# Canadian Students' Access to and Use of Information and Communication Technology

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## Abstract

Rapid growth and improvement in Information and Communication Technologies has led to the diffusion of technology in education. Studies in controlled environments suggest that the use of technology under the right circumstances improves educational outcomes, and many educators believe that a new pedagogy that incorporates technology is necessary to prepare students for work in the information age. This study investigates the extent to which students have access to computers and the Internet, whether access is related to their sex or socioeconomic status, and for those who have access to computers how they tend to use them. The analysis is based on the responses of nearly 30,000 15-year old Canadian students who participated in the Programme for International student Assessment (PISA). The findings indicate that nearly 9 out of every 10 (88%) of Canadian students have a computer at home, and 8 of every 10 (81%) use a computer at home nearly every day. However, students from low socioeconomic families were less likely to have access to computers and a link to the Internet at home. Females were also less likely to have access to computers and the Internet at home but these disparities were negligible for students in high socioeconomic status families. Students reported that they use computers mainly for accessing information on the Internet, communication, word processing, and games. Less than one-third of students who used computers reported that they used them to help them learn. Our conclusions argue that universal access at home is within reach and is essential if computers are to become a learning tool aimed at improving students' skills.

## Students' Access to and Use of Information and Communication Technology

Students' use of technology in education is expected to improve educational outcomes, increase skills in the use of technology, and decrease inequities between groups (Pelgrum & Anderson 1999; Industry Canada, 1997). It is considered an important indicator of their preparedness to succeed and excel in the future. This study examines Canadian students' access to and use of Information and Communication Technologies (ICT), using data from the Programme for International Student Assessment (PISA) 2000. This survey was conducted in 32 countries to assess the skills of 15-year-old students, who are at or near the end of their compulsory education, in the three literacy domains of reading, mathematics, and science. We examine students' access to ICT in the school and home environments and make comparisons between the provinces and other OCED countries.

There has been rapid growth and improvement in the diffusion of technologies that have been designed to handle information and aid communication. The study of this technology and the influence it has on society is known as Information and Communication Technology (ICT), and most commonly refers to the use of computers, software, and the Internet. For more than fifteen years, the use of computers in the classroom has been a source of controversy among governments, researchers, educators, policy-makers, and employers (Cuban, 1986; Cuban, 2000). An urgent plea from Stevenson (1997), in his report on Information and Communication Technologies in UK Schools, concluded that failure to adopt ICT in schools would place the UK at an enormous disadvantage from which it would be difficult to recover. At the same time, other countries such as Canada and the United States were also developing national strategies to incorporate these newfound technologies in education (President's Committee of Advisors on Science and Technology, 1997; Industry Canada, 1997). Currently, developed and developing countries alike are directing significant amounts of attention and financial resources on providing access to ICT in schools to instil students with basic skills deemed necessary in the information age.

Pelgrum and Anderson (1999) suggest that countries which fail to adopt ICT risk social exclusion, decreased capacity to compete in the new economy, missed opportunities to improve contemporary education needs, and missed opportunities to improve inequities among social classes. New theories of economic growth hold that production is not simply a function of capital and labour, as neoclassical economist theories maintain, but is also a function of knowledge and ideas (Romer, 1993). The new economy has intensified competition among nations, and rapid technological advances require a skilled workforce to keep up with constant changes occurring in the workplace. Adults now need a higher skill level to function well because society has become more complex, low skilled jobs are disappearing, and literacy requirements have increased dramatically. To meet these and other challenges, elementary and secondary schools will play a central role in laying a solid foundation upon which subsequent knowledge and skills can be developed (OECD and Statistics Canada, 2001).

Toward building that foundation, two primary goals of education in Canada are to develop high levels of academic achievement and to achieve equity in educational outcomes between the sexes, and across socioeconomic groups. Measuring achievement has become an important goal of many OECD countries, and is seen as a way to assess students' levels of preparedness to meet challenges in their future lives. Through the PISA, participating countries are able to gauge their own level of achievement and compare their results to other participating countries (Hirsh, 2002). These assessments also provide a means to examine inequities in educational achievement and access to learning resources (e.g, see OECD, 2001, Chapter 8).

Policy-makers in Canada expect that the introduction of ICT in education will improve academic performance, improve equity among students, and improve students' ability to use and apply technology and software in their future employment. A series of well coordinated federal policies and programs provide access to ICT in every school and every community in the country. For example, the *SchoolNet* program was responsible for coordinating the goal of connecting every school to the Internet, and is now aiming to ensure that every classroom is connected. *Computers for Schools* channels recycled computers that have been donated from government and corporations to schools in low-income areas, and *Community Access Programs* provide public access to the Internet during evenings and weekends.

Although some educators embrace the introduction of new technology, others oppose the diversion of scarce financial resources that support education goals aimed at furthering the interests of corporations (Froese-Germain & Mall, 2002). Opponents argue that the benefits of ICT are minimal, and others claim that far too few teachers use ICT to make the investment worthwhile. A 1999 study estimates that only five percent of all teachers in Canada are using computers for inquiry-based learning (Laferriere, 1999) and computers are located in places that are not conducive to adapting them for teaching (SchoolNet, 2000). In the meantime, teachers are expected to work more hours, schools are being closed due to a lack of funding, and many schools do not have adequate resources for helping needy students.

Becker (2000a) investigated the use of ICT by teachers in the United States. He concedes that technology does not currently fulfill a major role in education, but maintains ICT will play a significant role in the future as students using technology in an environment conducive to ICT demonstrate increased educational outcomes. Other studies demonstrate ICT use contributes to increases in reading, math and writing scores on standardized tests and contributes to a knowledge building pedagogy (Owston, & Wideman, 2001; Scardamalia & Bereiter, 1999; Chang, Henriquez, Honey, Light, Moeller & Ross, 1998). Chang *et al.* (1998) examined the impact of educational reforms, including the impact of technology, on standardized test scores for approximately 9000 students in Union City, New Jersey, USA. The educational reforms were implemented as a result of the districts poor educational outcomes in areas such as students' attendance and dropout rates, and standardized tests. In addition to many educational reforms, extensive investment into educational technologies was incorporated into the education system. The researchers maintain technology facilitates increases in communication among teachers, students, and parents, increases collaboration among teachers, and provides students with additional opportunities to write, edit, and undertake multi-media authoring projects. Becker (2000b) also found that ICT increases student engagement, which leads to increases in the amount of time students spend working outside of class time.

The authors of these studies caution that improved results are not completely due to the influence of ICT alone, but are dependent on an environment conducive to the use of this technology. For example, teacher pedagogy must change from the traditional *teacher-focused* approach to a *student-focused* approach and requires at least a 4-to-1 student to computer ratio in the classroom (Becker 2000b; Becker, Ravitz, & Wong, 1999). The traditional *teacher-focused* approach relies on the teacher as the source of information whereas the *student-focused approach* views the teacher as one who facilitates learning by teaching students how to learn independently. Students who have access to ICT in the classroom have the ability to gather their own information, to solve problems, and design solutions as they can access large amounts of information through the Internet. Thus, ICT becomes a tool, which enables teachers to incorporate a *student-focused* approach in the classroom. Adherence to the *teacher-focused* approach will minimize the benefits of ICT in the classroom because the teacher remains as the primary source of information.

Assessing the success of new programs is difficult. New programs may show extraordinary promise in the short term as people are excited about their implementation and expectations for success are high - the Hawthorne effect - or may experience disappointing results as teachers grapple with unfamiliar materials and processes (Fullan, 1992). The population in the Chang study received national recognition as a model for educational reform in the United States and was recognized by former President Clinton as a school system to be emulated by everyone else. Contextual factors such as higher expectations and efforts to increase parental involvement contribute to higher outcomes on standardized tests. Therefore, when measuring educational outcomes related to ICT, the teaching/learning environment may affect the results in a positive or negative way. As Becker (2000b) observed in a national study in the United States, the adoption of ICT in the classroom requires a fundamental shift in curriculum and pedagogy before technology can be successfully adopted and administered in schools. Schools must provide adequate access to ICT, teachers must learn how to use technology as a teaching tool, and students must learn to become lifelong or independent learners. Scardamalia and Bereiter (1999) argue that schools will have to change from service organizations to learning organizations as the qualities of a learning organization are more conducive to the needs of people living in the new economy and Pelgrum and Anderson (1999) aptly indicate society is currently emerging from the Industrial Age and into the Information Age; thus, we expect these changes in pedagogy will not happen quickly but over a longer period of time.

Given the level of commitment from governments throughout the world to implement ICT in education, and the positive direction of research that indicates ICT contributes to increased educational outcomes, along with the suggestion that using ICT will help students develop important skills in the use of technology, it is perhaps more prudent at this early stage to consider the issue of equity. There is sufficient evidence that ICT will contribute to improved educational outcomes some day, and therefore, to meet the goal of equity in education, it is important to examine the pervasiveness of ICT among Canadian students.

A considerable amount of research has been conducted on the division between those who have access to ICT and those who do not, and it is clear that the diffusion of ICT in society has not been equitable. Indeed, other studies conducted internationally have confirmed these findings throughout the world. Rodges (1983) posits that people who are innovative and quick to adopt new technology tend to be younger, better educated, and earn higher incomes than those who are later- or non-adopters of new technology, and this has certainly been the situation with the adoption of ICT. Studies monitoring the digital divide indicate, however, the divide between those who have access and those who do not have access is diminishing. Recent information from the United States indicates that there are no longer inequities in the number of males and females accessing the Internet, and also marks a decrease in the divide between ethnic groups. There are also some indications that the divide between socio-economic groups is shrinking but this remains the most serious concern.

In Canada, national averages for accessing the Internet from home vary by thirty percent from the highest to the lowest income cohorts. Adults with incomes of less than $20,000 per year report nearly sixty-five percent of their access to the Internet is through work or other public access sites, including access at school (Reddick, Boucher & Grosseilliers, 2000). Since there are about 1.4 million Canadian students living in poverty (Canadian Education Statistics Council, 2000), we would expect that a substantial number of K-12 students do not have access to the Internet from their home. The relationships among family socioeconomic status, access to educational resources, and equity in educational outcomes is an important policy issue that permeates many different policy sectors in Canada.

Due to several factors, students in low socio-economic households have less access to ICT from home. The primary policy response to this in Canada has been to provide access to Internet connected computers at school and other public access sites. While this is a positive step towards improving students' access to ICT, it is clear that the amount of access children have at school is not enough. The majority of computers in schools – two thirds – are located in computer labs and libraries in Canadian schools and only about five percent of teachers have adopted computers for inquiry based learning (Laferriere, 1999; SchoolNet, 2000). Moreover, a recent study by Tsikalas, Gross and Stock (2002) found over 75% of students used computers most at home, strengthening the case that bringing ICT to bear on improving students' skills and knowledge will require increased access at home.

Regarding the direct influence of home computers, the evidence is similar to that of the school based studies. Attwell and Battle (1999) examined the relationship between having a home computer and school performance, for a sample of approximately 64,300 students from the National Longitudinal study of 1988 in the United States. Their findings suggest students, who have access to a computer at home, for educational purposes, demonstrate improved scores in reading and math scores. However, the authors clearly warn that much of this effect is due to family background. Only 28% of the sample had access to a computer at home in 1988 and most of the students who had access were from wealthier families, with parents who had higher than average educations. The authors concluded that there was an effect associated with possessing a computer but this effect was equivalent to other forms of cultural enrichment. Advances in technology, the use of computers and the development of the Internet over the past decade and an increase in prevalence of computers in the home are expected to raise the importance of ICT in relation to educational outcomes, yet there is currently no definitive evidence to support this notion with regard to standardized test scores.

Having access to and using ICT is expected to increase educational outcomes and assist in developing technical skills required to successfully compete in the labour market in the future (Symons, 1997); therefore, equitable access to ICT at school and at home presents itself as an important aspect of child development. Students in Canada who do not have access to ICT at school and at home are "at risk" of falling behind. Therefore, it is important for policy makers and educators to understand the pervasiveness of ICT at school and at home, and to identify groups of students who are at risk of falling behind due to inadequate access to ICT. A number of studies have shown that the average socioeconomic status of a student's school has an effect on students' achievement, over and above the effects associated with students' family background (see Frempong & Willms, 2002, Willms, 2001, 2002a for reviews). This effect, referred to as a contextual effect, or "double jeopardy" (Willms, 2002b), was evident in every country that participated in the PISA, and associated with an inequitable distribution of school resources (OECD, 2001). Educational indicators in Canada demonstrate substantial variation in student-to-Internet connected computer ratios across Canada, with national averages that range from a high of 15:1 for elementary schools in Nova Scotia to a low of 5:1 for secondary schools in Manitoba. (Canadian Education Statistics Council, 2000). Research on the digital divide in Canada also indicates that adults in low socio-economic families rely more heavily on access to computers at work, school and other public locations, suggesting that they do not have access to ICT at home (Reddick, Boucher & Grosseilliers, 2000). Children living in these families will be disadvantaged in a school system that relies heavily on ICT for communications with teachers and classmates, information gathering on the Internet and the completion of homework duties.

International assessments of educational achievement conducted by the IEA and the OECD over the past twenty years have consistently shown a strong relationship between the "number of books in the home" and students' academic achievement. In low-income countries, this factor remains as one of the most important variables predicting academic achievement and explaining inequities among socio-economic groups (Willms & Somers, 2001). We maintain that "access to the Internet at school and at home" will become an equally important variable for high-income countries over the next two decades, as educational systems fully incorporate ICT into curriculum and pedagogy. For teachers it will be the primary medium to disseminate information, manage communications, provide structure to courses and homework, and provide feedback to students. For students, it will change their disposition towards learning; that is, it will change their worldview about access to information and communication with others. If Canada is to remain among the world leaders in education, it is not enough to achieve universal access in the schools; the goal must be to achieve universal access at home as well. This paper will help us discern how close we are as a nation to achieving this goal, and to assess the extent of inequalities in home access among provinces, between the sexes and among socio-economic groups.

## Data and Methods

This study used 2000 baseline data from the Programme of International Student Assessment (PISA; OECD, 2001). PISA is a survey of the knowledge and skills of 15-year old children and is conducted every three years. Thirty-two countries participated in the 2000 survey, and eight more countries have since participated. The primary aim of PISA is to assess the extent to which students have acquired the knowledge and skills essential for full participation in society when they are near the end of their compulsory schooling. The survey involves extensive testing of students' performance in reading, mathematics, and science, and the administration of a questionnaire, which asks several questions about factors affecting their learning at home and at school.

In most countries the sample comprised about 5000 students sampled from 150 to 250 schools. In Canada, a sufficiently large sample was drawn within each province to enable provincial comparisons and within-province analyses. Thus, the sample for Canada was considerably larger, including 29,687 students from 1117 schools. The data include a design weight to account for the sampling design and bias due to non-response.

Our analyses use information drawn from the main student questionnaire, particularly the demographic items, and a question pertaining to educational possessions in the home, and the Computer Familiarity Questionnaire. We constructed two dichotomous indicators denoting whether students had a computer at home, and if so, whether they had access to the Internet. In the first set of analyses we simply compared countries and provinces in the percentage of students who had access to a computer at home and access to the Internet. For a select group of countries[1] – Canada, Australia, Finland, Japan, and the United States – we also compared the percentage of students who had other educationally-related possessions at home, including software, a calculator, their own desk, and a quiet place to study. Our analyses also use a measure of students' family socio-economic status (SES), which was developed to describe socio-economic gradients in the PISA study (Willlms, 2001). SES is a statistical composite of parental education, parental occupation, cultural possessions in the home, educational possessions in the home, and wealth. SES was standardised to have a mean of zero and a standard deviation of one for all OECD countries. For the first analysis, we also created a dichotomous variable denoting low SES, which is coded 1 for students who had SES scores that were more than one standard deviation below the OECD mean on the SES scale.

The second set of analyses used logistic regression to assess the relationship of ICT access to a number of factors describing students' sex and family background. In the first of these analyses we conducted separate regressions for "computer at home" and "Internet access" on the separate factors describing sex and family background. We then fitted a simpler model, which regressed these outcome variables on only sex and the summary SES measure[2] to provide a summary of the important relationships.

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[1] We chose Australia because it is quite similar to Canada in socio-economic status, Finland because it ranked first in reading performance, Japan because it ranked first in mathematics, and the United States because of its geographic proximity to Canada.

[2] The SES composite includes educational possessions in the home as one of its components, and therefore to some extent positively biases the estimates. However, this bias is very small, as having a computer at home and Internet access are only two items among several items comprising the educational possessions factor, and educational possessions is one of five factors comprising the composite.

The third set of analyses pertained to the frequency with which students' used computers at home and at school, and how they used computers. We estimated the frequency of use at home and at school and found that most students used computers nearly every day or a few times each week. We therefore constructed two more dichotomous variables, which indicated frequent use (nearly every day or a few times each week versus 1-4 times per month or less), and estimated logistic regression models comparable to those estimated in the first set of analyses. Finally, we examined the frequency of various computer-related activities reported by students who had indicated they used a computer at least once a month.

## Results

### Student Access to ICT

Table 1 provides comparisons among five countries in student access to ICT. In 2000, 88% of 15-year old students had access to a computer at home, which is comparable to the percentage in Australia (91%), and higher than in Finland (82%), Japan (67%), and the United States (83%). However, only 69% of Canadian students had access to the Internet at home. This is comparable to students in Australia (67%) and the United States (69%), and considerably higher than students in Finland (54%) and Japan (38%). The possession of software varies similarly across the five countries. However, the possession of other educational possessions shows considerably less variation; for example, nearly all students have their own desk and a quiet place to study, and about 70% possess a musical instrument. Japan is an exception, as 80% of 15-year olds possessed a musical instrument. We would expect Canada to fare well in these comparisons, because only 8% of its students were in low SES families, which is similar to Australia, but considerably lower than the other three countries.

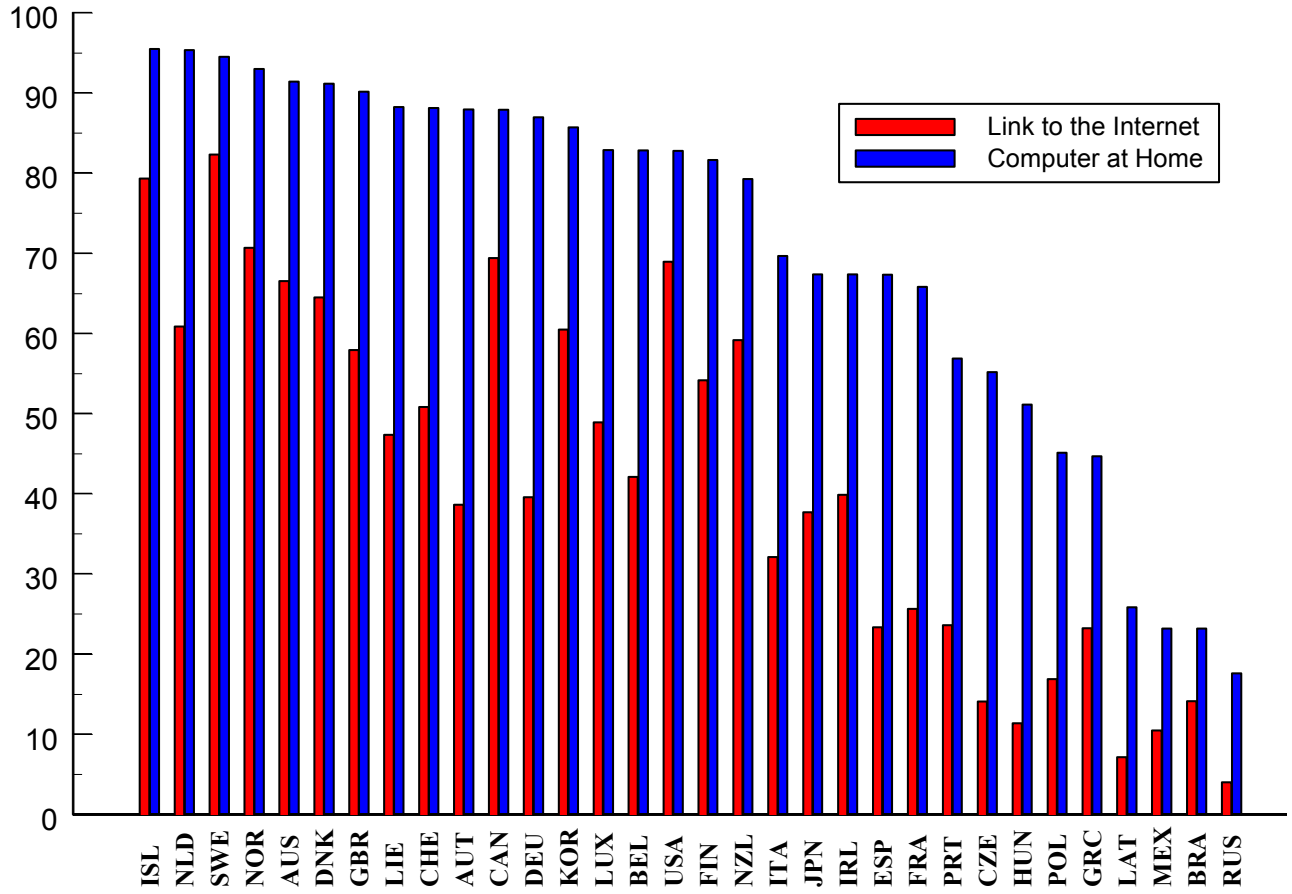
Table 1

| Possessions | Canada | Australia | Finland | Japan | United States |
|---|---|---|---|---|---|
| Computer | 88 | 91 | 82 | 67 | 83 |
| Link to the Internet | 69 | 67 | 54 | 38 | 69 |
| Software | 77 | 80 | 51 | 16 | 76 |
| Calculator | 99 | 99 | 99 | 99 | 98 |
| Quiet Place to Study | 94 | 90 | 93 | 82 | 91 |
| Own Desk | 85 | 90 | 95 | 96 | 78 |
| Musical Instrument | 72 | 70 | 70 | 80 | 67 |
| (percent Low SES) | (8) | (8) | (12) | (13) | (14) |

**Educationally-related possessions of youth in Canada and in four selected countries (Percent of 15-year Olds). Programme of International Student Assessment 2000.**

Figure 1 displays the percentage of students who had access to ICT across the 32 countries participating in the study. The countries are ordered by the percentage of students with computers at home. Canada lags behind several other countries in achieving universal access to computers at home - ranking 11th among 32 countries. Two countries – Iceland and Netherlands – have already achieved near universal access. However, Canada is relatively advanced with regard to Internet access: only 2 countries – Iceland and Sweden – exceeded Canadian students' connectivity at home, with Norway and United States reporting similar levels of Internet access.

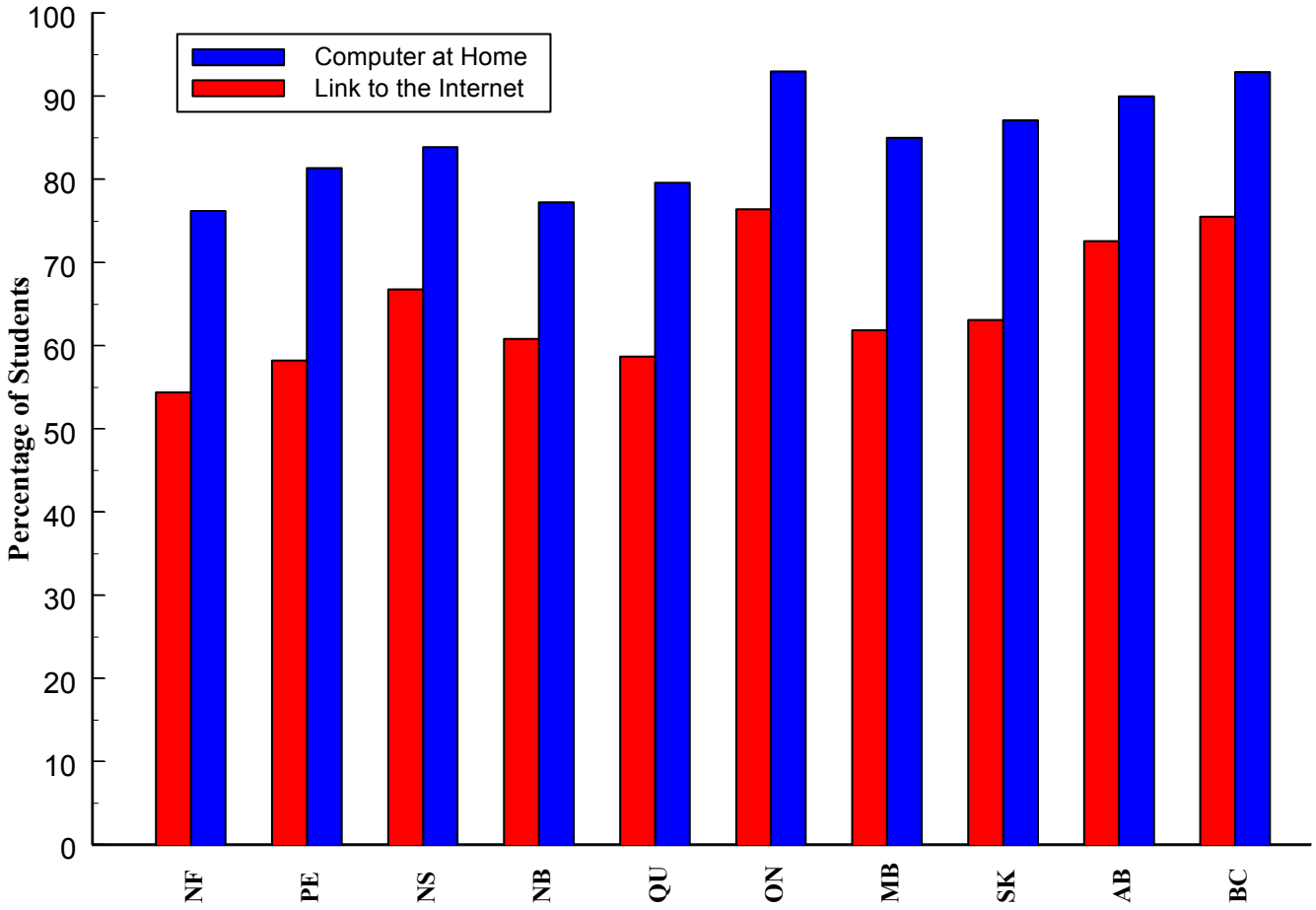
*Figure 1.*




**The percentage of 15-year old youth with a computer at home and access to the Internet, for countries participating in the OECD 2000 PISA.**

Figure 2 presents a similar comparison for the ten provinces. It shows that there are regional disparities in access to ICT. In Ontario and British Columbia nearly 95% of students had access to computers at home, while the average was lower amongst the Prairie Provinces, and lower still – about 80% – in Quebec and the Atlantic Provinces. Similar regional disparities were evident for access to the Internet. Ontario also had the highest percentage of students with access: over 75% of students in Ontario reported a link to the Internet in their home. In contrast, only about 60% of students in Quebec and the Atlantic provinces had access to the Internet at home.

*Figure 2.*




**The percentage of 15-year old youth with a computer at home and access to the Internet, for Canadian provinces, based on the OECD 2000 PISA.**

The results pertaining to inequalities in access between males and females, and along socio-economic lines are presented in Table 2 and Figure 3. All of the odds-ratios reported were statistically significant at a 0.05 level of significance.

The findings reveal that females are less likely to have a computer at home – the odds ratio is 0.85, indicating that the odds of a female having a computer is 15% less than that of males. The gender difference for Internet access is of similar proportion.

Students who were from families whose parents had more prestigious occupations and had higher levels of education were more likely to have had a computer at home and access to the Internet. For each additional year of parents' education the likelihood of having a computer at home increased by 18% and the likelihood of having a link to the Internet increased by 15%. An increase of one-point on the PISA scale describing occupational status (which for OECD countries ranged from 16 to 90, with a standard deviation of 16.3) was associated with an increase in odds of about 3 to 4 percent.

Table 2

| Predictor | Computer | Internet Link |
|---|---|---|
| Sex (Female = 1) | .85 | .87 |
| Parents' Occupation | 1.04 | 1.03 |
| Parents' Education (years) | 1.18 | 1.15 |
| Single Parent | .40 | .54 |
| Other Parent | .33 | .44 |
| Number of Siblings | .95 | .93 |
| Immigrant | 1.50 | 1.77 |

**Relationship between having a computer and a link to the Internet at home with sex and family background (odds-ratios). Programme of International Student Assessment 2000.**

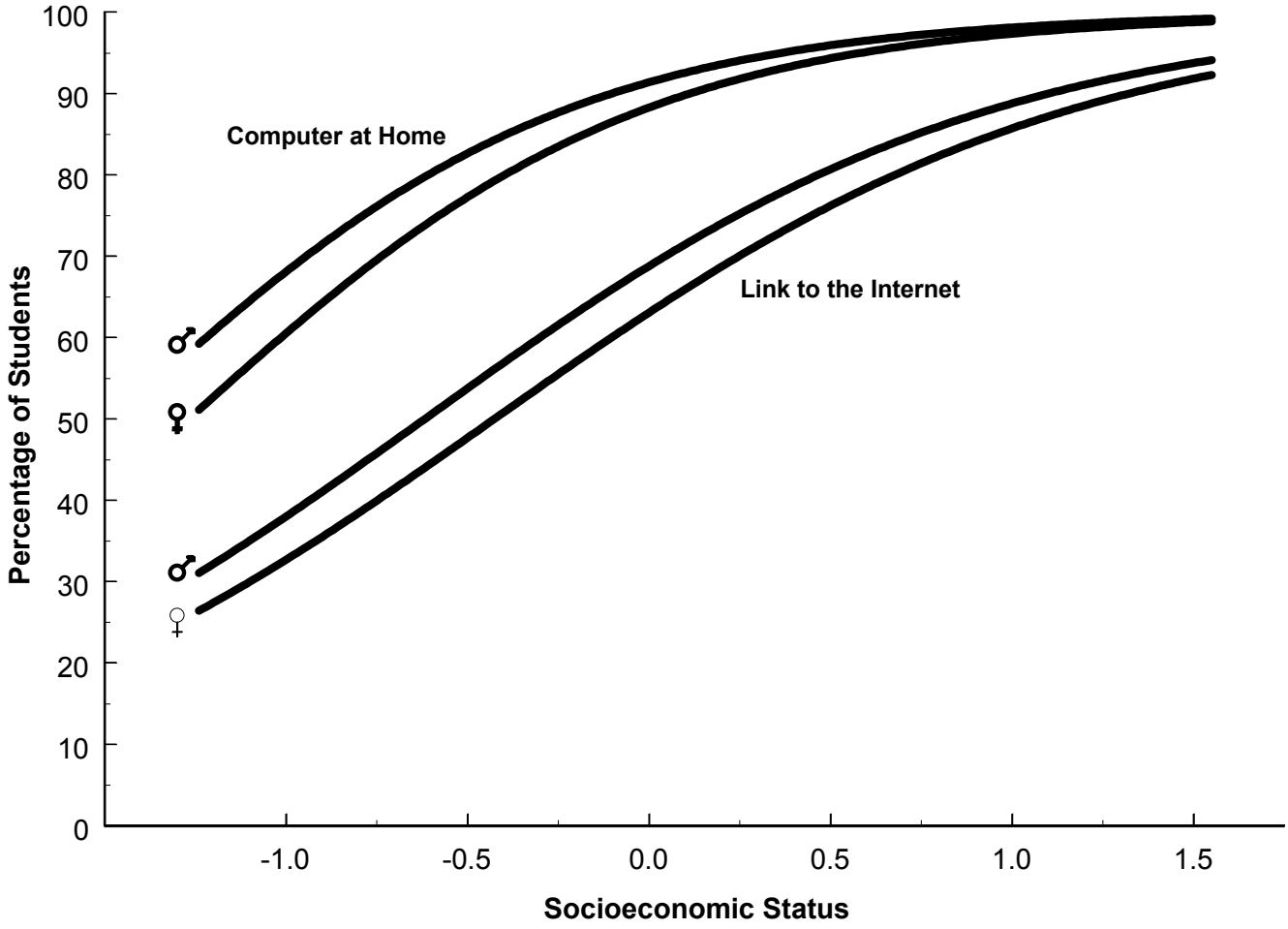
*Note. All odds-ratios are statistically significant at $p < 0.05$.*

Children living in single-parent families, or families headed by non-parent guardians, were much less likely to have a computer at home or Internet access. This effect is very large: the odds of a youth possessing a computer in a single-parent family was only about 40% of that of a youth in a two-parent family, and only about 33% for children in non-parent guardian families. The odds of these children having a link to the Internet are also poor, only about one-half that of children in two-parent families. The number of children in the family also influences ICT access: for each additional sibling the likelihood of possessing a computer decreases by 5%, and the likelihood of Internet access decreases by about 7%.

Immigrants are advantaged with respect to possessing a computer and having a link to the Internet. This effect is also very large as the odds of possessing a computer are 50% higher for students who have immigrated to Canada, and the odds of possessing a link to the Internet are 77% higher.

The analyses in Table 2 show that ICT access is related to both gender and socio-economic status. Figure 3 provides a summary of this "digital divide", using the OECD measure of SES. The figure demonstrates two important findings: First, there is a positive relationship between socio-economic status and the percentage of students who possess a computer and have a link to the Internet. Possession of a computer and having a link to the Internet are nearly universal among all students of high socio-economic status.

*Figure 3.*




**The likelihood of a 15-year old Canadian students having access to the Internet, by sex and socioeconomic status. (OECD 2000 PISA).**

A second important observation is the convergence of the gradients, for both males and females and for computer use and Internet access, as socio-economic status increases. The percentage of students possessing a computer and having a link to the Internet, for both female and male students of low socio-economic status, differs by approximately 10%. In contrast, there is practically no difference in computer possession and linkage to the Internet, between the sexes, for students of high socio-economic status.

**Students' Use of ICT**

The PISA survey asked students how often they used a computer at home and at school. The frequencies of responses are presented in Table 3. The results for at-home use indicate that over 80% of students use computers almost every day, and only 12% never use computers (which is consistent with the findings pertaining to access presented in Table 1). This is a simple but important finding, as it indicates that those with computers use them regularly. The distribution of responses for use at school is less skewed, with only about one-half of students using computers nearly every day, and about three-quarters using them at least a few times each week.

Table 3

| | Percent |
|---|---|
| **Frequency of Use at Home** | |
| Almost every day | 81.2 |
| A few times each week | 3.7 |
| Between once a week and once a month | 1.4 |
| Less than once a month | 1.2 |
| Never | 12.4 |
| **Frequency of Use at School** | |
| Almost every day | 52.0 |
| A few times each week | 24.3 |
| Between once a week and once a month | 11.6 |
| Less than once a month | 7.3 |
| Never | 4.9 |

**Students' Use of Computers at Home and at School (percentage).**
**Programme of International Student Assessment 2000.**

Table 4 provides the results of the logistic regression results, using similar models to those presented in Table 2. The findings are interesting, as they suggest that the opportunity to use computers at school enables many students to use computers when they do not have them at home. For example, females were about 12% less likely to use computers at home compared with males, whereas they were about 7% more likely to use them at school. Parents' occupation and parents' education were positively related to computer use at home, with odds-ratios similar to those pertaining to access (see Table 2). However, these factors were not strongly related to use at school, indicating that the socioeconomic gradient is flatter. The same trend is apparent with respect to family structure: living in a single-parent family, or in a family with parents other than the child's natural parents, or having a large number of brothers and sisters, were risk factors for infrequent computer use at home; however, the relationship with single- or other-parent family was weaker (odds ratios of about 0.85 compared with 0.45), and the effect associated with having more siblings was in the opposite direction. Similarly, while immigrants were more likely to use computers at home than non-immigrants, they were less likely to use them at school.

Table 4

| Predictor | Use at Home | Use at School |
|---|---|---|
| Sex (Female = 1) | .88 | 1.07 |
| Parents' Occupation | 1.04 | 1.01 |
| Parents' Education (years) | 1.16 | 1.06 |
| Single Parent | .45 | .87 |
| Other Parent | .44 | (.85) |
| Number of Siblings | .94 | 1.05 |
| Immigrant | 1.50 | .83 |

**Relationship between home and school use of computers with sex and family background (odds-ratios). Programme of International Student Assessment 2000.**

*Note. All odds-ratios are statistically significant at $p < 0.05$, with the exception of the odds-ratio for other parent for use at school.*

In assessing the frequency with which students used computers for various activities, we report only the frequency for use "every day', and for "almost every day" combined with "a few times each week", as we consider regular use of at least a few times each week is necessary to have any meaningful impact on their academic skills. The results are presented in Table 5, ordered by the frequency of use of at least a few times each week. The most frequent use of computers is for accessing information on the Internet, electronic communication, word processing, and playing computer games. Only about one-third of all students reported using computers to help them learn school material, and less than one-fifth regularly used educational software. About one-quarter of all students reported using a computer for programming; drawing, painting, or graphics; or analysing data with spreadsheets.

Table 5

| Activity | almost every day | at least a few times each week |
|---|---|---|
| Internet | 46 | 71 |
| Electronic communication (e.g., email or chat rooms) | 38 | 60 |
| Word processing (e.g., Word of Word Perfect) | 17 | 52 |
| Games | 21 | 48 |
| To help learn school material | 10 | 32 |
| Programming | 11 | 27 |
| Drawing, painting or graphics | 9 | 27 |
| Spreadsheets (e.g., Lotus 1-2-3, Excel) | 6 | 21 |
| Educational Software | 5 | 18 |

**Frequency of computer-related activities for students who use computers (percentage). Programme of International Student Assessment 2000.**

## Discussion and Policy Implications

All students at Acadia University in Nova Scotia receive a lop-top computer when they enter their first year of under-graduate studies. This presents many opportunities for professors and students to develop a radically different kind of educational experience. Course lectures and assignments are provided electronically, and professors can interact frequently with students via email. Also, students can collaborate in electronic discussion groups, and share materials electronically. Using ICT also enables professors to teach in different ways, as there is a common set of tools that can be used by all students. We would like to consider the question, "What if all Canadian students had a computer at home and access to the Internet when they entered secondary school at age 13 or 14?"

The results from this study indicate that Canada is close to achieving universal access to ICT at home – nearly 9 out of every 10 youth have a computer at home, and 7 out of 10 have access to the Internet. Moreover, there is a mechanism in place whereby government funds could be targeted to low-income families. For example, the federal and provincial governments could offer a direct tax rebate of up to $1,000 to cover the cost of a computer for families with children of a certain age – age 12, for example. Like other benefits of this nature, the amount of the reimbursement would depend on family income. Corporations could also participate in this intervention by offering computers at cost for children entering secondary school, and schools could provide dial-up access to their students. As a cost saving measure, Internet service providers could offer access to secondary school students for four years at a greatly reduced cost. This would not be unreasonably costly.

For example, consider New Brunswick, which has approximately 9,000 students entering secondary school each year. If this reform were targeted towards families at the bottom one-quarter of the income distribution (about 75% of NB 15-year old students currently have computers), this would cost the federal and provincial governments about $3 million, or about 0.4% of the 2001/02 projected budget for education. The telephone company in New Brunswick, NBTel, is already recognized as a world leader in providing services for schools to contact parents through a phone network (McKenna & Willms, 1998), and has become the province's major Internet-service provider. It could also be called upon to provide Internet services for secondary school students at substantially reduced rates.

Our findings indicate that while secondary school students regularly use computers to obtain information from the Internet, and to communicate with others, their main school-related activity is word processing. Almost as many students used computers as much for playing games as for word-processing, and less than one-third used computers to help them learn school material. These findings suggest that access to computers and costs are not the major barrier. A far greater challenge will be for educators to modify pedagogy and classroom practice to take advantage of ICT, and induce students to use computers in ways that contribute to their learning.

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