue of discovering precisely what is going on with computers in classrooms.

Given these comments of other researchers, and my own conviction that an observational approach is the most appropriate place to begin to develop an understanding of the classroom use of ICT, the current research initiative was designed as a case study involving in-depth observation of ICT projects in a single classroom. I posed the following set of questions:

- what are the dynamics of behaviours and interactions in a classroom in which students are participating in ICT initiatives?
- what factors impact on student's ability to have productive access with the ICT equipment?
- are there differences in the manner in which girls and boys engage with the technology?
- does home use of ICT impact on children's school use of the technology?

The Study

As noted above, the current project took an observational, case-study approach. Because observational research can be very time-consuming, I chose to select a single classroom for investigation. While I recognize that this research design does not permit generalization of results, I anticipate that the study may provide a model that can be replicated, modified, and used to inform additional research, perhaps as a prelude to a more broadly-based sample.

I decided to conduct the research in an elementary school, rather than in a high school, because computer activity in pre-high school classrooms was more likely to be compulsory and an integral part of classroom activities. Thus, I would have the opportunity to observe students of both genders as they engaged in ICT activities; in high schools, due to elective course selection, girls (as well as disinterested students of *both* genders) would likely be heavily under-represented in ICT activities.

Classroom observations took place between late September, 1995 and mid-February, 1996, and involved about 35 visits to the school.

Selection of Subjects

Since my goal was to observe classroom dynamics while students participated in ICT projects, I needed to locate a teacher who planned to involve his or her class in one or more ICT activities during the 1995-96 academic year, and who would be willing to permit an outsider to spend a considerable amount of time in the classroom. To this end, I submitted a research proposal to the Ottawa-Carleton Research Advisory Committee, an umbrella group representing the four English school boards in the Ottawa-Carleton area. The study was approved by the committee, and I was advised by one member that I was welcome to proceed with my research within her school board, subject to securing cooperation from a teacher and principal.

The school board's Office of Research Services forwarded the research proposal abstract to the principals of each elementary school within its jurisdiction. In addition, the Chief of Research Services had personal knowledge of three teachers who would likely be using ICT in the classroom

during the 1995-96 school year, and suggested that I contact them directly to explain the nature of my project. I chose not to approach one teacher who worked with learning-disabled and developmentally-delayed children in a hospital setting; results of a study conducted in this environment would likely have drastically limited relevance to what goes on in "regular" classrooms. One of the remaining two teachers was moving into a vice-principal position in September, 1995; while she was most interested in exploring state-of-the-art uses of technology in the classroom, she was not sure that any classrooms in her school would be equipped for ICT activities.

The third teacher, Mme. Gervais,⁴ proved to be an enthusiastic proponent of introducing computer, information, and communication technologies to students in the middle elementary years. She intended to involve her fourth-grade Early French Immersion class at Mackenzie School⁵ in one or more ICT projects during the 1995-96 year. Mme. Gervais was willing to allow my research to take place in her classroom, and secured the cooperation of the school principal.

It is important to note at this point that sending the abstract to all elementary school principals failed to generate a single response; without the recommendations from the Chief of Research Services, I probably would not have located a classroom in which to conduct my study. I do not know what the lack of response indicates; perhaps teachers and principals are generally

⁴ The teacher's name has been changed in order to preserve the anonymity of the student participants

⁵ The name of the school has been changed in order to preserve the anonymity of the students

reluctant to cooperate with research studies, particularly those that require a researcher to spend a protracted amount of time in a classroom. It is also possible, however, that two central requirements -- a classroom equipped for ICT activities, and a knowledgeable teacher who planned to undertake projects involving this relatively new use of computer technology -- eliminated every other elementary teacher and classroom within the school board. Whatever the underlying reason, it is clear that my sample is about as far from probabilistic as one can get. This is not, in my opinion, problematic. Since it is not my intent to produce generalizable results, the key issue in sample selection was to find a classroom in which ICT activities would be taking place, with a teacher not threatened by the presence of an outside researcher. Mme. Gervais' classroom satisfied both requirements.

The sample includes 30 pre-adolescent students (19 girls and 11 boys), from a single Grade four Early French Immersion class at Mackenzie School. Ranging in age from 8 to 10, the students are a racially homogeneous group: they are all white, with the exception of one Asian girl who was adopted as an infant into a white family. Mackenzie School is located in an area populated by middle-class families, with many parents in professional and managerial occupations; thus, most of the students in the class are from a mid- to high-SES background. All children have had some computer experience at school, typically consisting of using educational software packages in arithmetic and language arts. During Kindergarten and Grade 1, the children made occasional visits to the school computer lab and also had access to old Commodore computers in their classrooms. Visits to the computer lab

continued through second and third grades, and classrooms were equipped with at least one Macintosh computer.

Twenty-five students lived in homes equipped with computers at the beginning of the school year, and each of these students used the home computer for one or more purposes, including playing games and using educational software. Seven children had home experience with the Internet or the World Wide Web. For all 30 children, however, Mme. Gervais' classroom represented their first contact with ICT equipment in a school setting. This particular classroom is the only one at Mackenzie to be equipped with a telephone line and modem, and thus these students were the only group among a school population of 600 children to have the potential for classroom access to ICT equipment on a regular basis.

Prior to the beginning of my visits to the classroom, I sent a consent letter, briefly outlining the nature of my research, to the parents of the students in Mme. Gervais' class. I advised parents that their children's participation in the project was voluntary, and that only those who returned a signed consent form would be part of the study; affirmative consent forms were returned by all 30 children. The students were told by their teacher that I was a university student who wanted to learn about how schoolchildren are using computers. Upon completion of my observational sessions in their classroom, I held a debriefing session for the children. Rather than provide them with a pre-packaged explanation about my presence at their school, I encouraged them to

pose their own questions to me -- which I endeavoured to answer truthfully and completely.⁶

This paper, and any subsequent discussion of my study, will safeguard the anonymity of the children by referring to assigned pseudonyms rather than to their real names.⁷

The Setting

Mme. Gervais teaches in a one-room portable building, which is located, along with four other portables, in the yard adjacent to the main school building. The classroom is equipped with a black-and-white printer and four computers; three are vintage Macintosh Apple Classic II computers, and the fourth is a relatively new Macintosh LCIII equipped with a modem. As noted

⁶ I was surprised at how few questions the children actually asked of me. Their main interest was *why* I wanted to learn about what they were doing with computers. I explained that the use of the Internet and the Web in the classroom is a new phenomenon, that people just want to find out more about which kids are learning to use it, how they are using it, and what kind of problems they encounter. Beyond this, the kids wanted to know how much longer I'm going to be in school (forever), and if I was going to write a book (yes, a boring one with no pictures in it). A few kids had peeked over my shoulder as I wrote notes, and had figured out that the R in my notes referred to me -- and they wanted to know what it stood for. I was just about to explain when Steve, in a very loud voice and with a big grin on his face, yelled out "RETARD!" At this point we all had a good chuckle, and I explained that "R" stood for Researcher. The final question had to do with the "book" that I would be writing. The children wondered if they would be able to buy it in a bookstore, and what its title would be. The tentative title of the thesis was met with hisses and boos, and some suggestions for more interesting titles. Bertha suggested "The Horse and the Dog," which was vetoed by the others when I explained that a title should bear some relationship to the content. Steve, ever ready with a quick quip, suggested "The Kids and the Retard," which received unanimous support from his classmates. I told the children that I might get in trouble with my advisors if I used such a capricious title, but that I would work it into the thesis somewhere.....

⁷ Once my observational work was finished and the children had been de-briefed, I gave them the opportunity to select their own aliases, which they were happy to do. Some of the choices were interesting -- names such as "Bertha" and "Mabel" were the student's choice, not mine.

above, this is the only classroom at Mackenzie School to be furnished with an either an outside telephone line or networked access to the Internet.

Figure 1 (p. 37) shows the arrangement of furniture in the classroom. The computer desks and printer are located along the left-hand wall of the room, with the newest machine situated closest to the telephone jack. Mme. Gervais' desk is located at the back right-hand corner of the classroom. The location of the students' desks is only an approximation, as the children tended to move their desks around on a weekly (and sometimes daily!) basis according to the normal ebb and flow of peer relationships and learning activities.

The ICT Tasks

Mme. Gervais was particularly interested in designing and running an Internet-based project, involving electronic communication with students in other locations, that would integrate into some aspect of the standard Grade 4 curriculum. However, since most of her students had no prior experience with the Internet and the Web, Mme. Gervais decided that it was best to begin with an introductory project that would familiarize her students with some aspects of information and communication technology. Accordingly, she chose to conduct an on-line scavenger hunt, in which her students would use electronic tools to search for information but would not yet have contact with students in other locations. Once all her students had successfully completed the scavenger hunt, she would then run a curriculum-based project that would

Figure 1. Classroom Layout

involve other students in distant locations. This decision was fortuitous for my research, because it promised an opportunity to observe children in different stages of ICT work: first, learning about the technology as they proceeded with an introductory exercise and second, applying and expanding upon that knowledge as they proceeded with a curriculum-based project.

For help in developing her first project, Mme. Gervais turned to the gopher for Canada's SchoolNet which has, in the past, run a number of scavenger hunts that required participants to find a variety of electronic information. These activities are designed for users new to the system, and are intended to provide a fun and interesting means to explore SchoolNet and the Internet; copies of previous hunts are archived on the SchoolNet gopher, along with the answers to the questions (SchoolNet, 1995a). Because she wanted her students to actively search out information, rather than plucking correct answers out of the archive, Mme. Gervais chose to write a new scavenger hunt. To this end, she developed a set of 12 questions (see Appendix A), each of which was answerable by searching through the information contained in SchoolNet's gopher system. Two questions were designated as bonuses, to be tackled only if students had completed the other questions, and only if time permitted. Mme. Gervais also wrote two questions to use during a demonstration session, and two additional bonus questions that required the students to surf through SchoolNet's site on the World Wide Web (the Web).

The starting point for each question was the main SchoolNet gopher menu; arriving at the correct answer required the students to follow clues embedded in the question and to burrow deeper and deeper into the gopher

menus until they arrived at a text document that contained the answer. Some questions were relatively straightforward, requiring only two or three steps into the gopher system; others were more complex and necessitated digging into seven or eight layers of the gopher. The children were to complete any seven of the ten questions; as well as recording the answer, they were required to record the path that was followed in arriving at the answer. The students were permitted to use a keyword search to find the answers to a maximum of two questions, and were required to tunnel through the gopher for solutions to a minimum of five questions. Answers to the questions, along with the path followed, were recorded in specially-prepared booklets. Work on this project commenced on October 23, and finished on November 22.

For their second ICT project, the students conducted a bilingual electronic survey designed to test respondents' knowledge about the dangers of smoking and second-hand smoke. The school board's curriculum for Grade 4 includes an anti-smoking unit, and the pre-packaged set of teaching materials contains a questionnaire that tests kids' awareness of the risks of smoking. Mme. Gervais obtained permission from the school board to translate this questionnaire into English, and to use both the English and French versions in her project.

With input from the students, the teacher modified the questionnaire into a 12-question survey (see Appendix B) called "Don't Blow It!" in English, and "Au bout de souffle" in French. A call to participate was posted to three

electronic listservs,⁸ SchoolNet, InClass, and KidSphere, during National Anti-Smoking Week (January 15-22); the actual survey was posted to the listservs a few days later. Participating classes were asked to complete the survey on an individual basis, and return it via email to Mme. Gervais' class; in addition, respondents were asked to use electronic resources to find online information about second-smoke, and to provide Internet addresses (called Uniform Resource Locators, or URLs) so others could readily access the material.

Mme. Gervais' students checked their email inbox on a daily basis, printed out completed responses to the survey, and forwarded additional information to participants as requested. They also corrected completed questionnaires, assigned a score to each participant, and entered the scores on an electronic spreadsheet. Student work on this project began in mid-January, and continued until mid-February 1996.

Researcher Role

Researchers wishing to engage in observational work can assume a variety of roles, along a continuum that ranges from that of complete participant, through observational participant and participatory observer, to complete observer (Palys, 1992). Since a complete participant is one who has

⁸ A listserv is an electronic mailing list; generally, any individual who has an Internet e-mail address can subscribe to a listserv, although membership is sometimes restricted. Listservs are typically used to facilitate discussions among subscribers; a single posting to the listserv will generate an e-mail message for EACH subscriber to the list. By posting a call to participate to three listservs, Mme. Gervais was informing hundreds (possibly even thousands) of teachers around the world about the upcoming smoking survey, and offering them the opportunity to participate.

already taken part in a social situation and decides to write about it after the fact, this particular role was clearly not a possibility.

An observational participant is one who has the primary role of participant, with observational motives; from the perspective of the other participants, however, this researcher appears to be a full participant. The fact that my research needed approval of the school board, the principal and the teacher removed all possibility of my being an observational participant. Even had I been able to find "a way in" that would have hidden my true objective from the teacher -- perhaps volunteering my services as an expert who could help the children with ICT projects -- the observational participant role would have involved some limitations that I was not willing to confront. Data collection would have to be surreptitious or even delayed, leading to potential distortion; I wanted to gather detailed observations of behaviours and dynamics as kids worked on their ICT projects, and I doubted that my memory would serve me well if I could not make notes as events unfolded. Further, it would not be possible to obtain informed consent from the subjects, which violates an ethical guideline that I consider to be of major importance in research involving children. Finally, the observational participant role requires the researcher to participate in some way, which carries with it the potential that I would influence the situation that I was attempting to observe. These drawbacks are, in my opinion, too significant to be outweighed by the benefit of reduced reactivity (where the knowledge that they are being observed affects the subjects' behaviour).

The roles of participatory observer and complete observer are similar to each other in that the researcher obtains informed consent, and is open about his or her observational motives (while not necessarily fully disclosing the analytical objectives). I was required by the school board to provide the parents with a letter briefly outlining the research, and to secure their written consent before I could observe their children. While the students were given somewhat less detail about the nature of my project, they were told by Mme. Gervais that I was a university student who wanted to learn more about what children do with computers in classrooms, and that I would need to write notes to remember what I had seen. Thus, my observational motives were clear to all interested parties.

The participatory observer typically mixes in with the activity in question, while the complete observer assumes an external stance with notebook or tape recorder in hand, making no attempt to conceal the observational role. My initial plan was to be a complete observer, remaining at all times detached from the children and never engaging in any dialogue or interaction with them. However, discussions with the teacher about the nature of students' reactions to outsiders in the classroom convinced me that the complete observer role was likely to result in an unacceptable degree of reactivity.

Mme. Gervais stressed that children are less likely to exhibit atypical behaviour as they go about their daily classroom routines if they are familiar and comfortable with an outsider who has proven to be non-threatening and friendly. In effect, engaging with the students to some degree changes the

outsider to a welcome insider. Based on these discussions, I decided that an appropriate stance would fall somewhere between participatory observer and complete observer -- that of a 'friendly' observer. I *did not* take part in any of the ICT activities as they unfolded, but I *did* talk to the students when I entered the classroom. In fact, the children gave me little choice! During my first visit, they peppered me with questions: where did I buy my earrings, how many children did I have and how old were they, what kind of perfume was I wearing, why was I still a student at my (advanced?) age, would I please come and look at the artwork that they had finished earlier in the day.

I am convinced that, had I failed to answer their questions and praise their artwork, the children would have been uncomfortable with my continued presence in their space, and that this discomfort would have led to their observed ICT work being highly reactive. Their behaviour when other outsiders entered the classroom supports this contention; without fail, the appearance of other people -- be it a parent, an administrator, or a visiting speaker -- caused the kids to perform like a group of trained seals. Noise levels escalated, boys laughed raucously, girls put their heads together and giggled, pencils and erasers flew threw the air. Although I witnessed this type of behaviour on my first and second visits, the students quickly became nonchalant about my presence; a typical reaction when I entered the classroom was a chorus of "Oh, it's Shelley. Hi!" followed by a return to the task at hand.

I believe that the role of friendly observer was the best possible choice for the work that I wanted to do in the classroom, maximizing my ability to collect a rich set of data and minimizing the threat of reactivity.

Data Collection

Lofland & Lofland (1995) describe data logging as the process of careful recording by which qualitative researchers collect their data. Logging typically consists mainly of fieldnotes and interview write-ups, but can also include strategies such as mapping, census taking, photographing, and sound recording; video-taping is another potential source of logged data.

During the design phase of this study, I considered using written logs as my primary means of data collection, with either video- or audio-taping as a supplementary information to corroborate the written notes. However, the school board's Chief of Research Services cautioned that past experience demonstrates that parents are less likely to consent to their children's participation when video- or audio-recording is part of the research structure. Since I hoped to secure permission to observe each student within the selected classroom in order to arrive at as complete an understanding as possible of classroom dynamics during ICT activities, I decided to limit my data collection to hand-written logs. This proved to be a fortunate decision -- the layout of the classroom was such that appropriate placement of a video-camera would have been next to impossible, and noise levels in the room were often so high that sound recordings would likely have been unintelligible.

Palys (1992) notes that data logging can assume either a structured or an unstructured format. While structured data collection arms the researcher with useful checklists and coding schemes, an unstructured approach will provide maximum flexibility, and will likely produce a more comprehensive and rich set of data than is obtainable using a structured approach. Lofland &

Lofland assert that, during naturalistic inquiry, the researcher should not record only those events that appear to be significant or important, since "an enormous amount of information about the settings under observation ... can be apprehended in apparently trivial happenings or utterances, and these are indispensable grist for the logging mill" (Lofland & Lofland, 1995, p. 66).

As I prepared for the observational phase of my study, I developed a coding scheme to use as during note-taking, having anticipated that a pre-established set of symbols would facilitate the logging process. This frame allowed me to adopt a semi-structured approach to data logging. Specific letters of the alphabet assigned to actors and equipment (T for teacher, A for child in left-hand seat at the computer, B for child in right-hand chair, M for mouse, K for keyboard) minimized the amount of writing required to identify actors, and allowed for maximum opportunity to record speech and behaviour events on a verbatim basis. I endeavoured to capture, to the greatest extent possible, even those apparently trivial events that Lofland and Lofland suggest can be important snippets of information.

I attended all classroom sessions during which the teacher was working with the students as a group, introducing them to the projects and instructing them in the use of the equipment and relevant software. During these sessions, I sat at the back of the classroom and simply made notes of Mme. Gervais' instructions and the children's comments and actions. I also attended all classroom sessions in which students were doing ICT computer work, which comprised about 95% of my total visits to the classroom. During these sessions, I sat directly behind the students as they sat in front of the computer

desk. This vantage point allowed me to watch the computer monitor to follow the children's progress; to note which child was in command of the mouse, the keyboard, the notebook, and the pen; and to hear and record speech events between the primary actors and others (the teacher and intruding children). I recognize that some critics might argue that such close proximity to the children would introduce an unacceptable degree of bias because the children would be aware that they were being closely scrutinized. As noted above, however, I believe that my adoption of a 'friendly observer' role served to minimize the possibility of reactivity on the part of the children.

Following each observational session, and prior to the next session, I transcribed my hand-written log into computerized fieldnotes. These notes included personal observations and reflections, and a brief note about my overall impression of the nature of the work between teams of students (collaborative or competitive).

Although the bulk of the data was drawn from field notes taken during observational sessions, I also asked the children to complete a short questionnaire designed to gather some simple information about their use of home computers (see Appendix C). This questionnaire was delivered to the children by e-mail, and their responses were transmitted to me in the same manner. There were some inconsistencies in the children's responses: five students without modems attached to their home computers indicated that they had used the Internet or the Web at home. I questioned the children personally about these answers, and discovered that one girl used her grandmother's Internet hookup, while one boy connected regularly to the

Internet at a friend's house. The remaining three children had answered incorrectly, and the records of their responses were adjusted accordingly.

Reliability in Data Collection

Reliability is always a concern in qualitative data collection. There are a number of strategies that a researcher can adopt to address this threat, including the use of verbatim accounts, multiple researchers, and mechanically recorded data. As noted earlier, it was not possible for me to use video- or audio-recording as corroborative data. I did, however, attempt to capture verbatim records of speech events, and the discussion section of this paper will include direct quotations from the data to illustrate specific examples of events.

Although time and cost considerations did not permit two researchers to be present throughout the entire study, a trained second researcher was present for several key observational sessions. The secondary researcher accompanied me to the first two sessions during which teams of children were engaged in computer work on the scavenger hunt, to one session during the middle of the scavenger hunt, and to the final session for the scavenger hunt. We both sat behind the children working at the computer, and took notes according to the pre-established coding frame; immediately following each session, we had a lengthy meeting to compare our notes and reconcile any discrepancies.

During the first dual-researcher session, there were 134 points of complete agreement, 12 points at which the primary researcher (R1) recorded events in greater detail than the secondary researcher (R2), 15 events captured by R1 but not by R2, nine events recorded by R2 but not by R1, and four items

on which R1 and R2 disagreed about an event captured by both (for a total of 174 recorded events). The 12 items recorded in more detail by R1 all related to movements backward and forward through the gopher menus; R1 recorded the precise details for each step, while R2 recorded only that the students retraced their path. This discrepancy was not considered to be a matter for concern; R1 was able to record greater detail in this area simply because she was more familiar with the SchoolNet gopher system in which the students were working. Of the 15 items recorded by R1 and not by R2, 10 were speech events that R2 did not hear and five were actions taken by a student. The students involved in this session were whispering to each other, and background noise was considerable; we concurred that R2's head cold and R1's more advantageous vantage point were the cause of the discrepancy. Since in these two areas (items noted in more detail by R1, and points missed by R2), more detail was recorded by the primary researcher, who would be solely responsible for the bulk of the data collection, these discrepancies were not deemed problematic.

Of greater concern were nine points noted by R2 and not by R1; in each of these instances, R1 was looking at her book as she recorded a speech event and missed a non-verbal event. This led to a discussion of the relative importance of speech versus non-verbal events, and resulted in my resolve to train myself to write without looking at my papers. The remaining four items were actions attributed by R2 to one child, and by R1 to the other child. We were not able to reach agreement on these items, but concurred that disagreement on only four items from a total of 174 events represented a highly acceptable degree of correlation, at 97.7%.

Similar results were found when we compared our records of subsequent sessions, with R1 continuing to record more detail about paths followed through the gopher menus. Points of disagreement consisted of no more than 4% of total events recorded, and we were in complete agreement during the final dual-observer session (which, to be fair, was a very short 15-minute session, while the other sessions were each over an hour in length). I concluded that this high degree of inter-observer agreement indicates an acceptable degree of reliability in data collection.

Data Analysis Techniques

Coding

Once the observational phase of the study was over, and the handwritten field notes transcribed, the process of coding began. I used the coding frame that had been devised as a guide to note-taking as a starting point, and added new codes in order to facilitate the identification of various different categories of events.

As I worked through the field notes, I examined and coded each recorded action as either shared (the result of discussion or negotiation), unilateral, based on teacher advice, or resulting from one partner's direction to the other. Actions not based on collaboration were attributed to the originator. Verbal instructions or orders from one partner to another were identified as directions, and attributed to the originator. Mis-steps, equipment problems, and intrusions from other children were highlighted. An example of a set of coded field notes is included as Appendix D.

Just as it was essential to do a reliability check on my data-gathering by having another researcher attend several classroom sessions, it was also important to submit my data-coding to an inter-rater reliability check. Since I was especially interested in examining the degree to which the children collaborated on the ICT task, it was particularly important to have someone else review these coding decisions. A second analysis of transcripts from two full observational sessions, selected because they contained episodes that I considered ambiguous, was conducted by an independent coder as a reliability check. Inter-rater agreement of 100% was obtained for codes related to unilateral action and teacher-assisted actions. An initial agreement of approximately 85% was obtained for the categories "shared" and "gives direction," and agreement was 100% following consultation. Episodes were considered to be shared if they involved any interchange between the students; events coded as shared ranged from a brief query by one partner followed by a simple head nod from the other, to a protracted discussion about a strategy of attack. Following the inter-coder consultation, I reviewed all transcripts and adjusted coding as necessary to reflect the consultative decisions, and to ensure consistency in the coding.

Variables

Quantitative analysis of the scavenger hunt data focused on two dichotomous independent variables, prior ICT experience and gender. Prior ICT experience, captured on a Yes-No scale, was operationalized by two items on the survey of home computer use; one question asked each student if he or she had used the Internet or the Web at home, and the other asked the student

if he or she had used Netscape or another Web browser before starting the scavenger hunt. A child answering in the affirmative to either question was deemed experienced, while those children answering 'No' to both questions were deemed non-experienced.

Dependent variables that I anticipated might be affected by gender or prior experience included time, efficiency, teacher-assisted work, proportion of shared work, initiation of events, and involvement in events. The dependent variables were operationalized as follows:

Time: This variable was operationalized as the total time, in minutes, taken by each team to complete the required seven questions in the scavenger hunt. Total time excluded preliminary periods during which the teacher gave standard instructions, as well as periods of time when equipment problems necessitated a shut-down and re-starting of the computer. Total time also excluded periods spent working on extra or bonus questions once the required seven questions had been completed.

Efficiency: Efficiency was operationalized as the total number of mis-steps made by each team as they traveled through the gopher looking for information. Lower scores were taken to indicate higher efficiency, and vice versa.

Teacher-assisted events: Actions undertaken by one or both partners that were a direct result of a hint, advice, or direction from Mme. Gervais were deemed to be teacher-assisted. These were counted across all scavenger hunt sessions for each team, and the total number became each team's score for teacher-assisted events.

Proportion of shared work: A total event count for each team was compiled by adding the totals of shared events, teacher-assisted actions, unilateral actions by each partner, and directions given by each partner.⁹ The total shared events count, expressed as a percentage of total events, represents the proportion of shared work for each team.

Initiation of events: This variable allows investigation of the degree to which individual children controlled the non-collaborative action during the ICT activity, and is expressed as a ratio. The initiation ratio for each team was derived as follows:

1. For each partner, the count for unilateral actions was added to the count for directions given to the other child, to arrive at a figure representing the total number of events that were initiated by each child.
2. The initiation count for each partner was expressed as a percentage of total events, to arrive at a figure representing the proportion of total events initiated by each child.
3. The lower initiation score was divided by the higher score, giving an initiation ratio expressing the teammates' relative opportunity to direct or initiate actions during the ICT activity. A score close to 1 indicates that the partners were fairly equal in directing or initiating events, while a score close to 0 indicates that one child claimed virtually all the non-collaborative action.

Involvement in events: This variable allows investigation of the degree to which individual children were actively involved in the ICT activity, and is

⁹The work on each scavenger hunt section involved two distinct stages: the search for the answer, and the re-tracing of the path. I took detailed notes as I observed the children, whether they were working on the search stage or the re-tracing stage, but decided to drop the path re-tracing from my analysis. The backwards tracing of paths was an exercise requiring virtually no decision-making on the part of the children, but rather was an automatic process facilitated by Netscape's "Back" button and the fact that followed links turned a different colour. Accordingly, the total event count includes all events during the search for and recording of the answer to each question, and excludes all events during the re-tracing of the paths taken.

expressed as a ratio. The involvement ratio for each team was derived as follows:

1. For each partner, the count for collaborative events was added to the count for unilateral events and direction given to the other child, to arrive at a figure representing the total number of events in which each child was actively involved.
2. The involvement count for each partner was expressed as a percentage of total events, to arrive at a figure representing the proportion of total events in which each child was involved.
3. The lower involvement score was divided by the higher score, giving an involvement ratio expressing the teammates' relative active involvement in the ICT activity. A score close to 1 indicates that the partners were fairly equally involved in total events, while a score close to 0 indicates that one child claimed virtually all the action.

Strategies of Analysis

For the scavenger hunt data, exploratory analysis¹⁰ was conducted using Microsoft Excel and Minitab Data Analysis Software, version 7.2. Excel was used to compile two sets of tables, with one set containing information for each dependent variable sorted into two batches by gender and team, and the other set containing information for each dependent variable sorted into two batches by prior experience and team. Minitab was used to generate boxplots¹¹ to accompany each table. Taken together, the tables and boxplots provided a useful mechanism to describe the results of the scavenger hunt and

¹⁰ Exploratory analysis is an approach to working with data, pioneered by John Tukey, that helps the analyst look closely at the data in order to develop insights into problems or questions. Exploratory analysis is sometimes, but not always, used to generate hypotheses that are then tested using traditional confirmatory statistical techniques (Nosanchuk & Erickson, 1992).

¹¹ Boxplots are a graphical tool used in exploratory data analysis; they provide visual presentation of batches of data, and facilitate the analysis and comparison of batches (Nosanchuk & Erickson, 1992). Please refer to Appendix E for a brief explanation of how to read a Minitab-generated boxplot.

to compare results by the two independent variables, gender and prior experience. I also used Minitab to run t-tests to compare the means for each pair of batches (total time for male teams and total time for female teams, shared work for male teams and shared work for female teams, and so on).¹² Correlations were run to check for the existence and strength of relationships between dependent variables, since preliminary analysis suggested that some variables seemed to be related to others. Discussions and interpretations of the tables and boxplots are augmented by additional insights derived from the observational sessions and from discussions with the teacher.

Although transcripts from the smoking survey project were subjected to the same coding process as those from the scavenger hunt, there were not enough data to permit a similar quantitative analysis. Accordingly, the results from the second ICT project are presented and discussed on an interpretive basis.

¹² It is, of course, quite inappropriate to run t-tests on the data gathered during this study, since the data do not meet the requirements for statistical inference (in particular, the assumption of random sampling has been violated). T-test scores are reported only as an additional tool to aid in making a decision about the importance of differences between groups.

CHAPTER THREE

SCAVENGER HUNT PROJECT

Getting Ready

After deciding to initiate her students to the Internet and the Web by running an electronic scavenger hunt, Mme. Gervais then had to make a decision about how to organize the children to work on the task. Since only a few students had prior experience with the Internet, she felt it was essential to devise a structure that would provide all students with hands-on exposure to the technology. Because there was only one modem-equipped computer in the classroom, and thus only one individual or team could work on the hunt at any given time, Mme. Gervais decided that to have the students work individually would drag the hunt out for an unacceptably long period of time. Having teams of more than two students was also viewed by the teacher as potentially problematic, in that one or more students would have to sit behind the others and would likely have less opportunity for hands-on engagement with the equipment. Accordingly, Mme. Gervais decided that the students would work in teams of two.

Before the children could begin working on the scavenger hunt, it was essential that they receive some basic instruction in the use of the technology. It is impossible to do a demonstration for 30 people gathered around a small computer desk, so Mme. Gervais borrowed a machine that allowed her to project her computer monitor onto a standard-size projection screen. She also

arranged for Deb Johnson,¹³ a curriculum resource teacher from school board headquarters, to give a demonstration to her class. Much to Mme. Gervais' surprise, a technician appeared in her classroom the day before the scheduled demo, carted away her hard drive, and promised to return it the next day equipped with software that would help with the class's Internet projects. The new and improved machine was returned to the classroom the next day - sporting a copy of Netscape, a graphical Web browser software, and an account with a private Internet service provider. With these enhancements to the computer, the children could avoid dealing with the National Capital FreeNet (which is plagued by an over-supply of members and a shortage of telephone lines), and would not have to make do with text-based access to the Internet and Web. Rather, they had the luxury of connecting via the service provider (far more likely than FreeNet to have open telephone lines), and would be able to explore the Internet with a graphical browser that would be much easier (and more fun) to use than FreeNet's text-based system.¹⁴

On the day of the demonstration, I arrived in the classroom a few minutes before the students returned from their English class. As the children entered the room, they were buzzing with anticipation about the upcoming session in which they would learn about "surfing the Internet." It was

¹³ Name has been changed.

¹⁴ I was quite alarmed when this set of events took place, thinking that perhaps the interference (albeit well-intended) by school board authorities introduced a high degree of bias that would require me to abandon my project. Upon reflection, I decided that because my goal was to observe how students use the technology, the provision of better equipment that gave the students more reliable access to the Internet was actually not problematic but welcome. Without these enhancements to the equipment, it is likely that students would have encountered busy signals for up to an hour as they tried unsuccessfully to connect to FreeNet -- and that I would have gathered very little useful data.

impossible to keep tabs on everything that was going on among the group of 30 students, but I did not see anyone horsing around at the back of the classroom, and I had no sense that the boys were paying more attention than the girls, or vice versa.

Before the special guest began her instruction, Mme. Gervais asked the class if they knew what a modem is used for. Bertha said that a modem is used to communicate, Brian added that you can use it to download files, and Cara pointed out that it can also be used to send mail to friends. In response to the teacher's query about what they would be doing with the modem that day, Kayla replied that they would be using it to learn about the scavenger hunt, and Brian added that they would be looking for answers to some questions.

By the time Deb stepped to the front of the class to begin her Netscape demo, there was a high level of excitement in the room. Deb commented that the students were already well-prepared, because they knew they were going out onto the information highway to look for information at a particular spot called SchoolNet. She pointed out that looking around on the Web is like going into a store that has lots of stuff for sale, and not knowing where to go. After recruiting Bertha to operate the keyboard, Deb showed the class how to dial into the service provider and use Netscape to connect to the Internet. She explained that you need an address to get to any site on the web, and pointed out the "go to location" box where the user types the address of a location that he or she wants to visit (please refer to Figure 2, p. 58, to see the standard Netscape interface with which the students worked). Deb also showed the

Figure 2. Standard Netscape Interface

Figure 3. World Wide Web Gopher Menu

students how to use the "Net Search" button to look for places or information when the address isn't known, walked the class through the process of locating and going to SchoolNet's graphics-based web site, and taught the students how to use Netscape's "Bookmark" feature to make lists of web sites that they might want to return to. She then showed the students how to use the "Back" button to return to the previous page visited, and drew their attention to the fact that followed links have changed colour -- an important thing to keep in mind when re-tracing the steps taken during the scavenger hunt.

Following a break for recess, Deb placed Joe at the keyboard and continued the demonstration. She then explained that web servers, such as the one for SchoolNet that they had just visited, are very popular because they contain pictures and even sounds and movies. But before there were web sites, she noted, there were gopher sites containing only text information. Using a bookmark that she had set up during recess, Deb took the children to the SchoolNet gopher menu, which was to be the starting point for the scavenger hunt. She explained that menu items with a file folder icon point to other menus, while items with an icon that looks like a piece of paper with writing on it take the user to an actual document that can be read (see Figure 3, p. 58). The answer to each scavenger hunt question will be found somewhere in one of these documents. Deb also drew the children's attention to the menu item "Virtual School," which would likely be useful for a number of questions.

Deb then proceeded to begin working on two scavenger hunt demonstration questions by handing out copies of the first question: **"Name the school that is running a project called Canada Is... and find out**

where the school is located." Deb and the students read through the gopher menu together, and Emma suggested trying the menu item **"Classroom & Academic Projects"** because the question said that **"Canada Is..."** was a project. The others agreed, and Joe clicked on that item, which took them to another gopher menu. There was nothing on that page that looked it would be helpful in answering the question, so Deb asked the students how they could go back to the previous list. A chorus of voices directed her, correctly, to the **"Back"** button, and Joe clicked on it to return to the main gopher menu. Mme. Gervais directed the students to **"Virtual School;"** once there, the children insisted on checking out **"Recess"** but couldn't find anything that appeared useful. Deb led the children through the list of floors, and with some prompting from Mme. Gervais and a strong suggestion from Brian, the decision was made to try the **"Social Science Floor,"** and Joe clicked on it. The first item on the next menu was **"Canada Is..."** -- the discovery of which resulted in much clapping and cheering. Joe clicked on the menu item, and ended up at the start of a document explaining the **"Canada Is..."** project. Brian read the text aloud, and quickly identified the school as Our Saviour King Academy, located in Southern Harbour, Newfoundland. (Please refer to Figures 4 through 7, p. 61-62, to see the gopher menus through which the children had to travel to reach the correct answer.) At this point, the students seemed very anxious to know how to do the path information that was also a requirement of the scavenger hunt. Deb showed them how to re-trace their steps, using the back button and paying attention to which links had changed colour -- with a caution to be careful, because dead-end links also change colour. The

Figure 4. Step 1, 'Canada Is...' Demonstration Question

Figure 5. Step 2, 'Canada Is...' Demonstration Question

Figure 6. Step 3, 'Canada Is...' Demonstration Question

Figure 7. Step 4, 'Canada Is...' Demonstration Question

students seemed to grasp this process very quickly, and there was no need to repeat instructions.

Next, Deb and Mme. Gervais gave the students a copy of demo question #2: **"How many buckets of water do you need for the neat trick called *Hot or Cold?*"** This question could have been answered by digging through the gopher menus (first selecting "Kindergarten to Grade 6 Corner," then "Neat Tricks", and finally "Hot or Cold") but the intent was to use it to teach the children how to do keyword searches. Deb defined "keyword" for the students as a main idea or important word, and asked if anyone could spot a place on the main gopher that could be used for keyword searches. Johnny suggested "Internet Searchers," and Deb explained that they wanted to search the SchoolNet gopher, not the entire Internet. Ellen correctly suggested trying "Keyword Search of the SchoolNet Gopher," Deb agreed, and after a very brief discussion, the students decided that "hot or cold" would be an appropriate search term. Joe typed this phrase in the search box, hit return, and was rewarded with a menu containing several items all called "Hot or Cold." Clicking on a link marked by a paper icon brought up a text document containing a description of the trick, and the children found the answer (3 buckets) almost immediately. (Please refer to Figures 8 through 11, p. 64-65, to see the gopher menus through which the children had to travel to reach the correct answer.) The concluding item in the demonstration was the re-tracing of the path.

The following day, I attended another classroom session during which the students selected their partners and decorated the covers of their answer

Figure 8. Step 1, 'Hot or Cold' Demonstration Question

Figure 9. Step 2, 'Hot or Cold' Demonstration Question

Figure 10. Step 3, 'Hot or Cold' Demonstration Question

Figure 11. Step 4, 'Hot or Cold' Demonstration Question

booklets. Most children were quite definite about who they wished to work with, although two or three teams had to be organized by Mme. Gervais; not surprisingly, there were nine all-girl teams, five all-boy teams, and one mixed-sex pair. Each team drew a booklet, each of which had a number from 1 to 15 written inside the cover, from a box; the booklet numbers determined the order in which the teams would take their turn at the scavenger hunt.

The students spent the next half hour decorating their booklet covers. Their approach to this exercise turned out to be a harbinger of behaviour that I would observe during the scavenger hunt. Three of the five all-boy teams started by placing a heavy black line down the middle of the cover, with each partner working only on one-half of the page, and each drawing designs that had no relation to the other. In contrast, none of the female teams' booklets were marked with a dividing line; the girls either drew complementary designs on each side of the cover page, or worked together on one large overall design. This was a most interesting exercise to observe, and strongly suggested to me that the girls might be far more collaborative than the boys in their approach to the computer work.

Actual work on the scavenger hunt began a few days later. Because there was only a single modem-equipped computer in the classroom, only one team could work on the hunt at any given time, and typically did so as their classmates were involved in other activities such as math, language arts, and science. In some cases, the children were permitted to work through recess and lunch hour if Mme. Gervais was able to remain in the portable. The partners sat together at the appropriate computer table, which was located

along the left-hand wall of the classroom (See Figure 1, p. 37); I sat immediately behind and between the two partners. Team 1 began their hands-on work on the scavenger hunt on October 23, 1995; team 15 finished their questions on November 22, 1995. Mme. Gervais allowed the teams to use as much time as was needed to complete the required seven questions; some teams completed their task during one session with the computer, while others took two or three turns in front of the equipment. As each team took their place at the computer for their first attempt at the scavenger hunt, Mme. Gervais directed them to look for the clues in each question, reminded them about the "Back" button, told them that they could do two keyword searches, and instructed them to share the work. A few children asked how she wanted them to divide up the work, to which she always replied that they had to sort it out between themselves.

Gender

Results

In order to begin to understand how the children fared at this task, and whether or not there were differences by gender, I first examined measures of outcome. The most simplistic approach is to look at the number of questions completed successfully; this measure, however, is rendered meaningless because each of the 15 teams found appropriate answers for seven questions, with the exception of Team 2 (which arrived at answers to six questions).

Another measure of outcome, one that does contain some variability, is total time taken to complete the scavenger hunt. Table 1 (p. 68) displays

Table 1
Total Time (in minutes), by Gender

TEAM	TOTAL TIME
BOYS	
Team 15	63
Team 5	68
Team 1	69
Team 10	101
Team 2*	183
GIRLS	
Team 7	51
Team 8	66
Team 4	71
Team 3	79
Team 14	82
Team 11	86
Team 6	102
Team 13	105
Team 12	128
MIXED	
Team 9	46
Average, overall	87
Average, male teams	97
Average, female teams	86

Figure 12. Boxplots of total time by gender

these data. Female teams used an average of 86 minutes to complete the hunt, compared to 97 minutes for the boys (although the average time for boys is 76 minutes when team 2's anomalous score is removed from the calculation). The boxplots in Figure 12 (p. 68) present the data in an array that is easier to interpret than the tabular format in Table 1. While the median score for boys is slightly lower than that for girls, the outlier within the male group (Team 2, 183 minutes)¹⁵ pulls the mean score for boys slightly above that for girls. The range for boys, exclusive of the outlier, is less than that for girls, but the midboxes are virtually identical. It is clear from this plot that there is essentially no difference in average time between male and female groups. This interpretation is confirmed by a t-score of .47 which gives a probability of 0.66. Clearly, when time taken is used as a mechanism to compare outcomes for the male vs. female groups, there is essentially no difference between the genders.

A third measure of outcome is that of efficiency, operationalized as total mis-steps. It is inevitable that the children will make some wrong turns as they burrow through the SchoolNet gopher looking for answers; there are clues embedded in the questions, but following the correct path requires a certain amount of thinking and puzzling things through. Table 2 and Figure 13 (p. 70) provide information about mis-steps in tabular and boxplot formats. Male teams made an average of 21.2 mis-steps, compared to an average of 12.1 for the female teams. Although these means might suggest that there is a very large difference between the male and female groups, examination of the

¹⁵ Team 2 completed 6 questions in 157 minutes; the figure of 183 minutes included in my tables assumes that 7 questions would have required $7/6$ of the time taken to finish 6 questions; $7/6 \times 157 = 183$ minutes.

Table 2:
Total Mis-steps by Gender

TEAM	TOTAL MIS-STEPS
BOYS	
Team 1	8
Team 15	9
Team 5	16
Team 2	35
Team 10	38
GIRLS	
Team 13	7
Team 7	8
Team 11	8
Team 4	9
Team 6	10
Team 12	10
Team 3	11
Team 8	17
Team 14	29
MIXED	
Team 9	5
Average, overall	14.7
Average, boys	21.2
Average, girls	12.1

Figure 13. Boxplots of total mis-steps by gender

boxplots and the t-score ($T=1.33$, $P=0.24$) suggest that there is only a slight difference between the genders. Particularly notable is that, with the exception of two outliers, the female teams are clustered within a small range, while the variability within the male group is much more marked.

It is useful to look at measures of outcome to try to understand how girls and boys performed at this task, but to focus solely on **outcomes** is to ignore differences in **process**. My observational sessions highlighted the fact that there were interesting dynamics at play as the children worked on their tasks. It was clear, for example, that there was considerable variability in the degree to which the teams undertook actions as a result of guidance from the teacher. Table 3 and Figure 14 (p. 72) display the data on teacher-assisted events in chart and boxplot formats; two teams (one female and one mixed-sex) had no advice from the teacher, while 43 of the events within Team 2's scavenger hunt sessions were as a result of assistance from Mme. Gervais. Work by the male teams included, on average, teacher direction for 18.4 events, compared to 8.3 for the girls. Neither of these figures is startlingly high, suggesting that the teams were, generally, quite capable of attacking and completing the scavenger hunt tasks. An examination of the boxplots in Table 3b indicates that, while the median for male groups is a few points higher than that for female groups, the overall profile of these two groups is only slightly different. This interpretation is confirmed by a t-score of 1.23 and probability of 0.27.

It was evident from my observations that, while some partnerships worked quite collaboratively, the activities of other teams were controlled mainly by one partner. I believe this is a serious cause of concern because, as

Table 3a:
Total Teacher-assisted Events,
by Gender

TEAM	TEACHER ASSISTED EVENTS
BOYS	
Team 1	1
Team 15	4
Team 5	18
Team 10	26
Team 2	43
GIRLS	
Team 7	0
Team 11	2
Team 4	2
Team 12	3
Team 3	4
Team 8	7
Team 14	16
Team 6	17
Team 13	24
MIXED	
Team 9	0
Average, overall	11.1
Average, males	18.4
Average, females	8.3

Figure 14. Boxplots of total teacher-assisted events, by gender

the literature notes, two children sitting in front of a computer ostensibly working on the same task may be experiencing quite different learning activities if one partner is dominating the action. I used the measures of shared events, initiation ratios, and involvement ratio in order to examine the partners' collaborative activity, and to determine what kind of access *individual* children, as opposed to *teams* of children, had to the ICT task.

Table 4 and Figure 15 (p. 74) display the shared-work data in chart and boxplot formats. This is the most marked difference between the genders that we have seen thus far; boys collaborated in an average of only 18.2% of total events, compared to 49.2% for girls -- a difference of 31 percentage points. Examination of the boxplots shows just how real these differences are: the two plots bear little relation to one another, with the lowest score for the female group being several points higher than the highest score for the male group; the t-score and probability for this comparison are -6.35 and 0.0000. There is more variability within the female group than within the male group, indicating that there may be more intervening factors at play than what we see in the male group. Nevertheless, it is abundantly clear from these data that the level of collaboration between female partners was extremely different from that of the boys.

While it is useful to examine shared-work scores to get a sense of how the boys and girls worked together, it is also essential to take a look at those events that were **not** collaborative. Of those events that were neither collaborative nor teacher-driven, did each partner have roughly equal involvement, or was the action dominated by one partner? We can begin to

Table 4
Shared Work as a Percentage of Total
Events, by Gender

TEAM	SHARED WORK
BOYS	
Team 1	25.4
Team 5	22.3
Team 15	20.6
Team 2	12.0
Team 10	10.7
GIRLS	
Team 7	70.3
Team 12	59.8
Team 4	58.7
Team 3	50.0
Team 13	47.3
Team 8	43.1
Team 11	40.8
Team 6	40.0
Team 14	32.9
MIXED	
Team 9	20.8
Average, overall	37.0
Average, males	18.2
Average, females	49.2

Figure 15. Boxplots of shared work as a percentage of total events, by gender

answer these questions by looking at Table 5 and Figure 16 (p. 76), which provide data on initiation ratios. I was surprised by these figures; because the female teams were so much more likely to be collaborative than the male partnerships, I expected the females to have higher initiation ratios than the boys. In fact, as we see from Table 5, the average initiation ratio for boys, at .44, is virtually identical to that for girls, at .45; these figures indicate that, for male and female teams alike, one child controlled the action more than twice as often as his or her partner. The boxplot indicates quite clearly that there is no difference between the male and female teams in this regard; this interpretation is confirmed by a t-score of -0.06 and probability of 0.96.

I put together the shared-work data with the initiation data to come up with an involvement ratio for each team. These data are displayed in Table 6 and Figure 17 (p. 77). Here we see that the average involvement ratio for female teams is .78, compared to an average of .58 for male teams. Even though female teams were as likely as boys to include a more dominant partner, the female partners' tendency to work collaboratively meant that girls were, on average, involved in total events on a more equal basis than was true for boys. The boxplot for these data is as expected: it falls somewhere between the patterns observed in the shared-work and initiation plots. Involvement ratios for girls are, clearly, very different from those for boys, this is confirmed by a t-score and associated probability of -1.84 and 0.087.

Table 5
Initiation Ratio by Gender

TEAM	% of Total Events Initiated		Initiation Ratio
	by Partner 1	by Partner 2	
BOYS			
Team 2	39	34	.87
Team 5	43	24	.56
Team 10	21	56	.38
Team 1	15	59	.25
Team 15	9	67	.13
GIRLS			
Team 13	18	16	.89
Team 14	35	23	.66
Team 12	15	24	.63
Team 3	34	13	.38
Team 11	42	15	.36
Team 6	36	13	.36
Team 8	41	12	.29
Team 4	8	32	.25
Team 7	25	5	.20
MIXED			
Team 9	62	17	.27
Average, overall			.43
Average, boys			.44
Average, girls			.45

Figure 16. Boxplots of initiation ratio, by gender

Table 6
Involvement Ratio by Gender

TEAM	<u>% Involved in Total Events</u>		Involvement Ratio
	Partner 1	Partner 2	
BOYS			
Team 2	51	46	.90
Team 5	65	46	.71
Team 1	40	84	.48
Team 10	32	67	.48
Team 15	29	87	.33
GIRLS			
Team 13	65	64	.98
Team 12	74	84	.88
Team 14	68	56	.82
Team 7	95	75	.79
Team 3	84	63	.75
Team 4	67	91	.74
Team 6	76	53	.70
Team 11	83	56	.67
Team 8	84	55	.65
MIXED			
Team 9	83	38	.46
Average, overall			.69
Average, boys			.58
Average, girls			.78
Average, mixed			.46

Figure 17. Boxplots of involvement ratios, by gender

Discussion

It is most encouraging to find, based on simple measures of outcome, that girls are at least as capable of completing an ICT task as their male classmates. All children in Mme. Gervais' class participated in the original introduction session led by Deb Johnson, and all teams received a standard set of reminders from Mme. Gervais as they started work on the scavenger hunt; no additional or more detailed instructions were given to or demanded by the girls. As noted earlier, all teams except one all-male group managed to locate correct answers to seven scavenger hunt questions.

The girls fared very well in terms of total time required to finish the hunt, with their average of 86 minutes being 11 minutes less than the overall male average of 97 minutes, or 10 minutes more than the male average of 76 minutes with male Team 2's highly anomalous score removed from the calculation. The time disparity of 10 or 11 minutes may appear at first glance to be important, but examination of the boxplots indicated that the two groups were virtually identical on this measure.

According to Mme. Gervais, a time difference of this magnitude is completely unimportant in the classroom context; it simply reflects the time required to learn something new. The schedule for the scavenger hunt was deliberately designed to be flexible in order to provide each team with the amount of hands-on time required for the partners to learn and complete the task. The teacher had expected that there would be a difference in time required among the groups, based on her knowledge of the children's academic

and cognitive abilities and working styles, but did not consider any time differential to be problematic.

Mme. Gervais did note, however, that even small time differences could cause problems if this exercise took place in a computer lab, where time is tightly scheduled and at a premium. Students who do not complete an exercise during the allotted lab time may never have the opportunity to return to the activity. Further, in Mme. Gervais' experience, a computer lab setting in which students are working on the same task at the same time tends to promote a sense of competition among boys; they rush in order to "win," while girls are likely to be very meticulous, more concerned with accuracy than speed. If certain boys finish an exercise quickly, they must immediately be given something else to do to prevent them from become disruptive and disturbing other children. Although this is not an issue for Mme. Gervais' class during the current school year, because the computer lab at Mackenzie has been dismantled, it could be an important consideration for these children as they progress to middle and high schools.

By the seventh grade and continuing through high school, students rotate through academic subjects according to tightly-scheduled periods of time. Access to computers (for ICT or any other purposes) tends to occur in classrooms where the end of a period requires the children to move to a new room, and in computer labs. Those teachers who are responsible for ICT work would be well advised to guard against gender imbalance in the labs by providing sufficient time to accommodate female students' need to work methodically without being overshadowed by some male classmates' interest in

winning a (non-existent) race. ICT time limited by the scheduling of discrete time periods may disadvantage those students, both male and female, who work less quickly.

I found a slight difference between the male and female scores on efficiency, measured as total mis-steps, with the girls making an average of 43% fewer mis-steps than the boys, and with the male teams displaying much more variability than the female group. A review of the field notes indicates that this disparity relates to a difference in working style.

All the female teams, but only three of the five male teams, tended to work together on a fairly systematic basis: they read the question, attempted to extract the important ideas -- the keywords -- and tried to relate these to items on the gopher menus. Two male groups (Teams 2 and 10, representing 40% of the male teams) adopted a radically different approach. Apparently unable or unwilling to read the clues carefully, these boys tended to click gopher menu items on a completely random basis, with no regard for whether or not the selected items related to the question at hand. Both teams eventually decided to simply try clicking each and every menu item in the hope of arriving at an answer. Not surprisingly, this method generated mis-step after mis-step as the boys followed incorrect paths deeper and deeper through the gopher system, taking themselves ever farther from the correct answers. It was obvious that without teacher intervention, they would likely not have been able to find their way to correct answers -- and in fact, Team 2 completed only six questions. This flawed strategy was something that did not occur to any of the female teams, who tended to work on a much more systematic and efficient basis.

The two wayward male teams were also hampered by an apparent lack of interest in the entire task. Both members of Team 2, Johnny and Steve, frequently got up and wandered around the classroom, tended to sit facing away from the computer screen, and initiated irrelevant conversations with each other and with other students (including a 10-minute discussion about the merits of various brands of sport watches, and a spirited karate demonstration). One member of Team 10, Fred, exhibited similar behaviours. It was obvious that these boys were not fully engaged with the task at hand, and this lack of engagement led to an increased number of mis-steps and an overall lack of efficiency in completing the scavenger hunt. This extreme behaviour was not exhibited by any of the girls.

We saw another slight difference between the males and females in the amount of teacher involvement, with girls having an average of 8.3 teacher-assisted events during their sessions compared to 18.4 for boys; again, the variability was much greater among the male group. Not surprisingly, the same male groups (Teams 2 and 10) with unusually high teacher involvement were the same teams that made large numbers of mis-steps. Review of the field notes indicates that the differences in teacher involvement generally related directly to the amount of difficulty that teams were experiencing.

While it was impossible for Mme. Gervais to spend equal amounts of time with each team, she attempted to check each team's progress from time to time. The location of the computer desk near the centre of the classroom permitted her to keep watch over the ICT work, and to remain attuned to the students' need for help. During some sessions, however, she was delivering

lessons to the other children and was unable to go to the computer desk as soon as she was aware of problems, and could remain there for only brief moments. At other times, the class was doing independent work, and Mme. Gervais was able to spend longer amounts of time, if required, with the ICT group. In some cases, she arrived at the computer because the team members called for her help, but it was far more typical that she would notice that a team was experiencing difficulty and would come, unbidden by the children, to offer assistance. Team 2 partners Johnny and Steve, with the highest number of teacher-driven events at 43, were notable in that they called for help 14 times over three sessions (compared to all other teams who called for help between zero and three times). Team 10, also experiencing a relatively large number of teacher-assisted events, called Mme. Gervais only three times and was visited unbidden only twice -- but the boys were having so much trouble finding their way through the gopher that the teacher stayed for fairly long periods of time (in one case, about 10 minutes, as compared to a typical teacher visit of less than a minute).

One female group working during a lunch hour, Team 13, seemed to be having no more than routine difficulty but was afforded the benefit of having Mme. Gervais sitting at an adjacent desk marking papers and attending closely to their work. She stepped in 17 times, generally the instant they ran into even minor hurdles, and thus this team made relatively few mis-steps even though their teacher involvement was quite high. Team 13's experiences notwithstanding, it is quite clear that the reason for less teacher involvement for the female teams was related not to their gender but to their ability with the

assigned task. They seemed to work more collaboratively than their male classmates, sorted problems out between themselves, and simply needed and demanded less help than some of their male classmates.

An extremely large difference between the male and female groups was identified with respect to the overall proportion of collaborative work. On average, female teams collaborated in 49.2% of total events, compared to an average of 18.2% for the boys. These figures are not particularly surprising, given what we know about girls being more receptive to working collaboratively during educational computing activities. The boys' lesser tendency to collaborate would not be alarming if they were found to share equally the initiation of events that were not collaborative -- but we see from the initiation ratio that this is not the case.

For both male and female teams, the average initiation ratio was approximately .44, indicating that one team member acted unilaterally for an average of just over twice as many events as his or her partner; female teams were as likely as the males to include one partner who dominated the other. However, because girls were much more collaborative to begin with, the events that remained to be initiated by one child or the other were far fewer than was the case for the male teams. This results in a very large difference in involvement ratios. The average involvement ratio for girls, at .78, indicates that the more dominant partner of a female team typically participated in only about 28% more events than her partner. The involvement ratio of .58 for boys, in comparison, indicates that dominant male partners participated in almost twice as many events as their team-mates; some of the boys were clearly

at a marked disadvantage due to the overall lack of collaboration coupled with their partners' tendency to dominate the ICT sessions.

The involvement ratios give rise to some serious concerns about access to the ICT task. Mme. Gervais did her utmost to ensure that all children had equal opportunity to engage with the ICT activity, by organizing teams of two, providing as much time as necessary to complete the assigned task, and exhorting the children to share the work. In spite of these efforts, several children -- mainly boys -- had relatively low access to the task at hand, and, I would suggest, had a less meaningful ICT learning experience than many of their classmates. Notably, Eddie (Team 1), Fred (Team 10), Peter (Team 15) and Bertha (Team 9) suffered by being with partners who were highly dominant, and thus had relatively low access to the ICT activity.

Although the involvement ratio of .90 for male Team 2 indicates that these boys had almost equal access to the ICT activity, my observations of their behaviours give rise to questions about the overall quality of their experience. While Steve and Johnny were very non-collaborative (only 12% of total events were shared), they were almost equal in their independent initiation and direction of events. In many instances, however, one partner was forced to act on his own because his team-mate was running around the room or dancing on his chair. Further, as noted above, this team had extremely high teacher intervention (for 43 events, or 18% of the total) and also adopted the odd strategy of clicking gopher menus at random, rather than basing their choices on careful consideration of the questions and the menu items. I would suggest, then, that they failed to arrive at a solid understanding of the requirements of

the ICT task, and that their own unfocused behaviour impeded meaningful access to the exercise.

Correlations

Since the foregoing discussion identified some possible relationships between variables, it is useful to examine correlation coefficients in order to determine whether or not these relationships actually exist, and their relative strength.¹⁶

For male teams, there is a strong positive relationship (0.756) between time and mis-steps: as mis-steps increase, total time increases. This is not particularly surprising: it is expected that going to incorrect places in the gopher would result in a team taking longer to find the path to the correct answer, simply because the students must re-trace their path. For female teams, however, the relationship is negative and so minimal as to be deemed negligible (-0.144). Examination of the field notes indicates that, once boys had started onto an incorrect path in the gopher, they tended to work their way deeper and deeper down the wrong path, which resulted in them taking more time to find their way back. Girls, on the other hand, rarely strayed very far off the correct track, and thus their mis-steps seem to have had almost no impact on total time.

For collaboration and mis-steps, there is a very strong negative relationship for the male teams (-0.958), and a moderate negative relationship for the girls (-0.580): as collaboration increases, mis-steps decrease. This is

¹⁶ These correlations must be viewed cautiously, since the data are not drawn from a random sample, and the value of N for each set (5 female teams, 9 male teams) is so small.

not especially surprising; it appears that a tendency to discuss the moves through the gopher reduces the likelihood of going to the wrong place.

For both male and female teams, there is a negative relationship between time and shared work; as collaboration increases, time decreases. The relationship is strong for the male teams (-0.735), but weak for the female teams (-0.200). Review of the field notes indicate that this may be due to a difference between the male and female modes of collaboration. The members of the female teams often discussed their ideas and problems in considerable detail. The male style of collaboration, on the other hand, tended to involve very brief dialogue, often consisting of a simple query ("Is this one good?") followed by a short agreement or counter-suggestion ("OK, try it." or "No, this one is better.").

A positive relationship exists between time and teacher-driven work: as total time increases, the number of teacher-assisted events increases. For male teams, this is a very strong relationship (0.906), while it is a weak relationship for the female teams (0.397). The correlation coefficient for the girls, however, is heavily influenced by the score for Team 12; this group had the longest time, at 128 minutes, but teacher assistance for only three events. Team 12 took two sessions to complete the hunt, and both were during times that the teacher was giving lessons at the front of the class and was apparently unaware that these girls needed assistance. When the values for this team are removed from the calculation, the correlation between time and teacher-driven work becomes a strong 0.791 . These correlations for the male and female groups clearly

indicate that those teams who took longer to complete the ICT task also required more teacher attention and intervention.

A negative relationship, strong for the male teams (-0.833) and moderate for the girls (-0.586), exists between shared work and teacher-driven events: as collaboration increases, teacher involvement decreases. This finding suggests that, when partners worked together to devise strategies and plans of attack, there was less need for the teacher to intervene.

Mis-steps and teacher involvement are positively correlated for both male and female teams, although the relationship is strong for the boys (0.890) but weak for the girls (0.255). These figures are rather disturbing, because they suggest that the boys were more likely than the girls to obtain attention from the teacher when they experienced problems with the ICT task. The field notes indicate that this may be related to working styles; two male pairs (Teams 2 and 10) were very vocal when experiencing trouble, which was disruptive to the rest of the class. Accordingly, Mme. Gervais tended to move quickly to the computer desk, even if she was delivering a lesson, to settle the boys down. Girls tended to be much more restrained even in the face of problems, thereby sometimes attracting less attention from their teacher.

Prior Experience

The literature contains evidence that schoolchildren's interests in and achievements with computers in the classroom are influenced by exposure to and use of computers in the home. In other words, the pre-existing cultural capital that children bring to school can have an impact on the further

[illegible]

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acquisition of cultural capital. I wondered if time taken, mis-steps, teacher involvement, or dominance in the scavenger hunt could be attributed to the presence or absence of a home computer, and the children's uses of the home computer. A tally of information gathered from the children, however, indicated that 12 of 13 more-dominant partners make use of a home computer, while 11 of 13 less-dominant partners also make use of a home computer. Every single child with a home computer, whether a dominant partner or not, plays games at home, and thus experience with computer games cannot be used as a means to understand behaviour during the scavenger hunt. I did, however, find one home-use variable that seemed to have an important impact on the scavenger hunt: experience with the Internet or the Web.

Results

Within the class of 30 students, seven indicated that they had had some experience with the Internet outside of school prior to the beginning of the scavenger hunt project.¹⁷ Five of these seven experienced students were paired with non-experienced students; the remaining two, Bertha and Brian, worked together. In all cases except one (Team 7, Theresa and Kayla), the experienced partner dominated the inexperienced partner; the work of mixed-sex Team 9, which consisted of two experienced partners, was dominated by Brian.

Teams with an experienced partner tended to complete the scavenger hunt in far less time than those teams lacking an experienced member (Table 7 and Fig. 18, p. 89): the average time for experienced teams was 60.5 minutes,

¹⁷ 36% of the boys, and 16% of the girls, had prior experience. I find it rather alarming that a disproportionate number of boys had prior experience with the Internet.

Table 7
Total Time (in Minutes), Experienced
vs. Non-experienced Teams

TEAM	TOTAL TIME
Experienced	
Team 1	69
Team 5	68
Team 8	66
Team 15	63
Team 7	51
Team 9	46
Not Experienced	
Team 2	183
Team 12	128
Team 13	105
Team 6	102
Team 10	101
Team 11	86
Team 14	82
Team 3	79
Team 4	71
Average, overall	87.0
Average, exp.	60.5
Average, no exp.	104.1

Figure 18. Boxplots of total time, experienced vs. non-experienced teams

compared to non-experienced teams who took an average of 104.1 minutes to complete the scavenger hunt. This is a much larger difference than was found when comparing male and female teams, and it is clear that the presence or absence of an experienced partner has a much greater impact on total time than does the gender of the team members. That this is an extremely large difference is confirmed by both the boxplot and the t-score and associated probability ($T = -3.62$; $P = .0056$).

We also see differences in the number of mis-steps made by experienced vs. inexperienced teams; these data are displayed in Table 8 and Figure 19 (p. 91). On average, teams with an experienced partner made 10.5 mis-steps, compared to 17.4 for the inexperienced teams. The boxplot indicates that the difference between the groups is very large; this is confirmed by the t-score of -1.49 and its associated probability of 0.16.

As well as tending to make fewer mis-steps, experienced teams required notably less teacher input than their non-experienced counterparts, as can be seen in Table 9 and Figure 20 (p. 92). Work by the experienced teams included, on average, teacher direction for five events, compared to 15.2 for the teams without an experienced partner. Both the graphical array in the boxplots and the t-score and associated probability ($T = -1.86$, $P = .0087$) confirm that this is a very large difference.

There is also a difference in the amount of collaborative work undertaken by the experienced teams as compared to the non-experienced group (Table 10 & Figure 21, pg. 93), although the disparity here is less striking than was seen in the comparison between male and female teams.

Table 8
Total Mis-steps, Experienced vs.
Non-experienced Teams

TEAM	TOTAL MIS-STEPS
Experienced	
Team 9	5
Team 1	8
Team 7	8
Team 15	9
Team 5	16
Team 8	17
No experience	
Team 13	7
Team 11	8
Team 4	9
Team 6	10
Team 12	10
Team 3	11
Team 14	29
Team 2	35
Team 10	38
Avg., experience	10.5
Avg., no experience	17.4

Figure 19. Boxplots of total mis-steps, experienced vs. non-experienced teams

Table 9
Teacher-assisted Events, Experienced
vs. Non-experienced Teams

TEAM	TEACHER ASSISTED EVENTS
Experience	
Team 9	0
Team 7	0
Team 1	1
Team 15	4
Team 8	7
Team 5	18
No experience	
Team 4	2
Team 11	2
Team 12	3
Team 3	4
Team 14	16
Team 6	17
Team 13	24
Team 10	26
Team 2	43
Avg. experience	5.0
Avg. no experience	15.2

Figure 20. Boxplots of teacher-assisted events, experienced vs. non-experienced teams

Table 10
Shared Work as a Percentage of Total Events,
Experienced vs. Non-experienced Teams

TEAM	SHARED WORK
Experience	
Team 7	70.3
Team 8	43.1
Team 1	25.4
Team 5	22.3
Team 9	20.8
Team 15	20.6
No experience	
Team 12	59.8
Team 4	58.7
Team 3	50.0
Team 13	47.3
Team 11	40.8
Team 6	40.0
Team 14	32.9
Team 2	12.0
Team 10	10.7
Avg. experience	33.8
Avg. no experience	39.1

Figure 21. Boxplots of shared work as a percentage of total events,
 experienced vs. non-experienced teams

Experienced teams worked collaboratively for an average of 33.8% of total events, compared to 39.1% for the non-experienced groups; the boxplots and t-score and associated probability ($T = -0.53$; $P = 0.6$) suggest that this is only a slight difference. In other words, inexperienced teams were only slightly more likely than experienced teams to work more collaboratively.

When we look at the initiation ratio (Table 11 & Figure 22, p. 95) for experienced and inexperienced groups, we see an extremely large difference. Teams with an experienced partner had an average initiation ratio of .28, which indicates that dominant members among the experienced group acted unilaterally almost four times as often as their partners. In comparison, the initiation ratio for the non-experienced group is .53, indicating that the more dominant children in these teams acted unilaterally only about twice as often as their partners. Both the boxplots and t-score and associated probability ($T = -2.49$; $P = 0.028$) confirm that the differences in initiation ratio between the two groups is very large.

When we put together shared work and initiation ratios to arrive at the involvement ratio (Table 12 & Figure 23, p. 96), we again see some differences between the groups. Experienced teams have an average involvement ratio of .57, which indicates that one partner (almost always the child with prior experience) was actively involved in nearly twice as many events as his or her partner. The involvement ratio of .77 for non-experienced teams indicates that these children typically had more equal engagement with the ICT activity, with dominant children involved in only about 30% more events than their partners. Boxplots and t-scores and associated probability ($T = -2.29$; $P = 0.047$) confirm that this difference is very large.

Table 12
Involvement Ratio, Experienced vs.
Non-Experienced Teams

TEAM	% Involved in Total Events		Involvement Ratio
	Partner 1	Partner 2	
Experience			
Team 7	95	75	.79
Team 5	65	46	.71
Team 8	84	55	.65
Team 1	40	84	.48
Team 9	83	38	.46
Team 15	29	87	.33
No experience			
Team 13	65	64	.98
Team 2	51	46	.90
Team 12	74	84	.88
Team 14	68	56	.82
Team 3	84	63	.75
Team 4	67	91	.74
Team 6	76	53	.70
Team 11	83	56	.67
Team 10	32	67	.48
Avg. experience			.57
Avg. no experience			.77

Figure 23. Boxplots of involvement ratio, experienced vs. non-experienced teams

Discussion

Just as there were some interesting differences between the work of males and females during the scavenger hunt, we see some disparities between those teams that had an experienced partner, and those consisting of two inexperienced team-mates.

As displayed in Table 7 (p. 89), experienced teams completed the scavenger hunt in an average of 60.5 minutes, compared to 104.1 minutes for inexperienced teams; this is clearly an extremely large difference. Mme. Gervais stated that time differences, even of this sizable magnitude, are of little consequence in her classroom because they simply represent variations in the time required to learn a new task. She did, however, concede that a difference of this size could be highly problematic -- much more so than the observed slight differences in time according to gender -- if this exercise were to be conducted in a lab setting.

When only one set of students is working on an ICT task, there is no immediate opportunity for competition between groups. In a lab setting, according to Mme. Gervais, those children working much more slowly are likely to be aware that they are doing so, and to be self-conscious and concerned about their performance as compared to other students. Further, those students who complete an exercise in a far shorter time than their peers can be very disruptive. Again, as noted earlier, marked differences in time required to complete ICT tasks may become a serious problem for children as they advance through the middle-school and high-school years, when time is more rigidly controlled. Here we see the potential for students with prior exposure to have

greater access to the ICT activity than their non-experienced peers, by virtue of their ability to work more quickly.

We also saw a moderate difference in total mis-steps between the two groups, with experienced teams making 40% fewer errors than their inexperienced classmates. The variability among the inexperienced teams is much larger than that for the experienced teams, with male Teams 2 and 10 (recall that these teams suffered from an inability to focus) and female Team 14 being particularly prone to errors. These data suggest strongly that prior exposure to ICT outside of school is a form of cultural capital that renders children much more efficient in their ability to deal with ICT tasks in a school setting.

Another large difference was found between prior experience and teacher involvement, with the inexperienced groups requiring teacher involvement for three times as many events as their experienced classmates. While Mme. Gervais did not see this as problematic in the classroom, because only one group worked on the hunt at a given time and she endeavoured to provide help as soon as it was needed, it could (again) be a problem in a laboratory setting with one teacher and a number of groups working simultaneously.

We saw only a slight difference in the proportion of collaborative work by the experienced teams compared to the inexperienced teams, which is encouraging in that it suggests that those with experience were not completely dominating their partners (recall that all but one experienced team had only a single partner with prior exposure to the Internet). However, when we look at the initiation ratio, we see extremely large differences: experienced partners

acted unilaterally almost four times as often as their less knowledgeable partners, compared to the more dominant members of inexperienced teams who tended to act unilaterally less than twice as often as their partners. It is evident that the experienced students had a sizable advantage; they brought a certain level of cultural capital to the activity, and seized the opportunity to build on this capital while preventing their partners from access to an equivalent learning opportunity. When we examine the involvement ratio, which combines collaboration and initiation, we see a very large difference which mirrors that found between male and female teams.

One benefit that was more likely to accrue to experienced teams was the chance to do more work than the basic requirement for the scavenger hunt. Mme. Gervais allowed teams to do extra work (additional questions from the basic set of 10, one or both of two bonus gopher questions, and one or both of two questions written for the SchoolNet web site) if time permitted. Four of six experienced teams (67%) did extra work, compared to only two of nine inexperienced teams (22%). Here we see, then, that those teams with ICT experience were much more likely to have the chance to do additional work and thus, once again, build on their pre-existing cultural capital.

Correlations

Correlations for the experienced and non-experienced groups show similar relationships between variables to those found for the male and female groups. For both the experienced and non-experienced groups, there is a moderate positive relationship between total time and total mis-steps, with the relationship being slightly stronger for the experienced teams (0.655 vs.

0.434); as mis-steps increase, so does total time. Again, given the fact that mis-steps in traveling through the gopher system require the children to find their way back through their path and on to the correct path, it is not surprising to find that increased numbers of mis-steps correlate to increased time.

Surprisingly, there is almost no relationship between shared work and mis-steps for the experienced teams (0.038), but a strong negative relationship for the inexperienced teams (-0.894). For those teams lacking an experienced partner, increased collaboration is closely related to reduced mis-steps. This relationship, however, is not present among the groups with experienced partners. The experienced teams were relatively low in total mis-steps, and perhaps the simple presence of an experienced partner prevented errors, irrespective of whether or not the partners worked collaboratively.

The relationship between total time and shared work is negative for both groups: as collaboration increases, time decreases. This relationship is weak (-0.311) for the experienced teams, and moderate (-0.481) for the inexperienced teams. Although there must be other factors at play, it is clear that, whether or not the teams included an experienced partner, a tendency toward collaboration is reflected in reduced time being required to complete the ICT task.

For both groups, there is a positive and moderate correlation between time and teacher-driven work; as total time increased, so did the amount of teacher-driven events. The correlations are almost identical: 0.574 for the experienced teams, and 0.625 for those without an experienced partner.

The correlation statistic does not, of course, provide any conclusions about the direction of causality, but my observations suggest that teacher intervention increases as time increases due to the children's express need for help and guidance.

For the experienced groups, there is a weak negative correlation (-0.294) between collaboration and teacher involvement; the relationship is similar for inexperienced groups (-0.366). As was found when the data were examined by gender, teacher involvement decreases when collaboration increases; with weak correlations such as these, however, there are clearly other factors at play.

Mis-steps and teacher involvement are positively correlated for both groups, although the relationship is strong for the experienced teams (0.810) and weak for the inexperienced teams (0.266).

Other Issues

While coding and counting events and submitting them to quantitative analysis has identified a number of differences between males and females, and experienced and non-experienced teams, I have additional observations that cannot be so readily quantified, which also highlight some issues that I believe could be important to teachers and educational administrators.

Gender Revisited

The foregoing quantitative analysis demonstrated that girls were at least as competent as their male classmates at the scavenger hunt ICT task. My observations of the children at work have also highlighted the fact that the girls

tended to be somewhat more interested in and enthusiastic about the task than were the boys.

During the initial introductory session taught by Deb Johnson, as noted earlier in this paper, the children were excited about learning to "surf the Net." While it was difficult to keep tabs on everything that was going on among the group of 30 children, I had no sense that the boys were more attentive or enthusiastic than the girls, or vice versa. I did, however, receive very different impressions about the children's enthusiasm for the ICT activity as the project unfolded.

Mme. Gervais had told the students that, upon finding the required seven answers, they might be permitted to continue with extra or bonus questions. Among the fifteen teams, two male groups, three sets of girls, and the single mixed-sex team had the opportunity to tackle extra work.

The members of both male teams that did extra work were aware that they had finished seven questions, but simply proceeded to work on additional questions until the recess bell rang, at which time both partners bolted away from the computer desk. Bolting away from the computer seemed to be *de rigueur* for the males; no members of the male teams ever tried to negotiate for additional time, whether or not they had completed the required work. (The lone exception to the male pattern was Brian, partnered with Bertha, who secured for his partnership sufficient time to complete one extra gopher question and a Web question.) Boys tended to work until they had finished the basic task of seven questions, or until the bell rang. Further, no boy except

Brian expressed any excitement upon being told that it was his turn to work on the scavenger hunt; they simply went to the computer desk and got started.

Different patterns of behaviour were evident among the girls. There were two female teams (Team 12, Kimberly and Lila; and Team 13, Jazz and Jocelyn) who mirrored the male pattern of expressing little enthusiasm for the activity, not asking to do additional work, and bolting away from the computer desk when the schoolbell rang, but they were the exception rather than the norm among the girls.

Louise and Ashley (Team 3) were among the first groups to start the scavenger hunt, but had to wait several days before taking their second turn. They told me they thought it unfair that several other later-starting groups had been given second chances ahead of them, and announced that they were very anxious to get on with the activity. Kaitlin and Jessica (Team 6) required three sessions to complete the hunt; they insisted on a third turn the day after their second session, because they were almost done and, as Kaitlin said, "Madame, we just can't wait!" Team 6 also tried to secure extra time to work on bonus questions, but Mme. Gervais wanted another team to get started. The girls eventually capitulated, but only after a lengthy discussion.

Kayla and Theresa (Team 7) and Christine and Emma (Team 8) also requested, and were given, extra time to work on bonus questions once the required task was completed. Mabel and Frances (Team 11) completed six questions during their first session, and tried to secure permission from Mme. Gervais to work through the lunch hour; they accepted the teacher's decision to let another team have a turn only after she promised to let them take their

second shot the next day. At that time, they finished the remaining question very quickly, asked and received permission to continue, and successfully completed the two Web questions. When Cara and Susannah (Team 14) were given their first turn, Cara said, with great feeling "Well, I'm glad that it's **FINALLY** our turn!" This team completed five questions in 58 minutes, after which Mme. Gervais asked them to stop so another group could take a turn; Cara and Susannah argued for the right to continue, and agreed to stop only when assured that they would have another turn the following day.

These findings seem to contradict the popular wisdom about boys, girls and computers. The literature indicates that boys tend to have more positive attitudes about computers, and are far more likely than girls to try to secure additional time on the equipment. My observations clearly indicate that, in this classroom and with this type of computer activity, the opposite is true.

Keywords

Looking for information in the electronic world is very different from looking for information in books and encyclopedias. The Internet and the Web are dynamic, ever-changing and shifting mosaics of locations and information; a site that exists on the Web today may be lost and gone forever when you look for it tomorrow. A user's capacity to quickly locate useful information within this fluid environment is, in my not inconsiderable experience, directly related to his or her ability to search according to well-defined keywords.

A number of the students in my sample had great difficulty with keyword searching, and were unable to come up with appropriate search terms that would help them get to the desired information. While Deb Johnson took

the time to carefully explain and demonstrate keyword searching during her introductory session, this instruction was apparently insufficient for a number of children. Eleven of the fifteen teams attempted one or more keyword searches; only one team completed two searches, while nine teams completed one search and the remaining team had no successful searches. This was not for a lack of trying; it was quite common for a team to attempt a keyword search, but to give up after one or more submitted searches came back empty due to the inadequacy of the chosen search term. Only 3 of 11 teams that tried keyword searching were completely successful; that is, they submitted good keywords that generated a menu of choices, one or more of which led to the correct answer for the question at hand.

The remaining eight teams all experienced varying degrees of difficulty; four male teams and one female team completely abandoned one or more questions because they couldn't elicit useful information through a keyword search. One female partnership (Team 12) was particularly plagued with problems; they submitted seven different search terms as they attempted to complete a single question, and succeeded only after Brian delivered a very strong suggestion as to an appropriate keyword. To their credit, they tried keyword searches for two additional questions but abandoned each question after submitting two unsuccessful search terms -- spurring one partner to exclaim, with great feeling, "Life is tragic!" Several teams posed a question instead of using a one or two words; for example, for question #6 they would type 'how many potatoes does it take to make a potato-powered clock,' which generated no results, where the simple search term *potato* would have given

them a path to follow. In other cases, the students lumped a number of keywords into one search term -- unsuccessfully submitting 'Scholastic Books Ann Martin Babysitters Club' for question #10, when either 'Scholastic Books' or 'Ann Martin' or 'Babysitters Club' would have generated the information they sought.

Problems with keywords engendered a variety of negative reactions from the students, including comments such as "Life is tragic," "This is stupid," and "No, no, no, I do NOT want to try another keyword search." There was much moaning, groaning, and exasperation from students who had submitted several unsuccessful search terms; this was clearly a frustrating exercise for many children. I would suggest to teachers and educators that this is a finding that must not be taken lightly. As we turn more frequently to electronic searches to find information, the ability to identify useful and accurate search terms is certain to become an increasingly important skill. If we wish to equip our children for life in the "Information Age," we must first be prepared to teach them essential foundation skills, such as the ability to isolate keywords, that will contribute to successful and meaningful engagement with information technology. It is worthy of note that of the five teams who abandoned questions because of unsuccessful keyword searches, four were male partnerships; it is possible that boys need more comprehensive instruction in this skill than do girls.

Typing Skills

Another skill that is essential for anyone wishing or needing to engage with information technology is the ability to type accurately. While it is true

that for the most part, browsing through the Internet and the World Wide Web mainly requires the user to point and click with a mouse, it also true that at least some typing is necessary, mainly to enter and submit keyword searches. Typing (or 'keyboarding,' as it now tends to be called) is not generally introduced into the school curriculum until secondary school, and thus those children who are introduced to ICT in the elementary grades are highly unlikely to have had any classroom instruction in typing. Not surprisingly, some of the difficulties encountered during keyword searches by the children in my sample were due to incorrectly typed search terms; the children often verbally identified a good keyword that they then failed to type correctly. While I have no way to separate typing problems from spelling problems, and thus will not dwell on this point, it is clear from my observations that typing was a slow and arduous process for many children. Again, if we wish to give our children an early start with ICT, it would be advisable to teach rudimentary keyboarding skills at a much earlier grade level than is currently the practice.

High-level Text

Each of the questions in the scavenger hunt required the students to burrow through a series of gopher menus to arrive at a text document that contained the answer; some of the information that they encountered in these text documents was written at a level far beyond Grade 4. Mme. Gervais had recognized this as a potential problem when she wrote the scavenger hunt questions, and attempted to minimize the need for her students to wade through large amounts of high-level text by writing questions with answers that lay near the top of the applicable document. Nevertheless, a number of

children demonstrated a marked inability to understand the text that they encountered.

In several instances, a child read the appropriate text aloud but mispronounced the words and failed to recognize the correct answer when he or she arrived at it. There were several children who gasped and moaned each time their travels brought them to a document -- they clearly did NOT wish to read any text. This is, I believe, another issue of serious concern. Providing children with high-level reading skills at an early grade level is a much more daunting task (and perhaps completely impossible) than the introduction of typing and keyword skills. There is no simple solution to this problem; while there are some sites on the Internet and the Web that contain information written in language geared toward elementary school students, these sites are relatively few. I would strongly suggest that a sizable portion of the massive amounts of money currently being poured into the purchase of ICT equipment for schools might better be directed toward the development of an expanded network of sites written for elementary school children.

Equipment Problems

The children's ability to engage fully with the ICT task was mediated by factors such as typing skills and improper selection of keywords; another notable problem was related not to the children's abilities, but rather to the ICT equipment itself.

Some teams were slow getting started because the Internet service provider's telephone lines were busy; in two instances, sessions were abandoned because the students were unable to make a connection after 15 or

20 minutes of dialing. On several other occasions, team members were able to secure a telephone connection but encountered difficulty traveling electronically to some links within the gopher menus. The system of computer networks that forms the backbone of the Internet and the Web is notoriously unstable, and it is common for this system to slow down, or even to collapse, under the weight of large volumes of users. Further, Internet sites that are included as links in certain gopher menus sometimes become temporarily or permanently unavailable because network administrators remove the information from a server, or reorganize the server.¹⁸ When these situations occur, the system generates an error message explaining (generally quite cryptically!) the nature of the problem.

Eleven of the fifteen teams encountered a variety of error notices (examples are displayed in Figure 24, p. 110-111) during their travels through the SchoolNet gopher system. This situation was clearly frustrating for the children, particularly those who were confronted with errors early on in their session. The students were unable to interpret the text of the error messages, and tended to assume that *they* had done something wrong; they never imagined that the computer network was the culprit. Some teams tried repeatedly to travel to a desired link, clicking on a "bad" menu item over and over again, and becoming increasingly exasperated as the same error message was received.

¹⁸ Scavenger hunt question #2 became unanswerable part way through the project, because the link to the Canadian Coalition of Women in Science and Engineering became permanently unavailable.

Figure 24. (continued). Examples of error messages

This problem has no easy remedy. Because of the dynamic nature of the Internet and the Web, the location and availability of information are highly subject to change, and there is no reason to believe that this situation will improve in the near future. In fact, as more and more people become "wired," traffic on the Internet will continue to grow exponentially, and slow-downs and shut-downs due to volume of activity are likely to become even more commonplace than they are today. It is particularly unfortunate that the hours during which schoolchildren are most likely to be doing ICT work are also the hours during which the Internet is at its busiest. This situation means, of course, that children's access to ICT exercises may be seriously limited due to the exigencies of the global system of information networks. Although teachers and administrators can scarcely be expected to find a solution to these network problems, they can and should prepare their students for the types of barriers they are likely to encounter when searching electronically for information.

Although some of the problems noted here were exclusive to the scavenger hunt, others -- along with some new ones -- surfaced again during the smoking survey (described in Chapter Four), which was the second ICT project undertaken by Mme. Gervais' class.

CHAPTER FOUR

SMOKING SURVEY PROJECT

Getting Ready

Once her students had completed the scavenger hunt and thus were familiar with some aspects of information and communication technology, Mme. Gervais deemed they were ready to undertake a project involving interaction with other students in the wider world. She chose to have her class conduct an electronic survey designed to test respondents' knowledge about the dangers of smoking and second-hand smoke, and to gather online information about smoking. Intended learning outcomes for Mme. Gervais' students included:

- understanding the health risks associated with smoking and second-hand smoke
- determining other students' knowledge about smoking, and whether or not there are differences by sex or grade level
- familiarity with sending and receiving e-mail
- familiarity with the use of Internet search engines for locating information on the World Wide Web

In contrast to the scavenger hunt, during which teams of children were given as much time as they needed with the ICT equipment in order to finish the hunt, interactive access to the technology during this project depended upon the availability of incoming surveys from distant respondents. The primary mechanism for connecting to the Internet for this project also differed from the scavenger hunt; the students dialed into their school board's computer system to access Virtual Classroom, an online educational network

available to teachers, students, and parents. They were given an e-mail account in Virtual Classroom, which was absolutely essential for locating and communicating with respondents. Web searches for information about smoking were conducted using Netscape and a connection to the Internet through the local service provider.

Mme. Gervais did a substantial amount of preliminary work on this project before she was able to involve the children. She had decided to submit the project to SchoolNet's GrassRoots Project program,¹⁹ which involved writing and transmitting a detailed project proposal; this task was completed in late December, 1995, and the project was subsequently approved by SchoolNet. Mme. Gervais also had to translate the survey into English, draft a "Call to Participate" for posting to the SchoolNet listserve and other electronic bulletin boards, and post the French and English versions of the survey. This work began in December and was completed by mid-January, with the actual questionnaires being posted to the listserves on January 15, 1996. Several teachers e-mailed to indicate that their classes wanted to participate, and Mme. Gervais forwarded a copy of the survey to each interested respondent.

With the groundwork complete, it was time to involve the students. Mme. Gervais introduced the children to the smoking survey project on January 16, immediately following a classroom session during which the children had filled out a questionnaire to test their own knowledge about the

¹⁹ SchoolNet's GrassRoots Projects Program is a national community experience that seeks to motivate Canada's teachers to create and run small, curriculum specific, Internet-based classroom projects. Teachers are required to submit final reports to SchoolNet, and their school receives a cheque for \$300 (which the teacher can then use to purchase classroom supplies) once the final report has been submitted.

dangers of smoking and second-hand smoke. This activity was part of a standard curriculum unit taught to all fourth-grade students within the school board; Mme. Gervais had scheduled it to coincide with Canada's National Anti-Smoking Week (January 15-21, 1996). The e-mail survey was to take place between January 18 and February 1, and thus would also coincide with Anti-Smoking Week.

I arrived in the classroom just as the students had finished answering and scoring their own questionnaires, and discussing the correct answers. Not surprisingly, since this group of students had just finished the curriculum unit on smoking, they made few mistakes on the questionnaire. Mme. Gervais asked if they had learned anything new from the questions, and received in reply a resounding "No!" She then suggested that it might be interesting to see if other children across Canada could get the right answers, and asked her students if they could think of a way to involve other students in distant locations. Brian suggested that they do a survey, and Barney added that it should be done on the Internet;²⁰ this suggestion met with general agreement from the other children (which was fortunate, since Mme. Gervais had already done so much preparatory work!). The students also agreed with the teacher's suggestion that they ask participants to locate online information about smoking and second-hand smoke, and to send along the Internet addresses (called Uniform Resource Locators, or URLs) so that others could access the same material.

²⁰ Brian and Barney are among the group of students who had experience with the Internet prior to the scavenger hunt

When Mme. Gervais asked the students if they felt capable of using the computer to answer e-mail, almost every child shot a hand up into the air.²¹ The teacher then asked the class how they could decide, fairly, who should go first. Jocelyn suggested that Team 15 should start, followed by Team 14, then Team 13, and so on; a number of children, however, did not want to work with their original partners and thus this approach was rejected. Kayla suggested that Mme. Gervais draw names out of a hat, and her classmates voiced their approval of this idea. The teacher asked if any students wanted to work alone, and received an affirmative reply from some; accordingly, she decided to draw one student's name each session, and to give that child the option of working alone or with a partner. This strategy was acceptable to the majority of the students.

On January 23, I returned to the classroom to observe a session during which Mme. Gervais instructed the class on the use Virtual Classroom's e-mail system. Once again, the teacher had borrowed the machine that projects the computer monitor onto an overhead screen, and thus all the children were able to follow the various steps as they were being explained. Mme. Gervais explained to the students that she had sent the survey into cyberspace, and now they would learn how to check for answers. With Barney sitting at the computer manning the mouse, Mme. Gervais showed the students how to find the Virtual Classroom directory on the computer, and how to initiate the log-in

²¹ This happened so quickly that I was unable to identify all the children who DID NOT put their hands up -- but I did notice that Fred, who was supremely disinterested during the scavenger hunt, did not raise his hand.

procedure; this process took them to the opening menu of the Virtual Classroom system (Figure 25, p. 118). Kayla suggested checking the mailbox, and Barney clicked there; this action took the students to their mail inbox and a list of mail messages (Figure 26, p. 118).

Johnny took over at the keyboard as Mme. Gervais showed the students how to find the subject and date of receipt for each message, how to distinguish between incoming and outgoing messages, and explained that a red flag indicates unread incoming mail. Mme. Gervais instructed Johnny to find a relevant message and double-click to open it. Johnny began to swoop the cursor aimlessly around the screen -- accompanied by a chorus of catcalls from other students, apparently exasperated by his lack of focus.²² He eventually settled down and opened an appropriate mail message, which several other students read aloud; this note was from a class in Idaho who wanted to participate. Mme. Gervais showed Johnny how to start an answer to the message, but leaned over and typed the reply herself, thanking the Idaho students for their interest and advising them that a copy of the survey would be forwarded later. After placing Theresa at the keyboard, the teacher demonstrated the "Message - Send" command, and pointed out the postage stamp that is added to a message once it has been successfully sent (see Figure 27, p. 119).

²² Johnny was a member of scavenger hunt Team 2, and had also exhibited a propensity for highly unfocused behaviour during that project.

Figure 25. Virtual Classroom main menu

Mailbox				
9 Files 3 Folders				
	Te ah53@treenet.carleton.	1K Don't Blow It!	03/19/96	07:58 PM
	Grade4 students	1K smoting survey	03/19/96	03:07 PM
	alex@maracomm.com	2K News from RCMP Missing Child	03/16/96	08:46 PM
	Marco_Fratice@psbgn.	1K Re:	03/15/96	12:28 PM
	miled@cadvision.com	2K Grassroots Project - Migrator	03/15/96	02:13 AM
	mgold@oise.utoronto.ca	2K voting in quebec? (fwd)	03/15/96	01:10 AM
	leblanc@schoolnet.ca	4K Mailing list advice...	03/10/96	11:47 AM
	rseneau@EDU.YorkU.CA	2K Re: computers	03/05/96	08:14 AM
	pierre@direct.com	2K Cooperative learning	03/04/96	07:46 AM

↑

Sender of incoming
message, or recipient
of outgoing mail

↑

Size and subject of
mail message

↑

Date and time at
which message was
sent or received

Figure 26. Virtual Classroom mailbox

Figure 27. Virtual Classroom outgoing mail message

Theresa opened another mail message, which she and several classmates read aloud; they were amazed to discover that this completed survey had come from a high-school student in France. After a break for recess, Kaitlin asked and received permission to take a turn at the computer, and Mme. Gervais walked her through the required steps to print the mail message. Kaitlin then tried to open another message, but was confronted with a "timed-out" warning. This is an annoying feature of Virtual Classroom -- the user is disconnected after three minutes of inactivity, with "inactivity" including time spent reading, writing, or printing e-mail messages. I thought it likely that this would be an ongoing problem for these students, given their lack of typing skills.

Kaitlin went through the login procedure without any reminders from the teacher. The next message that she opened was a request for a copy of the questionnaire; Mme. Gervais placed Brian at the computer, and showed him how to paste a copy of the survey into a reply, and then mail the reply. This concluded the ICT session, and Brian logged off from Virtual Classroom and shut down the computer following the teacher's direction.

I noticed during this session that three boys sitting at the back of the room clowned around during the entire demonstration. Fred and Roger (Team 10 in the scavenger hunt) were two of the culprits; given their unfocused performance during the first project, it was not a great surprise to see them expressing a lack of interest in the new activity. The third boy, however, was Joe (Team 1) who had previous experience with ICT, and who had appeared highly focused during the scavenger hunt. I had no idea why his behaviour

changed so radically, but it will be interesting to see how he performs in the smoking project, given his lack of attention during this demonstration session.

The final demonstration session, held on January 24, consisted of a lesson in using a master copy of the questionnaire as a guide for scoring completed surveys. Each child was given copies of the first four responses for correcting, and Mme. Gervais monitored their work carefully to ensure that they understood the requirements of the task. There was a great deal of excitement during this session, with the students expressing amazement at some of the *wrong* answers submitted by other students. This discovery precipitated a spirited and lengthy discussion about the dangers of smoking and second-hand smoke.

Once the children had been trained in the various computer tasks for this project, Mme. Gervais checked their incoming mailbox and initiated a work session whenever there was incoming mail to be read and printed. Names were drawn to determine who would do the ICT task; other students were recruited to score completed questionnaires and to enter the data into an electronic spreadsheet. Questionnaire scoring and spreadsheet entry took place simultaneous to the ICT work.

Observations

On January 24, Spencer was chosen, via name-draw, to be the first student to do independent work on the ICT task for this project. Several other boys clamoured for the opportunity to work with him, with the nod going to Eddie. This was an unfortunate pairing for Eddie -- he had worked on the

scavenger hunt with a dominant experienced partner (Joe), and was now paired with *another* experienced partner who had been highly dominant during the first project. Spencer seated himself in Seat B (adjacent to the mouse), but Eddie reached past him to assume control of the mouse and initiate the login sequence. Once he reached the Virtual Classroom menu, however, he appeared confused, and clicked on "mailbox" only when directed by his partner. Spencer continued to direct Eddie through the opening and printing of a flagged message, then seized the mouse to close the message, and opened and printed two other messages (with no input from Eddie). Eddie then insisted on switching seats, took back the mouse, and opened a final flagged message; seeing that this note was not related to the survey, he closed it. The recess bell rang, and both boys bolted away from the computer. Although Eddie did manage to claim some action for himself, it was clear that he was less confident than his partner, and that Spencer dominated this session.

Christine was picked to do ICT work on January 25, and elected to work on her own. This was an interesting development; Christine was dominated during the scavenger hunt by her experienced partner, and I wondered if going solo today was a response to that situation. When asked why she didn't choose a partner, she said "Because I want to work by myself." Christine announced that she did not remember how to open Virtual Classroom, and Brian (an experienced user) stepped in, took control of the mouse, and went through the login procedure. Although Christine had not asked for additional help beyond logging in, Brian clearly had no intention of leaving, and clicked to

open the mailbox. At this point, Mme. Gervais noticed that he had commandeered the session and asked him to leave - which he did, reluctantly.

Chrisune proved to be very competent at the ICT task; she opened, read, and printed 13 e-mail documents, needing only a brief reminder from Mme. Gervais about the printing of messages. She suffered through unwanted and unwarranted advice from other students (Brian, Bertha, and Emma -- all of whom had prior experience), essentially paying them no heed. She chose to work through recess, stopping only when Mme. Gervais asked her to leave some mail for other students to read.

Fred's name was drawn on January 29. Oddly, nobody asked to work with him, whereas a number of other boys had wanted to partner with Spencer. Perhaps other students were reluctant to work with him due to his clear lack of interest, expressed by his incessant clowning around during the demonstration sessions. Fred proved himself to be completely incompetent at this task; he managed to deal with three messages only after intervention in each step of the process, with guidance provided by Mme. Gervais and several other students (experienced users Brian and Joe, and Eddie, who had already done some ICT work during the smoking survey project). One incoming message asked for a copy of the survey; working very slowly and receiving a number of time-out warnings, and with considerable input from Joe, Fred managed to paste a copy of the questionnaire into a reply, type a short note, and send the message. This session was concluded when the recess bell rang and Fred raced away from the computer.

When no new mail arrived in the next couple of days, Mme. Gervais became suspicious. She discovered that the messages read by Fred on the 29th had been received on January 26, and no new mail had come in during the following five days. The lack of incoming messages strongly suggested a problem with the school board's Internet mail gateway,²³ and indeed, a phone call to Administration confirmed that the gateway had crashed and had not yet been repaired. Concerned that completed surveys might have been lost in cyberspace, Mme. Gervais used a private e-mail account to write everyone who had expressed an interest in participating, asking them to re-submit messages sent between January 26 and February 1. She also decided to extend the deadline for participation by two weeks, to February 15, to allow participants adequate time to re-submit.

On February 1, Mme. Gervais drew Peter's name; several boys expressed a desire to work with Peter, and he gave Scott the go-ahead. This session began with an argument over who would sit in Chair B (adjacent to the mouse), with Peter insisting on having his way because his name had been drawn. Even so, Peter had no idea how to proceed, and needed detailed direction from Scott in order to log in. There were no new mail messages, and Mme. Gervais suggested that they try using Netscape to search for material about second-hand smoke. Although Peter was in command of the mouse, he clearly did not know what to do, and managed to shut down Virtual Classroom and login to

²³ A mail gateway is a computer that is used to connect two or more e-mail systems, and to transfer messages between them (McKie, 1995). The architecture for gateways can be quite complex, and it is not uncommon for newly-installed systems (such as the one at the school board) to experience prolonged slowdowns or shutdowns (crashes) due to technical problems.

Netscape only with step-by-step direction from Scott. They encountered constant busy signals from the Internet service provider, but persevered and successfully connected after 10 minutes of re-dialing.

Scott appeared to become frustrated by his partner's inability, and reached over to take control of the mouse; for the duration of the session, he either did the mouse work himself or directed Peter. Following a refresher from Mme. Gervais on how to use Web search engines, and a few unsolicited words of advice from Brian, Scott initiated a keyword search for "second-hand smoke", doing both the typing (slowly) and mouse work himself. The search returned a lengthy list of results from which, after a brief discussion, the boys selected several items for investigation (please refer to Figure 28, p. 126, for an example of a Web search results screen). Most of the sites that they explored were written in high-level language, and both partners had difficulty reading the text. They eventually found three readable and relevant sites, which Scott bookmarked²⁴ for future reference.

Mme. Gervais initiated another ICT session on February 2, after discovering that the gateway problems had been fixed and new e-mail received. She drew Jessica's name, and gave permission for three other girls to work on the ICT task because Jessica could not decide who to choose from her group of friends. These girls needed a little direction from the teacher in order to initiate the Virtual Classroom login procedure, but put their heads together and figured

²⁴ Web browsers, such as Netscape and Microsoft's Internet Explorer, include a bookmark function that allows the user to flag URLs. This feature allows the user to return to a site of interest at any time in the future, without having to search for the location via a Web search engine.

Figure 28. Web Keyword Search Results

out how to open and read mail. Although there were four girls in this group, only three were actively involved; there was not enough room for all four to sit in front of the computer, and Ashley was essentially excluded from the action. Once they had dealt with all new mail messages, they elected to do a Web search for material about smoking; at Mme. Gervais' suggestion, two girls split off to do spreadsheet work, while two remained to do the search.

Jessica and Lila both appeared somewhat uncertain about how to conduct a search, but discussed various approaches and quickly figured out what to do. A search on the term "second hand smoke" generated a list of 100 links. The girls' strategy for locating useful information was to go to each item on the list, starting at the top. The first three sites contained information that they deemed worth keeping (after considerable discussion), and they explored the various options in Netscape until they came across the bookmark facility, then flagged each URL of interest. The next several sites, however, were written in highly scientific language, which caused the girls to shriek and moan (Jessica was one of the children who had experienced great difficulty reading text during the scavenger hunt), and precipitated a decision to end the session by escaping to the school-yard for recess.

The schoolboard gateway crashed again between February 2nd and 9th, and thus no new mail was received for almost a full week. Mme. Gervais, once again, used another e-mail account to contact participants and request re-submission from those whose e-mail may have been caught in the system crash.

Ten new e-mail messages, each containing a completed survey, appeared in the children's mailbox on February 9; when Theresa's name was pulled from the hat, she picked Cara as her partner. These girls were somewhat collaborative, in that they discussed the e-mail messages before deciding whether or not to print them. Theresa (an experienced user) dominated the action on the equipment, however; she commandeered the mouse throughout most of the session, opening and printing seven messages and leaving only three for Cara. This session concluded when all new e-mail had been opened and printed; neither girl wanted to continue with a Web search for information about smoking.

When Barney was chosen to do e-mail on February 16, he picked Joe as his partner; both boys had prior experience with the Internet. This was a short session, with only four new survey responses to be opened, read, and printed. Although Joe never got his hands on the mouse, he was more cognizant than Barney about the requirements for this ICT task. Joe directed Barney through the login to Virtual Classroom and entry into the mailbox, and also guided him through the printing process. This session terminated with the ringing of the recess bell; neither Joe nor Barney wanted to skip recess to conduct a net search for information.

No additional e-mail was received after February 16, although a number of completed surveys were received by fax and post office mail. The teachers who chose these methods of transmission did so because they lacked sufficient access to an e-mail system to permit their students to complete and submit their responses on-line. In fact, one teacher had no Internet access at all, and

had been given a paper copy of the survey's call to participate by the computer teacher in her school. Of the 175 responses to the survey, only 58 were transmitted by e-mail, with 22 of these being in spreadsheet format within a single e-mail message. Sixty-five responses were received in a single fax, also in a spreadsheet, and the remaining 52 responses were delivered by regular mail. Although Mme. Gervais' students had identified a few Web sites containing information about smoking and second-hand smoke, only one other survey respondent forwarded any relevant URLs. It is not known why respondents did not complete the (optional) information search component of the survey, although I suspect that a lack of full Internet access is likely to blame.

All completed surveys, including those received by fax and snail mail, had been scored by students throughout the duration of the project. A number of children had also taken a turn at entering the data into a spreadsheet, recording the gender, age, grade level, and score for each respondent, and noting which questions had been answered incorrectly. Mme. Gervais had intended to teach the students how to submit the data to basic statistical analysis (simple averages, overall and broken down by grade level and by gender). Unfortunately, there were problems with the spreadsheet software on the classroom computer, and Mme. Gervais had to complete this aspect of the project on her home computer. Once the data were analyzed, Mme. Gervais prepared overhead slides to show the results to the children. Her students were pleased to discover that boys and girls did equally well on the survey, with boys averaging 7.68 correct answers (out of 10) compared to 7.78 for the girls.

Scores increased with grade level, with Grade 4 respondents having an average score of 7.19, compared to 8.38 for Grade 7 students.

Although Mme. Gervais had hoped to provide participants with the survey results by the end of March, delays due to gateway crashes along with her regular teaching duties, preparation of report cards, and spring break caused a postponement of this task. Results were e-mailed to participants on April 15, 1996; the final report was submitted to SchoolNet on April 25, 1996.

Discussion

Although it was not possible to submit the gathered data for the smoking survey to quantitative analysis similar to that undertaken for the scavenger hunt project, my observations highlight some issues that I believe to be important.

It is quite evident the 30 students in Mme. Gervais' class did not have equal access to the ICT equipment and tasks during this exercise. Table 13 (p.131) displays a list of the students and their involvement in computer tasks. While every student took part in some aspect of the project, for 11 children (28% of the class), active participation was limited to scoring completed surveys. Another five students had contact with a computer to do spreadsheet entry, but no opportunity for e-mail or keyword searching. Only 14 students (47% of the class) worked with e-mail and/or undertook a keyword search. Further, within this group of 14 students, there were three whose involvement was marginal at best. Fred was incapable of proceeding with e-mail without step-by-step help from others; Ashley worked in a group of four and was

Table 13
Student Involvement in Smoking Survey Tasks

STUDENT	E-MAIL	KEYWORD SEARCH	SPREAD SHEET	SCORE SURVEYS	PRIOR EXPER.
Jessica	X	X		X	
Lila	X	X		X	
Barney	X			X	X
Cara	X			X	
Fred	X			X	
Christine	X			X	
Joe	X			X	X
Theresa	X			X	X
Kimberley	X		X	X	
Ashley	X		X	X	
Eddie	X		X	X	
Spencer	X		X	X	X
Peter		X	X	X	
Scott		X	X	X	
Bertha			X	X	X
Emma			X	X	X
Mabel			X	X	
Susannah			X	X	
Brian			X	X	X
Ellen				X	
Frances				X	
Jazz				X	
Jocelyn				X	
Johnny				X	
Kaitlin				X	
Kayla				X	
Louise				X	
Madelaine				X	
Roger				X	
Steve				X	

essentially excluded by her physical location, and Peter acted only upon detailed direction from Scott. While the ongoing discussions about smoking and second-hand smoke indicate that the students achieved the learning outcomes related to understanding the health hazards of smoking, it appears that only 11 students (28%) accomplished the ICT-related learning outcomes for this project.

This lack of equal access to the technology occurred despite the teacher's best intentions, and her initial commitment to ensuring that each student had an opportunity to do either e-mail or electronic searches. Although 175 survey responses were received, only 58 were transmitted by e-mail; 22 of these were included in spreadsheet format within a single e-mail message. In total, then, the students received 37 pieces of e-mail containing survey responses; four of these were dealt with during the teacher's demonstration sessions, and 33 remained for students to open, read, and print. Of these 33 messages, 13 were handled by Christine and 10 by Theresa and Cara, with the remaining 10 split among Spencer and Eddie, Barney and Joe, and Fred. Christine, Fred, and Jessica's group each also had the opportunity to read and respond to one or two e-mail messages from people requesting copies of the survey. For this classroom of children, the opportunity for hands-on experience with e-mail clearly depended on an adequate supply of mail, and there was simply not enough incoming mail to permit all students to take a turn at the computer. Short of initiating another initiative in which her students would communicate electronically with others, which was impossible given the time required to

design, administer, and conduct such a project, Mme. Gervais had no way to provide all the children with hands-on e-mail experience.

A second learning outcome established by the teacher but not accomplished by most students was familiarity with the use of Internet search engines. While this activity was not dependent upon communication from survey participants, and could have been undertaken at any time by any willing students, only two pairs of students (13% of the class) expressed interest in trying keyword searches. Both groups eventually found some interesting information about smoking and second-hand smoke, but they also experienced considerable difficulty deciphering documents written in complex language -- just as was the case for many teams during the first project. It is not known why so few students were interested in undertaking searches for information, but I would suggest that frustrating experiences with keyword searches and complex text during the scavenger hunt may have led to an unwillingness to try this activity again.

Although the data gathered during the smoking survey exercise were not sufficient to permit a detailed comparison of processes and outcomes according to gender and prior experience, some of my observations appear to support findings from the scavenger hunt project.

Just as boys were found to be relatively non-collaborative during the scavenger hunt, with one partner tending to control the action, each of the three male groups that did ICT work for the second project included one partner who was noticeably dominant over the other. In contrast, Jessica's group exhibited highly collaborative behaviour during e-mail activity, with three

of four partners roughly equally involved in discussions, mouse work and typing; Ashley's exclusion appeared to be a function of her physical positioning behind the other girls. Once Kimberley and Ashley split off to work on the spreadsheet, Jessica and Lila turned to a keyword search and continued to work very collaboratively, each taking turns with the mouse and keyboard. Theresa and Cara were also somewhat collaborative, although their collaboration consisted mainly of discussing and agreeing upon strategies of attack, and Theresa claimed the larger share of the mouse and keyboard work for herself. Overall, however, it would appear that girls working on this project had more equal engagement with the ICT equipment than was the case for their male classmates.

The inclusion of a partner with prior experience seems to have had an negative impact on collaborative work during this project, just as it did during the scavenger hunt. Spencer, for example, was highly dominant over his partner during the first project, and continued this behaviour during the smoking survey. His partner, Eddie, was initially unsure how to proceed, which caused Spencer to take control and dominate most of their session. Perhaps if Eddie had been paired with another less-experienced child, he would have had the opportunity to figure things out for himself; instead, he was relegated to a noticeably less active role. Theresa, also an experienced user, worked more collaboratively than Spencer in that she engaged in discussions with her partner rather than issuing orders, but still claimed the bulk of the mouse and keyboard work for herself.

In one interesting pairing, two experienced boys (Joe and Barney) worked together; both boys had been dominant over their partners during the first ICT project. Because both maleness and prior experience were linked to reduced collaboration during the scavenger hunt, I did not expect this pair to work collaboratively, although I did anticipate that, by virtue of possessing prior experience, each would claim roughly equal opportunity to initiate events during this activity. Their work, however, was quite clearly dominated by Joe. I was surprised that Joe was highly capable at the e-mail task, since he had been very inattentive during the demonstration session. I had, however, observed him giving extensive guidance as Fred struggled to deal with e-mail, which suggests that Joe's prior experience may well have included familiarity with an e-mail system. Although this is only a speculation, it is a possible explanation for his dominant behaviour when partnered with Barney, particularly if Barney's prior Internet use did not include e-mail. Barney's experience notwithstanding, it does appear that a student's prior access to the Internet or Web sparked domination over a partner, and resulted in the experienced user having more access to the ICT task during smoking survey groupwork. This tendency toward domination is a mirror of the experienced students' observed domination of the ICT work during the scavenger hunt.

I find it interesting that all seven experienced students managed to claim some hands-on computer work during the smoking survey. Three experienced children had their names drawn for ICT work by the teacher, and one then proceeded to choose another experienced child as his partner; the remaining three experienced users all volunteered to do spreadsheet work. This is in

contrast to the 23 inexperienced students, of whom only 7 expressed an interest in spreadsheet entry. Brian was desperate for a chance to do some e-mail, but his name was never pulled; when he turned to spreadsheet work, he said to me, "Well, at least it's **something** on a computer!"

Even though Brian had no formal opportunity to work at an ICT task during this project, he made his presence known by frequently giving directions to other children as they worked on e-mail or keyword searching. Brian was seated immediately behind the researcher's chair, and was able to keep tabs on what was happening at the computer desk and jump in when he thought help was needed -- which was often. Three other experienced users (Emma, Joe, and Bertha) also, upon occasion, offered unsolicited advice to their classmates. In total, four of the seven experienced users (57%) became involved with other students, compared to only 1 of the 23 inexperienced users (Eddie). Proximity may have had something to do with this phenomenon, since Brian, Emma, and Bertha were seated near the computer station and could eavesdrop and offer advice without getting up from their desks. There were also, however, five or six inexperienced children seated within whispering distance of the computer desk, and not one ever intruded upon the ICT sessions.

This demonstrated willingness of experienced users to step in and help other children seemed, at first glance, to be constructive; the teacher cannot be in all places at once, and peer advice may be a good substitute for teacher advice. Upon reflection, however, it appears that involvement from more experienced classmates may actually be counter-productive to students who are trying to work something through on their own. When Mme. Gervais

assisted, she asked questions and offered hints, clearly encouraging the children to work through the roadblock and figure out *for themselves* what to do. In contrast, when another student "assisted," he or she always issued directions or orders, leaving no room for the other student(s) to reflect on the process. This appears to be a case where the possession of cultural capital by some students impedes the acquisition of cultural capital by others.

CHAPTER FIVE

CONCLUSIONS

In this work, I have tried to sketch a detailed description of what occurred in a classroom in which children were using information and communication technologies, and to emphasize some important issues surrounding the educational use of ICT. My research has focused on observation and analysis of the events in a single Grade 4 classroom in which 30 students used a single computer to connect to the Internet and the Web in order to work on two on-line projects designed by their teacher. While the results of this project are not generalizable, I believe that they highlight some areas of concern that should be of interest to educators and administrators who are considering introducing ICT in their schools, and to sociologists and other researchers who are interested in questions of access to technology and the impact of prior experience and gender on the classroom use of ICT.

What happens in a classroom during ICT activities?

It was clear that the *idea* of connecting to the Internet and the Web appealed to the children, as evidenced by the high level of excitement that permeated the classroom when Deb Johnson came to give the first introductory session. This observation supports comments from other authors who have commented on the motivating power of the Internet (Robinson, 1992; SchoolNet, 1996a; Walker, 1995; West, 1993). It was also evident, however, that the experience may not have lived up to its promise for all the children in the class. Equipment problems, pairings with dominant partners, and

difficulties with keyboarding, keyword searching, and the abstraction of text impacted on various students' experiences during ICT activities. Accordingly, it was quite apparent that some students had more positive and satisfying engagement with the technology than did others.

My findings also corroborate that, as other teachers have noted (Gray, 1995; Robinson, 1993; SchoolNet, 1996a), classroom ICT exercises do not take place without enormous preparation and involvement on the part of the teacher. Mme. Gervais did a great deal of preliminary work on both projects before the children could be involved. She learned how to burrow through the SchoolNet gopher looking for information, in order to be able to write suitable questions for the scavenger hunt. She learned how to use a graphical Web browser, Netscape, as a mechanism to connect to the Internet, in order to be able to show her students how to utilize this technology. She learned how to design an Internet-based project that would appeal to other students and teachers, and how to use Internet listservs to contact potential participants.

As the projects unfolded, Mme. Gervais also discovered that ICT exercises can be impeded by a plethora of equipment and network problems beyond her control (and sometimes communicated to the user by baffling error messages), and she learned, through trial and error, how to solve these problems when they surfaced. She also discovered that some components of Internet-based projects, such as writing lengthy e-mail documents to participants, are beyond the capacity of Grade 4 students and thus must be shouldered by the teacher.

There is some mention in the literature about the limited availability within schools of computers equipped for ICT activities, and I think that Mme. Gervais' scavenger hunt project is a good example of how a teacher can work around this problem and attempt to provide access to all students. A variety of strategies, such as having the students work in pairs, using a flexible time line, and permitting children to have multiple sessions in front of the computer, ensured that each team would be able to complete the required number of questions. However, the fact that the scavenger hunt had to take place concurrent with other classroom activities, including both the teaching of lessons to the other students and periods of independent work, meant that different teams had varying opportunity to secure assistance, when needed, from Mme. Gervais. This was less a problem for teams that worked collaboratively, since these partners often were able to sort out problems between themselves. Non-collaborative teams, however, were less efficient than the others, made more mistakes, and thus required more teacher assistance. When this help was not immediately forthcoming, the partners often exhibited high levels of frustration, and sometimes engaged in behaviour that was disruptive to the rest of the class.

The Impact of Gender

A second research question asked whether or not there are differences in the manner in which girls and boys engage with information and communication technology in the classroom; the answer to this question is clearly a resounding 'Yes.' Perhaps the most satisfying finding of this study is

that when measures of outcome were examined, girls did at least as well, and sometimes better, than their male colleagues. During the first project, girls and boys alike managed to complete the requirements of the scavenger hunt by digging through the SchoolNet gopher to locate answers to seven questions. Those girls who had the opportunity to deal with e-mail during the smoking survey proved to be quite capable of handling the requirements of the activity, as did their male classmates (with the notable exception of Fred).

While girls used, on average, either slightly less time than the boys to complete the scavenger hunt, or slightly more time when one anomalous male score is ignored, examination of the time differential indicated that it was not an important disparity. Mme. Gervais' comments on the relative importance of variations in time also highlight the fact that differences between female and male performance in this regard are not important within the context of her classroom, although they could be a problem in laboratory settings. Girls also proved to be more efficient than the boys, in that they made fewer mis-steps during their work, although the differences on this measure proved to be fairly small.

A most interesting finding had to do with the manner in which the boys and girls dealt with the collaborative nature of the ICT tasks set up by their teacher. In Mme. Gervais' classroom, the ICT exercises were designed to be undertaken by children working in pairs. The students were directed by their teacher to share the work, and this directive seems to have been followed more closely by the girls than by their male classmates; correlations among the variables indicated a positive relationship between collaboration and overall

efficiency. These findings support and extend the literature that has found that other types of computer work organized as a same-sex collaborative activity is appealing to and productive for girls (Beynon, 1993; Collis, 1991; Culley, 1993; Fisher, 1993; Fredman, 1990; Kirkup, 1992; Koch, 1994; Light, 1993; Moses, 1993; Neilsen, 1985; Nelson & Watson, 1991). Although there was some dominance within the female pairs, their typical working style during both projects was much more collaborative than that of the boys, with the result that female partners were very likely to have roughly equivalent hands-on experience with the technology, while some boys were markedly disadvantaged by being paired with a dominant male partner.

The finding about boys dominating other boys during the ICT exercises appears to be something new; while the literature is rife with examples of boys, singly or in groups, shoving girls off computers and claiming the bulk of hands-on access for themselves, there is no mention whatsoever of some male students being excluded by the actions of more assertive males. It is possible that this is a phenomenon exclusive to ICT activities, and has not been reported in the context of other computer work because it does not occur. I think it more likely, however, that male-to-male dominance *does* occur in other computer settings, but has gone unnoticed because research questions have focused on male-to-female dynamics. If this is the case, I would suggest that it is imperative for investigations of classroom access to computers, for ICT and non-ICT activities alike, to move beyond the focus on gendered differences and look at overall disparities in access, perhaps considering prior experience with the technology as an explanatory variable.

Perhaps the most provocative finding of this study related to gender is the observation that the girls seemed to be more enthusiastic about the ICT work than were the boys. Earlier research has highlighted the fact that boys typically exhibit higher levels of enthusiasm and more positive attitudes about computers than do their female classmates (DeRemer, 1989; Eastman & Krendl, 1987; Nelson & Watson, 1991). My observations, however, indicate that the girls in Mme. Gervais' class were no less enthusiastic than the boys about the projects at the introductory stages of each. Further, as the scavenger hunt project proceeded, a number of girls -- but only one boy, Brian -- expressed excitement when it was their turn to sit at the computer. In addition, several female teams lobbied for time to complete extra scavenger hunt questions, while only one boy (Brian again) wanted to do additional work. The other boys, without fail, vacated the computer desk once the required work was completed, or when the recess or lunch bell rang.

These findings are in direct opposition to the previous literature, which shows that boys, but rarely or never girls, typically try to claim the bulk of the hands-on classroom computer time for themselves (Beynon, 1993; Beynon & Mackay, 1993; Culley, 1993; Jacobson, 1994; Kirkup, 1992; Moses, 1993). It is possible that the very nature of the computer tasks in Mme. Gervais' classroom are at the root of this behaviour. Almost all earlier research on educational computing focuses on situations in which children learn *about* computers, or how to program computers. Both of these activities place the computer squarely in the realm of math and science, and it is thought that the tendency of girls to be averse to math and science spills over into negative

attitudes about computers. In contrast, computers were used as *tools* during the ICT exercises in Mme. Gervais' classroom, and the literature suggests that this use of the equipment may be more appealing to girls than programming or learning about the machines; my results tend to support this assertion.

My findings also point to something *not* present in the literature, that is, that boys may be relatively disinterested in computers-as-tools exercises. It is possible that, for this type of activity, boys regard the computer not as a 'Computer,' but rather as a necessary evil with which they have to interact to complete yet another routine or dreary classroom task. I must be cautious, of course, in drawing any inferences from this finding because I did not observe Mme. Gervais' students in computing activities outside the ICT context; perhaps the boys in the class were simply an atypical group. I would suggest that a fruitful avenue for future research might be a case study, involving several mixed-sex groups of children, in which a researcher compares behaviour during ICT exercises to behaviour during more typical computing activities (programming, or learning *about* computers). Such a research design would permit more reliable conclusions to be drawn concerning any observed differences between the genders.

The Impact of Prior Experience

Just as the literature suggests that gender will affect students' classroom computing activities, it also suggests that prior experience with computers will have an influence on children's engagement with the technology. I anticipated that advantages would accrue to those children

possessing home computers, or to those who play games on their home machines. Neither of these items, however, turned out to be useable, in that they were almost universal among the thirty students. I did, however, find that the presence or absence of prior experience with the Internet or the Web had a notable impact on students' ICT experiences.

During the scavenger hunt, teams that included one experienced partner used markedly less time than their counterparts, were more efficient, and required far less teacher involvement. These differences were larger than what was found when comparing males and females. Another difference surfaced when I examined the data for shared work, initiation ratios, and involvement ratios. Although teams with an experienced partner tended to do only slightly less collaborative work during the scavenger hunt than inexperienced teams, their non-collaborative work was much more one-sided -- and in all cases but one, it was the experienced partner who dominated the inexperienced partner. Similar behaviour was also exhibited during the smoking survey.

These findings indicate that those students unfortunate enough to be paired with experienced students had limited engagement with the technology. They were clearly disadvantaged by the fact that their partners actively (but I would hope, not deliberately!) prevented them from securing equal access to the ICT activity. I would suggest that this is a concrete example of the possession of home-generated cultural capital providing notable benefits to its owners, permitting them to use and expand upon their cultural competencies. Further, this opportunity to increase their cultural capital occurred at the expense of other less privileged children.

Mme. Gervais' class of 30 students included both girls and boys with prior ICT experience. It is encouraging to discover that some parents are providing their daughters with exposure to this type of computer application, although the fact that only 16% of the girls, compared to 36% of the boys, had non-school experience with ICT is perhaps a cause for concern. This indicates that, as has been the case with other types of computer applications (Nelson & Watson, 1991; Wajcman, 1991), boys may receive more parental encouragement than girls to use a home computer for ICT purposes. There does not appear to have been any comprehensive investigation of boys' and girls' differential experiences with and access to ICT in the home, and I would suggest this is another question that warrants future research.

The Issue of Access

Many discussions of access to computers in schools focus on simplistic measures centred around student-to-computer ratios, or student access hours. While the presence of equipment in a school or a classroom is a necessary condition of access, it by no means assures that all children will obtain hands-on and meaningful engagement with the technology. Maddux (1994) has suggested that considerations of access should examine not only the presence of computers, but also classroom management techniques and the ability of students to engage with the technology in educationally relevant ways. I have attempted to add to Maddux's argument by defining access as those periods when a student has hands-on and productive engagement with the technology

while working on an educational task, and by carefully delineating events and dynamics that appear to influence children's classroom access to ICT. As the current study progressed, it became abundantly clear that, just as Maddux suggests, the mere physical presence of ICT equipment did not guarantee equal access to all children in Mme. Gervais' classroom, and that a variety of factors impeded their access.

The 30 children in my study were privileged over others in their school of 600 students, because their classroom was the only one at Centennial equipped for ICT activities. By virtue of the presence of the computer, modem, and telephone line, they had the opportunity for access to the Internet in their classroom on a daily basis. Mme. Gervais' techniques for classroom management built upon this opportunity. Although time constraints made it impracticable to permit individual work on the scavenger hunt, the decision to limit the teams to two children meant that each child would be able to sit directly in front of the computer; working in teams of three or more would likely have marginalized those children who had to sit to the side or behind the others. Allowing the children to have more than one computer session guaranteed that each team had the potential to work with the equipment as long as needed to complete the requirements of the scavenger hunt. Some children wanted to work alone during the smoking survey ICT work, likely as a reaction to having been dominated during the first project, and Mme. Gervais permitted them to do so.

All 30 children, then, had the *potential* for equal access to the ICT activity during the scavenger hunt by virtue of the project design. However,

external technical problems beyond the control of the teacher impeded access for some students. The Internet service provider's telephone line was sometimes busy for long stretches, the volume of daytime traffic on the Internet often caused the system to be painfully slow to respond, and some gopher sites that were part of the path to a correct answer became temporarily or permanently unavailable. During the smoking survey, problems with the schoolboard's gateway caused incoming e-mail to disappear; this resulted in an unplanned extension to the time-line for the project. Further, the fact that only 33 e-mail messages were received meant that a limited number of students had the opportunity to read and print mail messages; 18 of the 30 students had no access at all to the main ICT task of the project.

Even though they were able to secure a functioning connection to the Internet, some students experienced difficulty with keyboarding, selection of useful keywords, and reading high-level text. While all students (with the exception of scavenger hunt Team 2, Johnny and Steve) eventually completed the required number of scavenger hunt questions, it was obvious that access during this ICT exercise was less productive and more frustrating for some students than for others. I am particularly concerned with the children's difficulties with keyword searching during the scavenger hunt, and the fact that this problem seemed to spill over into work during the smoking survey. Only four students wanted to try keyword searching during the second project, and thus 26 children voluntarily denied themselves access to this ICT activity. Because the ability to locate electronic information according to well-defined keywords is certain to become an increasingly valuable skill in our information-

based society, the children's lack of interest in pursuing keyword searches does not bode well for their future experiences with this technology. I would suggest that, if ICT is to be introduced into classrooms on a widespread basis, educators must encourage productive access with the technology by providing students with comprehensive training in the skill of keyword searching.

Access was also influenced by the gender of the partners. Because girls typically worked quite collaboratively, female team-members were much more likely than male team-members to have fairly equal hands-on access to the ICT activity during both the scavenger hunt and the smoking survey. Three boys (Barney, Eddie and Peter) had limited hands-on experience during the smoking survey because a dominant partner claimed most of the action; three boys (Eddie, Fred, and Peter) also had noticeably limited access during the scavenger hunt by virtue of being paired with a highly dominant partner. To be fair, Fred's partner Roger may well have dominated the scavenger hunt sessions out of necessity, since Fred spent a great deal of time looking around the classroom; Fred essentially limited his own access because of his lack of focus. An inability to focus during the scavenger hunt was also self-limiting for Steve and Johnny. These boys were not collaborative, but they were roughly equal in their unilateral initiation of events. However, because their work strategy consisted mainly of random selection of items on gopher menus, finding correct answers was more related to blind luck (and teacher assistance) than it was to thoughtful and systematic engagement with the technology. I would doubt that Steve and Johnny learned very much about looking for information on the Internet during the scavenger hunt; their access to

meaningful engagement with the technology was clearly impeded by their own behaviour. None of the girls in the class displayed similar behaviour.

Prior experience is the final factor that influenced access for some students. During both projects, those students with non-school exposure to the Internet tended to claim for themselves a disproportionate amount of the hands-on ICT work, thereby increasing their own access to the technology while inhibiting that of their partners. Further, those students who can connect to the Internet at home also have the opportunity for *sustained* access to ICT; this advantage is not open to their classmates (unless their parents provide them with modems and Internet hook-ups). Because Mme. Gervais' classroom is the only one at Centennial equipped for ICT exercises, the children in her class will *not* have opportunity for classroom access to the technology in the upcoming school year. Only those students connected outside of school will have the potential for ongoing access to ICT.

I have attempted, in this discussion, to outline the beginning of a typology of access which moves beyond the physical presence of a computer to consider external technical issues, strategies of classroom management, and the ability of the students to engage with the technology. A fuller treatment of the typology will be a project for future analysis, but I would hope that the comments contained in this thesis might serve as useful guidelines for administrators and teachers concerned with equality of access as they introduce schoolchildren to information and communication technology in the classroom.

Future Research

The preceding discussion has included some ideas for potential future research, such as a case study involving several mixed-sex groups of students involved in both ICT and other classroom computing activities, and an examination of children's home use of information and communication technology. The results of my study also suggest a variety of other possibilities for further investigation.

One possible critique of this study is that it is not generalizable in the classical sense. It should be pointed out, however, that this work has been informed by a different view of generalizability that hinges on the notion of "fittingness," as posited by the educational anthropologist Margaret Eisenhart (Eisenhart & Borko, 1994). This approach emphasizes the extent to which the current situation matches other situations of interest, and involves the provision of a rich description of the unit(s) of study and the setting, in order that other analysts can make informed decision as to the applicability of the findings to other sites. Nevertheless, it would still be most useful to replicate the study in different venues, with samples drawn from Grade 4 classes in different cities or in schools whose populations have a more heterogeneous SES composition than was the case at Mackenzie. Expanding such a study to include a sample from other grades, perhaps starting with Grade 2 or 3 and extending to high school students, would allow additional comparison of boys' and girls' approaches to ICT work to determine whether or not the observed differences exist among different age groups of students. Since Mme. Gervais

noted that time differences in completion of ICT work could be more problematic in laboratory settings than in a regular classroom, it would also be useful to examine ICT activities that take place in a computer lab.

The current study focused on prior experience and gender, while noting that race and class have been found to have an impact on students' access to educational computing. If, as has been the underlying premise of my work, familiarity with ICT is an important source of cultural capital with benefits that extend to the workplace and everyday life, it behooves the sociological community to examine access to ICT according to other indicators such as race and class. I would also suggest that such a study should not be limited to schoolchildren.

Mme. Gervais' students were involved in two specific ICT projects, but there are many other types of classroom activities that use information and communication technology. Accordingly, it would be instructive to design studies in which researchers observed students as they communicate electronically with penpals, tap into Internet discussion groups, and use sophisticated graphics technologies and hyper-text markup language (html) to write Web pages.

In a perfect world that included an infinite supply of research funding (not to mention time!), I would design a longitudinal study that followed one group of children through several years of schooling and examined their behaviours during ICT and other computing activities. Such a study might permit a researcher to observe the manner in which the presence of cultural capital continues to accumulate and to accord advantages to children. A

longitudinal study would also allow examination of changes in boys' and girls' interest in and engagement with information and communication technology over time.

My work has suggested that there may be an intersection between gender and prior experience. It might be profitable to conduct a similar study with a larger sample, where sample size would permit multi-variate analysis of the relationships between gender and prior experience with ICT, and dependent variables such as time, efficiency, and collaboration.

A re-analysis of my data, taking into account psychological learning theories, could provide a fuller understanding of the observed dynamics and behaviours in Mme. Gervais' classroom. Vygotsky's principles of communication and learning, which consider the role of social interaction in classroom-based learning (DeVillar & Faltis, 1991), appears to have the potential to be particularly illuminating in any attempts to understand the dynamics of classroom interactions during ICT and other computing exercises.

Finally, the field of sociology has a long tradition of studies of the social system of the classroom, beginning with the work of Talcott Parsons (1959) and including that of other analysts such as Bourdieu and Jencks. Parsons, working from a functionalist perspective, analyzed classroom structures and their roles in preparing children for their eventual allocation into American society's adult role structures. An extension of Parson's work, taking into account the role of classroom computers and information technologies in these processes of socialization, could make a positive contribution to this long-standing tradition of classroom inquiry.

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APPENDIX A: SCAVENGER HUNT QUESTIONS

QUESTION #1

During the last school year, some kids from Ottawa (and their teacher) ran a Classroom and Academic Project, a survey called "Taming the Tube."

Which TV show was the number one favourite of boys? Which TV show was the number one favourite of girls?

Answer: The Simpsons (for both boys and girls)

Path: Classroom and Academic Projects

Examples of Projects Previously run on SchoolNet

Taming the Tube

Taming the Tube Results

Favourite TV Shows

Global Results

QUESTION #2

SchoolNet includes lots of information about "innovators" (people who are experts in things like science, math, engineering, etc.).

Who wrote the book about women scientists called "Women in Science: 100 Journeys into the Territory"?

Answer: Viviane Gornick

Path: Electronic Innovators

Canadian Coalition for Women In Engineering Science & Technology

Resources: books, journals, articles, databases

Books

WIS books

QUESTION #3

In SchoolNet, you can travel to a newsstand that has information about current events around the world. "Earth and Sky" is a radio show that is heard all over Canada and the United States. What was the topic of the show on Monday, February 7, 1994?

Answer: Antarctica

Path: Electronic Newsstand

Arts & Entertainment

Earth and Sky

Earth and Sky Feb. 7-11 1994

QUESTION #4

SchoolNet includes information about many government programs, including government-run museums such as the Canadian Museum of Nature. Name one plant that should be avoided by people planting a monarch butterfly meadow.

Answer: Purple loosestrife

Path: Government Program Information

Canadian Museums

Canadian Museum of Nature Monarch Butterfly Net

Monarch Meadow

Plants Suitable for Wildflower Meadow

QUESTION #5

SchoolNet gives you several different tools that you can use to search for information on the Internet.

What does the searcher called JUGHEAD stand for? Find searchers named for two of Jughead's friends.

Answer: Jonsy's Universal Gopher Hierarchy Excavation and Display; Archie and Veronica

Path: Internet Searching Tools and Other Connections

JUGHEAD

About JUGHEAD

QUESTION #6

SchoolNet has information about a bunch of cool activities that kids from Kindergarten to Grade 6 can try at home or at school.

How many potatoes does it take to make a potato-powered clock?

Answer: Two

Path: Kindergarten to Grade 6 Corner

Cool Things to Try

Make a Potato-Powered Clock

QUESTION # 7:

How many ways are there to register with SchoolNet?

Answer: Two

Path: SchoolNet registration

How to register with SchoolNet

QUESTION #8

SchoolNet often follows special events, such as an Arctic expedition that started in January 1995.

One of the participants in the Arctic expedition, Richard Weber, is a Canadian whose home is close to Ottawa. Where does Richard Weber live?

Answer: Aylmer, Québec

Path: SchoolNet Special Events

Weber-Malakhov Trans-Arctic Expedition

About the Weber-Malakhov trans-Arctic Expedition

The Team

QUESTION #9

You're going on a "virtual" scavenger hunt using SchoolNet. Many other children around the country have also done electronic scavenger hunts during class, or during their spare time.

List one of the resources that kids could have used if they were working on the space scavenger hunt.

Answer: Any one of: NASA ftp site, Lunar and Planetary Lab, Hubble Space Telescope Images, Cleveland FreeNet

Path: Virtual School

Recess

Scavenger Hunts

Canada's SchoolNet Space Scavenger Hunt

QUESTION # 10:

SchoolNet has information about the kinds of books that you might see in the school or public library.

Which of the girls in the Baby-sitters Club books (published by Scholastic Books) was modeled after Ann Martin (the author)?

Answer: Mary Anne

Path: Virtual School

Library

Scholastic Internet Centre

Baby-sitters Club

Ann Martin

QUESTION #11 (BONUS):

You can find out about ocean-going ships by looking around in SchoolNet. Who is the Captain of the Canadian research ship, the "Alfred Needler"? What length is the ship?

Answer: Captain A. Adams; 50.3 meters

Path: Virtual School

Science and Engineering Floor

Environmental Science Room

OCEANIC, the Ocean Information Centre

Research Ship Information and Cruise Schedules

Worldwide ships by country

Canada

Alfred Needler

QUESTION #12 (BONUS):

"Kanata" is the name of a city near Ottawa, and it is also a word from the language of the Huron-Iroquois native tribes. What is the meaning of the word Kanata?

Answer: a group of huts or community

Path: Virtual School

Social Science Floor

Native Canadian Information

Kids from Kanata

About Kids from Kanata

WEB QUESTION #1:

The math & science room in SchoolNet has lots of information about saving the environment. What kind of insect is on the page for the Evergreen Foundation?

Answer: A butterfly

Path: Math & Sciences

Environment and Geology

The Evergreen Foundation

WEB QUESTION #2:

SchoolNet includes information about different sciences, such as biology. Find the picture of the ladybug or ladybeetle that shows the name of the body parts. Name the two body parts that start with the letter A.

Answer: Abdomen & antenna

Path: Biology & Health Services

The Ladybug Survey

Ladybugs

APPENDIX B: SMOKING SURVEY QUESTIONS**a) Tell us about yourself**

1. Are you a boy or a girl? Boy _____ Girl _____
2. How old are you? _____
3. What grade are you in? _____
4. Where do you live? City/town _____ Province/state _____

b) Answer some questions about smoking

1. People who don't smoke are healthier. True _____ False _____
2. It is hard for most people to stop smoking. True _____ False _____
3. People of all ages can legally buy cigarettes. True _____ False _____
4. Some girls smoke because they are afraid of gaining weight.
True _____ False _____
5. Most people in Canada have never tried a cigarette. True _____ False _____
6. Most teenagers prefer to hang around with other teenagers who
don't smoke. True _____ False _____
7. When you smoke, you only do harm to yourself. True _____ False _____
8. Cigarette smoke can hurt unborn babies. True _____ False _____
9. Cigarettes contain a number of drugs. True _____ False _____
10. Many people decide not to smoke because they want to stay healthy.
True _____ False _____
11. Does anybody in your home regularly smoke cigarettes. Yes _____ No _____
12. If you answered 'Yes' to question 11, please indicate who it is.
Mother _____ Father _____
Sister _____ Brother _____
Self _____ Other _____
13. If you smoke regularly, why do you smoke?

14. Have you ever tried smoking a cigarette?
Yes _____ No _____
15. If you answered 'Yes' to question 14, please indicate why
you tried smoking a cigarette.

c) Using whatever electronic resources are available to you, find one or more interesting facts about the effects of second-hand smoke. Be sure to provide the source of this information (i.e. include the Uniform Resource Locator, the gopher address, etc.)

APPENDIX C: COMPUTER USE QUESTIONNAIRE

1. What is your REAL first name?
2. What is your "alias" name?
3. Did you have a computer at home at the beginning of this school year?
YES_____ NO_____
4. Do you use your home computer? YES_____ NO_____
5. If you use your home computer, what do you use it for?
 - games YES_____ NO_____
 - getting information from encyclopedias YES_____ NO_____
 - typing your school projects or homework YES_____ NO_____
 - using educational software YES_____ NO_____
 - surfing the Internet or Web YES_____ NO_____
 - other things (tell me what they are)
6. Does your home computer have a modem? YES_____ NO_____
7. Had you ever used Netscape, or Mosaic, or Microsoft Explorer before you used Netscape to do the scavenger hunt?

APPENDIX D: EXAMPLE OF CODED FIELD NOTES

- 1 = partner #1
- 2 = partner #2
- T = teacher
- R = researcher
- A = left-hand chair
- B = right-hand chair
- KB = keyboard
- S = shared or collaborative event
- D = direction given to partner
- AC = unilateral action by one partner
- FD = follows direction of partner
- FD (T) = follows direction or advice from teacher

Tuesday October 31

Team 5 should have been on today, but one partner was sick, and Team 6 was designated as the replacement. Two girls - Jessica (blonde) and Kaitlin (dark) today. Kaitlin arrived first and chose chair B, & Jessica sat in A. Coding for this session: Jessica is 6-1, and Kaitlin is 6-2. Other kids leave for recess.

10:32

Teacher gives the usual instructions - choose 7 of 10, share the work. Asks girls how many times they can do KW search; 6-2B says twice. T says they can abbreviate when writing the path, can ask T for help, and reminds them that the main menu page is long and that they may want to scroll down to get to places such as Virtual School.

10:36 start

- T leaves
- 6-2B has mouse on her side
- 6-1A places book on lap, open to #1
- both read aloud - simultaneous
- 6-2B "Try this one?"
- 6-1A "OK" - props book behind keyboard, in the middle
- 6-2B scrolls ↓ as both appear to read [S]
- 6-1A points out 'Events'
- 6-2B reads booklet
- 6-1A says, "TRY 'special events' "
- 6-2B "OK" and clicks as directed ⇒ menu [S] [mis-step]
- both read - look at each other and shake heads [S]
- 6-2B clicks back
- 6-1A tells partner to scroll up [1D]
- 6-2B scrolls ↑ [2FD]

- both read screen, together [S]
- 6-1A looks at partner
- 6-2B giggles
- 6-1A "Down" [1D]
- 6-2B scrolls ↓ [2FD]
- 6-1A places finger on screen and reads aloud [1AC]
- T arrives and, [APPARENTLY NOTICING THAT THEY HAVE SCROLLED DOWN ON THE MAIN MENU], asks if they've checked above
- 6-1A "Yes"
- T reminds - Intro. contains a clue - might give a keyword that will help them decide where to go
- 6-2B scrolls ↑ [2FD(T)]
- 6-1A points to 'Classroom & Academic Projects' [1FD(T)]
- T asks her to explain why that choice
- 6-1A reads aloud the Introduction to #1, stressing Classroom & Academic Projects [1FD(T)]
- T asks if they think they should try that
- both say yes
- 6-2B clicks there ⇒ menu [2FD(T)]
- 6-2B clicks on first item, 'Designing and Running Your Project' [NO CONSULTATION ON THIS ONE - SHE SEEMS TO HAVE CLICKED ON IT BECAUSE IT WAS THE FIRST ITEM ON THE MENU] [2AC] [mis-step]
- both appear to read
- 6-1A points to 'about'
- T says try - if nothing there, go back and try something else
- 6-2B clicks there ⇒ menu [2FD(T)]
- both read, shake heads } - [S]
- 6-2B clicks back
- 6-1A points to the first item ('About') - "This one, or should we go back?"
- 6-2B "Hmmm"
- 6-1A "What's your decision?"
- 6-2B "go back, maybe"
- 6-2B puts hand on mouse, but doesn't click
- both appear to read
- 6-2B moves cursor, apparently randomly, around the screen [2AC]
- 6-1A points to 'about' again [1D]
- 6-2B clicks there ⇒ text [2FD]
- both read
- T says to remember, it's not **your** project but one done by another class. See anything here? [T hints]
- both say no
- 6-2B clicks back ⇒ menu [2FD(T)]
- Female interloper speaks to T; T takes her to the door
- 6-2B watches T and I
- 6-1A reaches over, places hand on mouse

- 6-1A "Maybe this" & points to 'Science Projects & Academic Affairs' [S]
- 6-2B "Don't know"
- 6-1A places finger on screen
- discussion
- Two other girls enter classroom
- partner turn to look at interlopers
- 6-1A still controls mouse - points to 'Examples of...' [S]
- 6-2B says she doesn't know, but maybe try it
- 6-1A "Networking?"
- 6-2B "No, I don't think so" [S]
- 6-1A "Common Heritage?"
- 6-2B shrugs, then says to try it [S] [mis-step]
- 6-1A clicks there ⇒ menu
- both read menu, look at each other, shake heads [S]
- 6-1A clicks back
- 6-1A "I want to try 'Examples of ...' "
- 6-1A clicks there [1AC]
- 6-1A "Woo-hoo!" and clicks on 'Taming the Tube 1995' ⇒ menu [1AC]
- 6-1A clicks on 'Taming the Tube Results' [NO DISCUSSION FOR EITHER OF THESE 2 CLICKS] ⇒ menu [1AC]
- 6-1A asks partner which one to try [S]
- T returns, reminds them to read question to be sure of what is asked for, then leaves
- 6-1A points to 'Results of Anonymous...' [S]
- 6-2B points to 'Taming the Tube Results & Statistics' - "This is better"
- 6-1A "OK" and clicks there ⇒ menu
- both read, discuss, appear to agree on going back [S]
- 6-1A clicks back
- 6-1A clicks 'Results of Anonymous...' ⇒ text [1AC] [mis-step]
- both read
- 6-1A clicks back [1AC]
- 6-1A points to 'Favourite TV shows' [S]
- 6-2B "OK"
- 6-1A clicks there ⇒ menu
- 6-1A clicks back [TOO BAD - THEY WERE ALMOST THERE!]
- 6-1A 'Feedback?'
- 6-2B no, go back [S]
- 6-1A clicks back
- 10:45
- others return from recess; lots of noise as they enter the room; teacher settles them down -- they are doing independent work (writing a story in French, I think)
- 6-1A suggests going to 'Taming the Tube Results'
- 6-2B "No, it was last year" [REFERRING TO QUESTION THAT SAYS PROJECT TOOK PLACE LAST SCHOOL YEAR] [S]

- 6-1A clicks back [NOW THEY'RE BACK AT 'CLASSROOM & ACADEMIC PROJECTS' MAIN MENU] [1AC]
- T arrives, looks at screen, suggest they try 'Examples of...' again
- 6-1A clicks there ⇒ menu [1FD(T)]
- T "You found Taming the Tube"
- both kids tell her, it says 1995 and THIS school year is 1995
- T points out that LAST school year was 1994-95
- 6-1A clicks on 'Taming the Tube 1995' ⇒ menu [1FD(T)]
- T leaves
- female interlopers enter, watch R writing for a few seconds, and leave
- 6-1A clicks on 'Taming the Tube Project 1995' ⇒ text [1AC]
- 6-1A [SOUNDING EXASPERATED] shoves mouse at partner and says "Why don't you do this?" [THIS IS DELIVERED IN AN ACCUSATORY-SOUNDING TONE, WHICH IS INTERESTING IN THAT 6-2B HAD NEVER REFUSED TO DO THE MOUSE THING; 6-1A HAD REACHED OVER AND COMMANDEERED IT FOR HERSELF]
- Both read aloud
- 6-1A asks partner "Is this it?" [S]
- 6-2B shrugs - "I'm not sure"
- 6-1A tells partner to scroll up and down [1D]
- 6-2B scrolls ↓ [2FD]
- both read
- 6-2B scrolls ↑ [2FD]
- 6-1A says, not here [1D]
- 6-2B moves mouse around [2FD]
- 6-1A "Let's go back" [1D]
- 6-2B doesn't click back [2FD]
- 6-1A points to text and tells partner to click [1D]
- 6-2B tries, but the text is not linked and nothing happens [2FD]
- T arrives and asks how it's going
- 6-1A "It's hard"
- T says to go back [T hints]
- 6-2B clicks back [2FD(T)]
- T asks what's in 'Taming the Tube Results'
- kids do nothing
- T says to try it
- 6-2B clicks [ALL LINKS ARE PURPLE - THEY'VE GONE TO EACH BUT NOT FAR ENOUGH] [2FD(T)]
- T "You've tried them all?"
- both "Yes"
- T reminds them they're looking for favourite shows
- 6-2B clicks 'Favourite TV shows' ⇒ menu [2FD(T)]
- T [OBVIOUSLY NOTICING THAT NEITHER LINK HERE HAS BEEN FOLLOWED] "You didn't try these"
- T leaves

- 6-2B points to 'Australia'
- 6-1A points to 'Global'
- 6-2B shrugs
- 6-1A "What now?" [S]
- both call for teacher
- T arrives
- 6-1A "Is this it?"
- T says they are in the right place. Did question ask for Australia?
- both say no
- 6-2B clicks 'Global...' ⇒ text [2FD(T)]
- T leaves
- both appear to read screen
- 6-2B rocks her chair
- 6-2B rests hand on edge of screen [GETTING TIRED?]
- 6-1A points at scrollbar [1D]
- 6-2B scrolls ↓ [2FD]
- 6-2B "It's Simpsons"
- 6-1A disagrees [S]
- 6-2B points to booklet
- 6-1A agrees
- 6-2B "Write it" [2D]
- 6-1A says they need the path first [1FD]
- both call for teacher
- T returns, asks if they have the answer
- 6-2B says yes
- T tells them to write it down
- 6-1A passes book to partner [FD(T)]
- 6-2B writes
- [they go through process of retracing and recording path]
- 11:03
- (ONE QUESTION COMPLETED; DURATION 35 MINUTES)
- 6-1A "Now we're changing"
- **SWITCH**
- Kaitlin (6-2) moves to chair A, and Jessica (5-1) moves to seat B.
- 6-2A turns to #2 and props book centrally behind keyboard [2D]
- 6-1B reads out loud as partner watches closely [S]
- both appear to read screen
- 6-2A points to 'Electronic Innovators'
- 6-1B "hold on - oh - cool. Yes, OK" [S]
- 6-1B clicks there ⇒ menu
- 6-1B moves cursor along words
- 6-1B (stopping at Canadian Coalition..) "This one - don't you think?" [S]
- 6-2A nods
- 6-1B clicks there ⇒ menu
- both appear to read screen
- 6-1B moves cursor through the list

- 6-1B "This one" (pointing to 'resources: books...') [S]
- 6-2A "I'm not sure"
- 6-1B looks at question booklet
- 6-1B clicks back twice [NOW BACK AT MAIN MENU] [1AC]
- 6-1B clicks on 'Electronic Innovators' [1AC]
- 6-1B points at 'Canadian Coalition' and looks at partner [S]
- 6-2A says nothing, stares at screen, looks at book, shrugs
- 6-1B clicks there [1AC]
- 6-2A says to try the bottom one
- 6-1B "This?"
- 6-2A "Try it" [S]
- 6-1B "OK" and clicks there ⇒ menu
- 6-1B "There's books, journals..."
- 6-2A (emphatically) "BOOKS"
- 6-1B "Are you sure?" [S]
- 6-2A "Yes"
- 6-1B clicks there
- 6-1B reads "History of women.....Try this?"
- 6-2A "Sure" [S] [mis-step]
- 6-1B clicks there ⇒ text
- 6-1B [SEEMS DISMAYED AT HAVING ENDED UP WITH A TEXT SCREEN] "Oh no! I don't think this is it"
- 6-1B clicks back [1AC]
- 6-1B clicks 'WIS books' [1AC]
- both read screen
- 6-1B moves mouse through text as partner reads [S]
- 6-2A places finger on screen at correct answer
- some discussion, then agree it's the right answer [S]
- 6-1B takes book from behind keyboard, passes to partner "Your turn"
- 6-2A writes [S]
- 6-1B "That was a bit easier"
- 6-2B moves mouse around screen
- [they go through the process of re-tracing and recording the path]
- 11:14
- [SECOND QUESTION COMPLETED; DURATION 9 MINUTES; THEY DIDN'T NEED ANY HELP FROM THE TEACHER ON THIS ONE, AND T DIDN'T COME TO CHECK - PERHAPS WAS PERIPHERALLY AWARE THAT ALL WAS WELL. T IS NOW BUSY AT FRONT OF CLASSROOM, GIVING A LESSON TO THE OTHER CHILDREN]
- 6-2A turns to #3, props book behind keyboard [2AC]
- 6-1B reads aloud and moves mouse along words as she reads [1AC]
- 6-1B stops at 'K to 6 Corner'
- 6-1B "Hey what about Electronic News" reads question out loud, emphasising the word newsstand [S]
- 6-2A "OK"
- 6-1B clicks ⇒ menu

- both read screen
- 6-1B moves cursor through text as they read [S]
- 6-2A tells partner to scroll down [2D]
- 6-1B does as directed [1FD]
- 6-2A "The Newsstand?"
- 6-1B "Newsstand? this?" [S] [mis-step]
- 6-2A "Yes"
- 6-1B "Oh, OK" & clicks ⇒ menu
- both read screen together, 6-1B moves cursor as she reads [S]
- 6-1B asks if partner wants to stay here or go back
- 6-2A says to stay and scroll down [S]
- 6-1B scrolls ↓
- 6-1B "Let's go back" & clicks back [1AC]
- 6-1B clicks back again, to main menu [1AC]
- 6-1B reads question
- 6-2A looks at screen
- 6-1B moves cursor around screen, scrolls down "Can't go any farther" [S]
- 6-1B looks at partner **[THEY ARE COMPLETELY STUCK HERE,**
- both look at screen, then at book **BUT THEY ARE IN IT TOGETHER!]**
- 6-1B "Oh brother"
- 6-2B "Yeah, oh brother is right!"
- 6-2A points to Electronic Newsstand "It's the only one"
- 6-1B "there has to be another"
- 6-2A "No" [S]
- 6-1B "OK" clicks on "Electronic Newsstand"
- 6-1B reads question "It's like a TV show"
- 6-1B points at 'Arts & Entertainment' - "Should we try here?"
- 6-2A "No - OH, I don't know - maybe" [S]
- 6-1B clicks there ⇒ menu
- 6-1B clicks on 'Earth & Sky' ⇒ menu [1AC]
- 6-1B clicks on 'Feb. 7-11' ⇒ text [1AC]
- 6-1B "Oh, man!" **[APPARENTLY REALLY DOESN'T LIKE COMING ACROSS TEXT]**
- 6-2A "We've found it, I think"
- 6-1B "What's the question?" reads booklet "We need the topic"
- both read screen
- 6-1B "I see it (reads from screen) on a subject far from home - here's the word subject, so it has to be FAR -- FROM -- HOME"
- 6-2A "Antarctica" [S]
- 6-1B "I think it's far from home"
- 6-2A "OK"
- 6-2A picks up book and writes
- **[they go through the process of re-tracing and recording their path]**
- **11:29**
- 3 QUESTIONS DONE; DURATION FOR THIS ONE IS 15 MINUTES. NO CALLS TO TEACHER, EVEN THOUGH THEY GOT INTO A LITTLE TROUBLE.
- 6-1B reaches for book, places back behind keyboard in the middle of desk

- 6-1B reads #4 out loud [1AC]
- both read screen
- 6-1B "Gov. Program Information?" [S]
- 6-2A nods
- 6-1B clicks there ⇒ menu
- both read, with 6-1B moving cursor along the lines as she reads [S]
- 6-1B "Canadian Museums?" [S]
- 6-2A checks book
- 6-2A OK
- 6-1B clicks there ⇒ menu
- 6-2A "OK!"
- 6-1B "It has to be this" [BOTH ARE REFERRING TO FACT THAT THERE'S ONLY ONE MENU ITEM HERE] [S]
- 6-1B clicks there ⇒ menu
- T comes, asks how things are going [FINISHED DELIVERING LESSON TO OTHER KIDS];
- both answer, OK
- T leaves
- 6-1B clicks on "About..." ⇒ text [1AC] [mis-step]
- both appear to read
- discussion [S]
- 6-2A has finger on screen "I don't know"
- 6-1B clicks back [1AC]
- 6-1B clicks on "Butterfly Beyond Boundaries" ⇒ menu [1AC] [mis-step]
- 6-1B clicks on 'Introduction' ⇒ text [1AC]
- 6-1B clicks back [1AC]
- 6-1B clicks on 'About...' again ⇒ menu [1AC]
- T arrives and asks if they're tired
- both say yes
- 6-1B says they want to stop [S]
- 6-1A agrees
- T says to make notes of where they went for current question
- [they go through process of re-tracing and recording path]
- 6-2A OK - DONE
- both get up and leave
- 11:37
- **END OF SESSION; TOTAL TIME 62 MINUTES. 3 QUESTIONS COMPLETED, AND A START ON THEIR FOURTH**

OVERALL IMPRESSION: THERE WAS DEFINITELY A GREAT DEAL OF COLLABORATIVE WORK GOING ON, LOTS OF DISCUSSION, WITH MANY ACTIONS UNDERTAKEN ONLY WHEN BOTH GIRLS AGREED. FOR THOSE EVENTS THAT WERE NOT COLLABORATIVE, JESSICA SEEMED TO BE INITIATING LOTS MORE THAN KAITLIN. WILL BE ABLE TO GET A BETTER IDEA AFTER I CODE THIS SESSION. ALSO, THESE GIRLS, ESPECIALLY JESSICA, WERE NOT AT ALL HAPPY TO ENCOUNTER TEXT DOCUMENTS -- I DON'T KNOW WHERE THEY THOUGHT THEY WOULD FIND THE ANSWERS TO THE QUESTIONS, BUT THEY CLEARLY WOULD PREFER NOT

HAVING TO READ ANYTHING! NOT A HUGE AMOUNT OF TEACHER INVOLVEMENT; THEY CALLED FOR HELP A FEW TIMES DURING THE FIRST QUESTION, BUT SETTLED IN AND PRETTY MUCH HANDLED THINGS ON THEIR OWN AFTERWARD. TEACHER DID NOT NOTICE A FEW TIMES WHEN THEY WERE STUCK, PROBABLY BECAUSE SHE WAS BUSY AT THE FRONT OF THE CLASSROOM, **AND** THESE GIRLS WERE VERY QUIET, EVEN WHEN DISTRESSED (AS IN ENCOUNTERING TEXT THAT HAD TO BE READ!).

COUNT OF EVENTS:

Events as a result of teacher direction or hint	13
Shared events	47
Actions taken unilaterally by partner #1, Jessica	24
Direction given to partner by #1, Jessica	8
Actions undertaken unilaterally by partner #2, Kaitlin	4
Direction given to partner by #2, Kaitlin	4
Total events	102
 Total mis-steps	 9

APPENDIX E: HOW TO READ BOXPLOTS

A boxplot displays, in graphical format, various features of a batch of data, while omitting unnecessary detail. Boxplots are a highly useful tool for quickly determining the important features of a batch (level, spread, asymmetry, unusual values, and upward or downward trends), and also facilitate comparison among two or more batches (Nosanchuk & Erickson, 1992).

The batch displayed in this boxplot has a well-balanced midspread, with the median situated almost in the centre of the midbox (the middle half of the data). It trails upward markedly in the extremes, and there are two very unusual values, as indicated by * and O.

END

1 7 - 0 6 - 9 7

FIN