Articles

Information and communication technology: Access and use

Introduction

Students' use of technology in education is expected to improve educational outcomes, increase technological skills, and decrease inequities between groups (Pelgrum and Anderson 1999; Industry Canada 1997). Students' use of technology is considered an important indicator of their preparedness to succeed and excel. This study uses data from the Programme for International Student Assessment (PISA) 2000 to examine Canadian students' access to and use of information and communication technologies (ICT). The PISA survey was conducted in 32 countries to assess, in the literacy domains of reading, mathematics and science, the skills of 15-year-old students at or near the end of their compulsory education. The survey gathered data regarding students' possession of ICT at home and access at school. The results for Canadian students in general are compared with the results of students from each province and from other countries in the Organisation for Economic Co-operation and Development (OECD).

The new economy has intensified competition among nations, and rapid technological advances require a skilled work force to cope with constant changes in the workplace as well as in day-to-day living. Adults require higher skill levels as society becomes more complex, low-skill jobs decrease and literacy requirements increase dramatically. To meet these and other challenges, elementary and secondary schools have a central role in laying a solid foundation on which subsequent knowledge and skills can be built (HRDC, CMEC and Statistics Canada 2001).

The system of education in Canada strives to develop high levels of academic achievement and to attain equity in educational outcomes between the sexes and across socio-economic groups. Measuring achievement has become an important goal of many OECD countries and is seen as a way to assess students' readiness to meet future challenges. Through PISA, participating countries are able to gauge their own level of accomplishments and compare their results with other participating countries (Hirsh 2002). These assessments also provide a means of examining inequities in educational achievement and access to learning resources (e.g., OECD 2001, Chapter 8).

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Policy makers in Canada expect that the introduction of ICT in schools will improve academic performance, equity among students and, ultimately, students' ability to use and apply technology and software in their jobs. Co-ordinated federal policies and programs provide access to ICT in every school and every community in Canada. For example, the SchoolNet program was responsible for connecting every school in Canada to the Internet and is now aiming to ensure that every classroom is connected; Computers for Schools channels recycled computers, donated from government and corporations, into schools in low-income areas; and Community Access Programs provide public access to the Internet on evenings and weekends.

The diffusion of many new technologies in society has not been equitable. Rogers (1983) theorized that people who are innovative and quick to adopt new technology tend to be younger and better educated and to earn higher incomes than later- and non-adopters of technology. However, recent studies suggest that there are no longer differences in the rates of Internet access between the sexes and that the divide between ethnic groups is decreasing. There are also some indications that the gap between socio-economic groups is also narrowing, but the current unequal rates of access for students of lower socio-economic status remain a serious concern (NTIA 2002).

In Canada, access to the Internet from home varies substantially with income. Nearly 65% of adults with incomes of less than $20,000 per year report that their access to the Internet is through work, educational institutions, or public access sites (Reddick, Boucher and Grosseilliers 2000). With about 1.4 million Canadian students living in poverty (CESC 2000), it could be expected that a substantial number of students from kindergarten to Grade 12 do not have access to the Internet from home. The relationships linking family socio-economic status, access to resources and equity in outcomes are an important issue in many of Canada's policy sectors, including education.

Students in low socio-economic households may have less access to ICT from home because of many different factors, ranging from economic issues to a lack of parental interest in technology. The primary policy response to this in Canada has been to provide access to Internet-connected computers in schools and other public access sites. While this is a positive step toward improving students' access to ICT, it is clear that the amount of access time children have at school is insufficient and inconsistent among schools (CESC 2000).

In schools across Canada, tremendous differences exist in the ratio of students to Internet-connected computers: averages range from 15:1 for elementary schools in Nova Scotia to 5:1 for secondary schools in Manitoba (CESC 2000). Two-thirds of the computers in Canadian schools are located in computer labs and libraries, and only about 5% of teachers have adopted computers for inquiry-based learning (Laferrière, 1999; SchoolNet 2000). Moreover, Tsikalas, Gross and Stock (2002) found that over 75% of students use computers most at home, strengthening the case that using ICT to improve on students' skills and knowledge will require increased access at home.

International assessments of educational achievement conducted by the International Association for the Evaluation of Education Achievement (IEA) and the OECD over the past 20 years have consistently shown a strong relationship between the number of books in the home and students' academic achievement. As educational systems fully incorporate ICT into curriculum and pedagogy over the next two decades, access to the Internet at school and at home may become as important a variable for high-income countries as the number of books in the home.

Data and methods

This study used 2000 baseline data from the Programme of International Student Assessment (PISA), a school-based survey that assesses the knowledge and skills of 15-year-olds (OECD 2001). Thirty-two countries participated in the 2000 survey; eight more have since participated. The primary aim of PISA is to assess the extent to which students who are near the end of their compulsory schooling have acquired the knowledge and skills essential for full participation in society. The survey extensively tests students' performance in reading, mathematics and science; it also administers a questionnaire that examines home and school factors affecting learning.

In most countries, a sample of about 5,000 students from 150 to 250 schools was surveyed. In Canada, a larger sample was drawn (29,687 students from 1,117 schools) to enable interprovincial comparisons and within-province analyses. The sample weight includes a correction for non-response.

In this study, we drew on information from PISA's main student questionnaire, particularly from the demographic items, the questions pertaining to educational possessions in the home, and the Computer Familiarity Questionnaire. We compared the percentage of Canadian students who had home access to a computer and to the Internet with the same statistics for other countries and for individual provinces. For a select group of countries—Canada, Australia, Finland, Japan and the United States[1]—we made comparisons based on the percentage of students who had other possessions at home that were considered to be educational: these included software, a calculator, their own desk and a quiet place to study. As a measure of students' family socio-economic status (SES), the analysis used a statistical composite[2] of parental education, parental occupation, cultural possessions in the home, educational possessions in the home, and wealth. Using the same procedures as in the first international report for PISA (OECD 2001), we standardized SES to have a mean of 0 and a standard deviation of 1 for all OECD countries.

We used logistic regression to assess the relationship of ICT access to a number of factors describing students' background. We computed separate regressions for 'computer at home' and 'link to the Internet' for the different factors describing students' background. We then fitted a simpler model to provide a summary of the important relationships.

Finally, we examined how students used computers—and how often they used them—at home and at school.

Findings

Student access to ICT

In 2000, 88% of 15-year-old Canadian students had access to a computer at home, compared with 91% in Australia, 83% in the United States, 82% in Finland and 67% in Japan (Table 1). However, Internet use is less prevalent: only 69% of Canadian students had access to the Internet at home. Still, this is comparable with Australia (67%) and the United States (69%) and considerably higher than Finland (54%) and Japan (38%). While possession of software varied similarly across the five countries, other educational possessions showed considerably less variation. Nearly all 15-year-old students in these five countries had their own desk and a quiet place to study, and about 70% had a musical instrument—Japan was the exception, with 80% of its students owning an instrument. We expected that Canada would fare well in these comparisons, as only 8% of all Canadian students in this sample came from families with a low SES—a rate similar to Australia's but considerably lower than those of the other three countries.

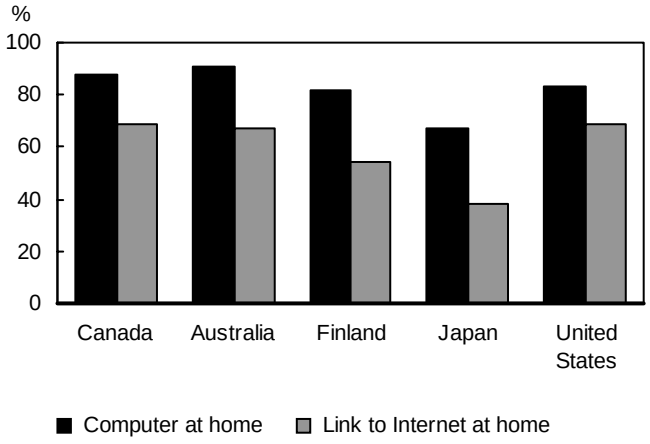
Table 1
Education-related possessions of 15-year-olds, by country

Possessions	Canada	Australia	Finland	Japan	United States
	% of 15-year-olds				
Computer at home	88	91	82	67	83
Link to Internet at home	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
Low family SES	8	8	12	13	14

Source: *OECD, Programme of International Student Assessment, 2000.*

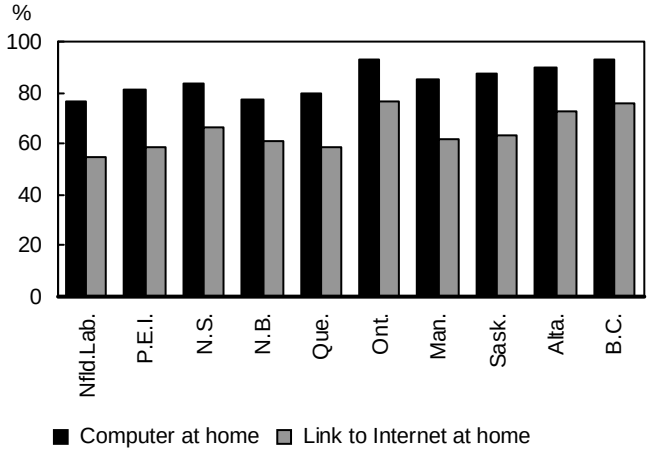
Graph 1 depicts the proportion of students with home computers and home Internet access for the 32 countries participating in PISA. For access to computers in the home, Canada ranked 11th. However, with regard to Internet access, only Iceland and Sweden exceeded Canadian students' connectivity at home, with Norway and the United States reporting similar levels of Internet access.

Graph 1
Percentage of 15-year-olds with a computer and a link to the Internet at home, by country



Source: *OECD, Programme of International Student Assessment, 2000.*

Graph 2
Percentage of Canadian 15-year-olds with a computer and a link to the Internet at home, by province



Source: *OECD, Programme of International Student Assessment, 2000.*

In Canada, regional disparities exist in the rates of access to ICT (Graph 2). Nearly 95% of students in Ontario and British Columbia had access to computers at home; the average was lower (85% to 90%) among the Prairie provinces, and lower still (about 80%) in Quebec and the Atlantic provinces. Similar regional disparities were evident for Internet access: Ontario again had the highest percentage, with over 75% of its students reporting a link to the Internet in their home. In contrast, only about 60% of students in Quebec and the Atlantic provinces had home access to the Internet.

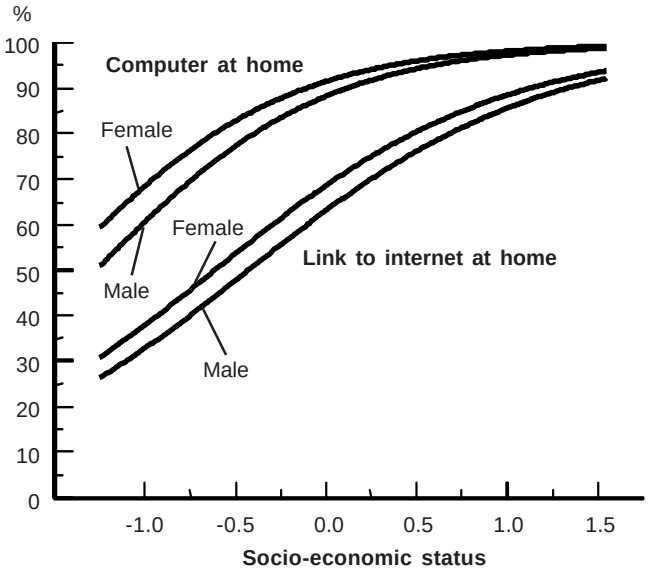
Table 2 and Graph 3 present the findings pertaining to inequality of home access to computers and the Internet by sex and along socio-economic lines. All odds ratios reported were statistically significant at the 0.05 level. The findings reveal that girls are less likely to have a computer at home: the odds ratio of 0.85 indicates that the odds of a girl having a computer are 15% less than the odds of a boy having one. The difference between the sexes for Internet access is of a similar proportion.

Table 2
Likelihood of Canadian 15-year-olds of having a computer and a link to the Internet at home

Predictor	Computer	Link to the Internet
	odds ratio	
Sex (male = 1)	0.85	0.87
Parents' occupation	1.04	1.03
Parents' education (years)	1.18	1.15
Single parent	0.4	0.54
Other parent	0.33	0.44
Number of siblings	0.95	0.93
Recent immigrant	1.5	1.77

Note: *All odds ratios are statistically significant at $p < 0.05$.*
Source: *OECD, Programme of International Student Assessment, 2000.*

Graph 3
Canadian 15-year-olds with a computer and a link to the Internet at home, by sex and socio-economic status



Source: *OECD, Programme of International Student Assessment, 2000.*

Students whose parents had more prestigious occupations and higher levels of education were more likely to have access to both a computer and the Internet at home. For each additional year of parents' education, the likelihood of having a computer at home increased by 18% and of having a link to the Internet by 15%.

Children living in lone-parent families or families headed by non-parent guardians were much less likely to have a computer at home or Internet access. These differences were considerable: the odds of a child in a lone-parent family owning a computer were only 40% those of a child in a two-parent family, while the odds for a child in a non-parent guardian family were 33%. The odds of both these groups of children having a link to the Internet at home were only about one-half those of children in two-parent families.

The number of children in a family also influenced ICT access: for each additional sibling, the likelihood of possessing a computer decreased by 5%, and the likelihood of Internet access decreased by about 7%.

The odds of possessing a computer were 50% higher for students who had recently immigrated to Canada, and the odds of having a home link to the Internet were 77% higher.

Graph 3 shows a positive relationship between SES and the percentage of students who possessed a computer and a link to the Internet. Having a home computer and a link to the Internet were nearly universal among students with high SES.

Among students with low SES, the percentages of girls and boys with a home computer and a link to the Internet differed by approximately 10%. In contrast, there was practically no difference between the sexes among students with high SES.

Students' use of ICT

The PISA survey asked students how often they used a computer at home and at school. Table 3 indicates that those with home computers used them regularly: over 50% of students used them almost every day and more than 20% used them a few times each week, while only 13% never used them. (This is consistent with the findings pertaining to access in Table 1.) With respect to school computers, roughly one-fifth of students used them nearly every day, with about 40% using them at least a few times each week.

Table 3
Frequency of Canadian 15-year-olds' use of computers at home and at school

Frequency of use	% of 15-year-olds
At home:	
Almost every day	51.6
A few times each week	21.3
Between once a week and once a month	9.6
Less than once a month	4.2
Never	13.3
At school:	
Almost every day	18.1
A few times each week	21.2
Between once a week and once a month	22.9
Less than once a month	22.2
Never	15.6

Source: *OECD, Programme of International Student Assessment, 2000.*

The availability of computers at school enables many students to use them even though they may not have a computer at home (Table 4). For example, students in lone-parent families were 40% less likely than students in two-parent families to use computers at home, whereas both groups were equally likely to use them at school. Similarly, students with siblings were less likely than students without any siblings to use a computer at home (odds ratio of 0.92), whereas the opposite was true with respect to computer use at school (odds ratio of 1.06). Immigrants were more likely than non-immigrants to use computers at home, but the differences were not as pronounced for their use at school.

Parents' occupation and parents' education were positively related to computer use at home, with odds ratios similar to those pertaining to access in Table 2. However, these parental factors were not strongly related to school computer use, also indicating that the availability of computers at school increases use for many students. With respect to family structure, the same trend is apparent for those living in a lone-parent family, living in a family headed by a non-parent guardian, or having a large number of brothers and sisters. However, the availability of computers at school does not seem to have much effect on the differences in use between the sexes: girls were less likely than boys to use computers both at home and at school.

Table 4
Likelihood of Canadian 15-year-olds using a computer at home and at school

Predictor	Use at home	Use at school
	odds ratio	
Sex (male = 1)	0.68	0.64
Parents' occupation	1.02	0.998
Parents' education (years)	1.12	1.01
Single parent	0.6	0.98
Other parent	0.56	1.52
Number of siblings	0.92	1.06
Recent immigrant	1.70	1.37

Note: *All odds ratios are statistically significant at $p < 0.05$, with the exception of the odds ratio for 'Use at school' with 'Parents' Education' and 'Single parent.'*
Source: *OECD, Programme of International Student Assessment, 2000.*

In assessing the frequency with which students used computers for various activities, we estimated the percentage of students who used the computer almost every day and at least a few times each week (Table 5). We did not consider less frequent use because it was unlikely to have a meaningful impact on students' academic skills. Students most frequently used computers for accessing information on the Internet, communicating electronically, doing 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 doing programming, drawing, painting or graphics, or for analysing data with spreadsheets.

Table 5
Frequency of computer-related activities for Canadian 15-year-olds who use computers

Activity	Almost every day	At least a few times each week
	%	
Internet	46	71
Electronic communication (e.g., e-mail or chat rooms)	38	60
Word processing (e.g., MS Word or WordPerfect)	17	52
Games	21	48
Learning 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

Source: *OECD, Programme of International Student Assessment, 2000.*

Summary and discussion

Rapid growth and improvement in information and communication technologies (ICT) 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 examines the extent to which students have access to computers and the Internet, whether that access is related to sex or socio-economic status, and how those who have access to computers 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 Canadian students have a computer at home, and those with home computers used them regularly: over 50% of students used them almost every day and more than 20% used them a few times each week, while only 13% never used them. However, students from families with low socio-economic status were less likely to have access to computers and the Internet at home. On average, girls were also less likely than boys to have access to computers and the Internet at home, but the disparities

between the sexes were negligible for students in families with high socio-economic status. Students reported that they used computers mainly for accessing information on the Internet, communicating, doing word processing, and playing games. Less than one-third of students who used computers reported using them for learning purposes. The conclusions drawn from this study suggest that universal home access to computers and the Internet is within reach and is essential if computers are to become a learning tool aimed at improving students' skills.

The results of this study indicate that Canada is close to achieving universal access to ICT at home—nearly 9 out of every 10 young Canadians have a computer at home, and 7 out of 10 have home access to the Internet.

The 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 for playing games as for word processing, and less than one-third used computers to help them learn school material. Further research is required to investigate the contribution of ICT to educational outcomes and the importance of ICT skills in the new economy. EQR

Notes

1. The countries were selected for the following reasons: Australia, because it is quite similar to Canada in its 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 and Internet access at home are only two of several items that the educational possessions factor comprises, and having educational possessions is only one of five factors that contribute to the composite.

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