CANADIAN COUNCIL ON LEARNING CCL CCA CONSEIL CANADIEN SUR L'APPRENTISSAGE

LESSONS IN LEARNING

Gender differences in career choices: Why girls don't like science

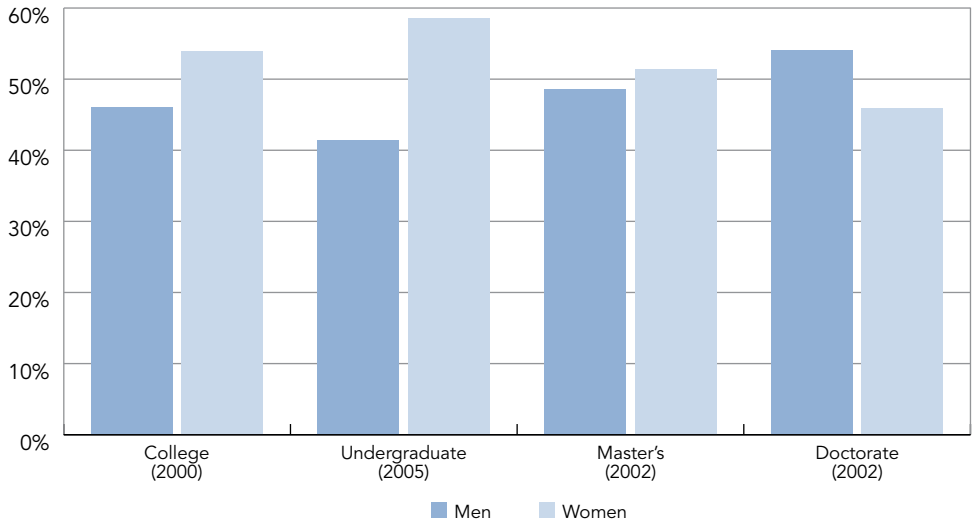
November 1, 2007

Growing numbers of Canadian women are successfully pursuing post-secondary studies, but there still exists a large gender gap in science-related occupations and a gender-based wage gap. A number of factors, including parental attitudes, social pressures, and girls' perceptions of and experiences with science turn girls and women away from science and engineering. A number of programs have been developed to foster interest in science among girls.

Women in post-secondary education

Educational attainment among Canadian women has risen rapidly over the past few decades. In 1971, only 3% of Canadian women held a university degree.[1] By contrast, 15% of women had a university degree in 2001 and women currently outnumber men at most levels of post-secondary education (see Figure 1). However, women remain sharply under-represented in some fields of study, particularly mathematics, physical sciences, engineering and applied sciences. This is true at all levels of post-secondary education, including college, undergraduate and graduate levels of study (see Figure 2). In contrast, women are over-represented in other fields of study, including education and health sciences (see Figure 3).

Figure 1:
Gender distribution of post-secondary students

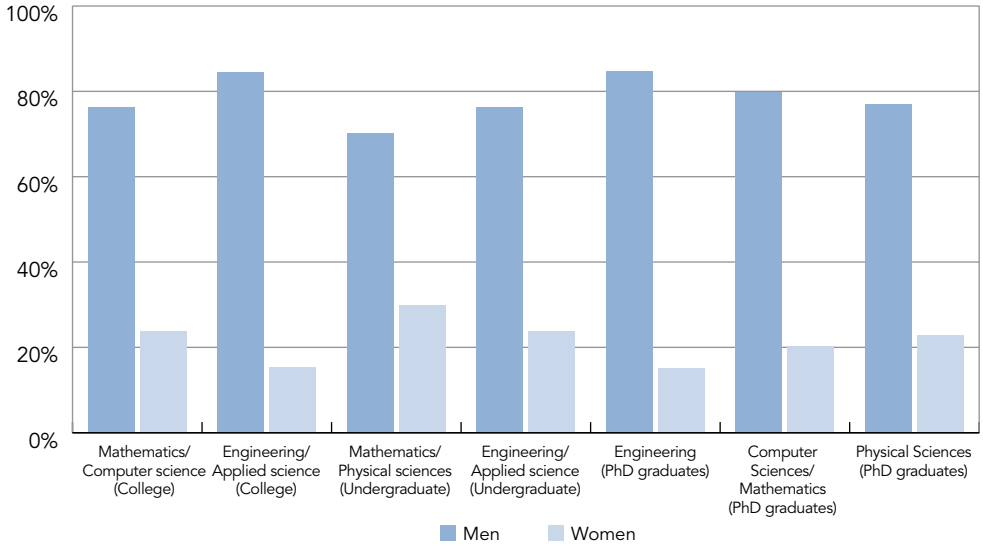


Source: Statistics Canada (2006): Women in Canada. Catalogue no. 89-503-XIE; Statistics Canada (2006): *University Enrolment*. The Daily, November 7, 2006.

Women in the labour force

The dearth of women in scientific fields of study is reflected by a similar under-representation of women in science and engineering occupations. Over the past three decades, women in Canada have joined the labour force in ever-increasing numbers: as of 2006, women accounted for 47% of all workers in Canada. Over the same period, women have accounted for a steadily increasing proportion of workers in health care and social assistance and educational services, but the relative proportion of women in professional, scientific and technical services has declined (compared to the overall proportion of women in the labour force; see Figure 4).

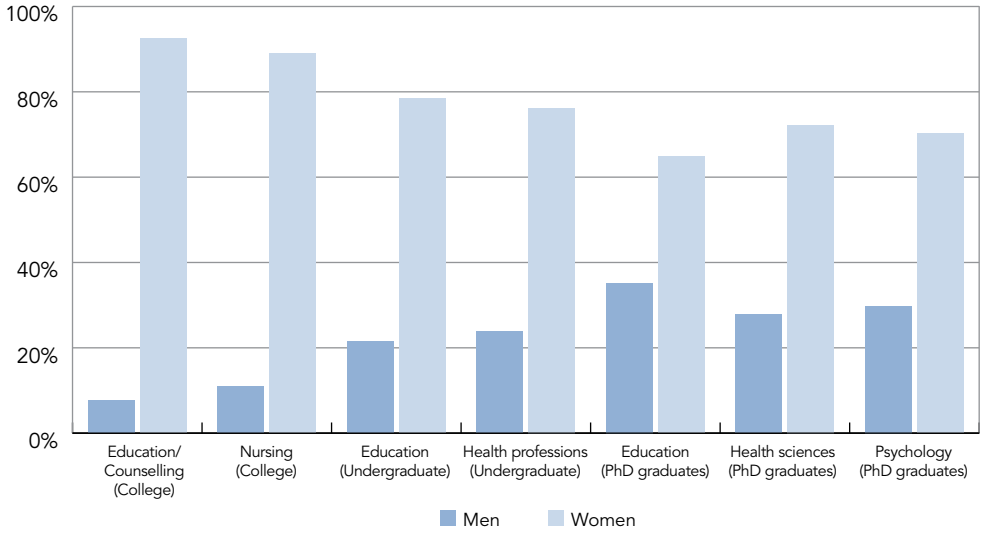
Figure 2:
Gender distribution of post-secondary students in science & engineering fields



Source: Statistics Canada (2006). Women in Canada. Catalogue no. 89-503-XIE; Statistics Canada (2005). *Survey of Earned Doctorates*. Catelogue no. 81-595-MIE2005032

The under-representation of women in science and engineering contributes to a gender-based wage gap. In recent years, real wages have declined in female-dominated disciplines such as health and education while real wages have increased in male-dominated disciplines such as engineering, mathematics, computer science and physical sciences. For example, the occupations most commonly held by young women with university degrees are elementary and kindergarten teachers.[2] Between 1995 and 2000, average earnings for women in these occupations increased by less than 1%. In contrast, earnings for young men in computer and information systems (the most commonly held occupations among young university-educated men) increased by 15% (see Table 1).

Figure 3:
Gender distribution of post-secondary students in education and health fields

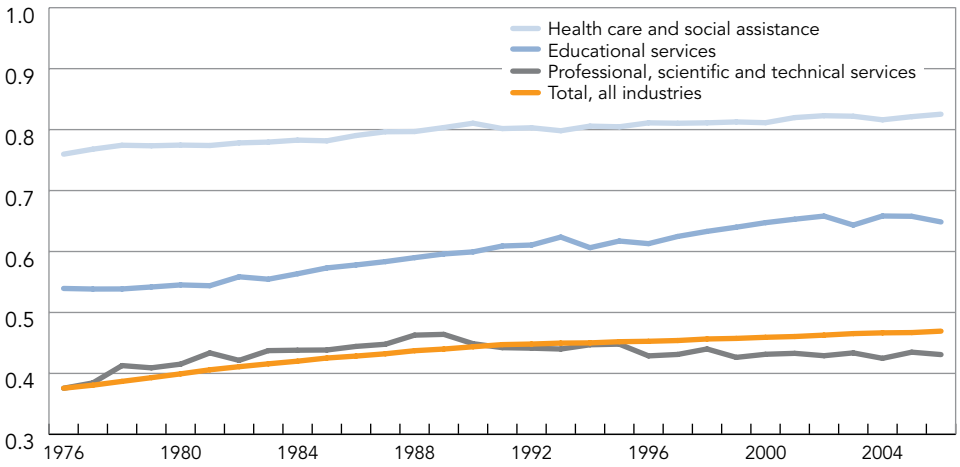


Source: Statistics Canada (2006). Women in Canada. Catalogue no. 89-503-XIE; Statistics Canada (2005). *Survey of Earned Doctorates*. Catalogue no. 81-595-MIE2005032

Although young women are now significantly more likely than young men to pursue post-secondary studies, young women have made little progress in closing the wage gap. In 1991, 21% of young women and 16% of young men (aged 25 to 29) held university degrees, and young women earned 20% less than young men. By 2001, 34% of young women held university degrees, compared to 21% of young men. Nonetheless, young women still earned 18% less than young men.

Given that young women in Canada clearly see the value of a post-secondary education, what keeps them from pursuing studies in science and engineering?

Figure 4:
Proportion of the labour force accounted for by women



Source: Statistics Canada, Labour Force Survey Historical Review

What keeps women from pursuing careers in science?

Research investigating gender differences in science aptitude suggests that boys and girls have similar levels of ability. For instance, secondary analyses of the findings of hundreds of studies examining boys' and girls' cognitive abilities reveal that, overall, boys and girls have similar abilities in complex problem solving, a skill considered highly relevant for science and engineering. In fact, no gender difference in aptitude was found between elementary and middle-school boys and girls.[3] These findings suggest that cultural or environmental factors, rather than biological ones, affect girls' interests and career choices.

Table 1:
Average earnings in occupations most commonly held by men and women aged 25 to 29 with a university degree (in constant 2000 dollars)

	Average Earnings Men			Average Earnings Women		
	1995	2000	% change	1995	2000	% change
Elementary schools and kindergarten teachers (most commonly held by women)	$ 48,827	$ 46,413	-4.9%	$ 39,965	$ 40,018	0.1%
Computer and information systems (most commonly held by men)	$ 48,178	$ 54,953	14.1%	$ 41,530	$ 45,120	8.6%

Source: Statistics Canada, censuses of population, 1901 - 2006

Parental attitudes, beliefs and perceptions

Parents may inadvertently influence girls' lack of interest in science by responding differently to sons and daughters. Although boys and girls are equally likely to ask science questions, parents are more likely to explain scientific concepts to sons than to daughters, and this is true of both mothers and fathers.[4] Research also shows that a child's gender influences parental use of science-related teaching language. Fathers in particular tend to use more cognitively-demanding language during science activities (e.g., explaining causes, asking conceptual questions, using scientific vocabulary) with sons than with daughters.[5]

Parental use of teaching language has been shown to increase children's conceptual understanding in the domain of science. Tenenbaum and Leaper speculate that if parents are using less cognitively-demanding language with their daughters, girls may be exposed to fewer opportunities to practice scientific problem solving.[6] As a result, girls may be less likely to develop self-confidence or interest in science.

Parents (especially mothers) encourage boys more than girls to participate in out-of-school science activities, such as playing with a chemistry set or a microscope. Science materials (e.g., books, games, or toys) are purchased more often for boys than for girls.[7]

Parents of daughters are more likely to believe that their child is not interested in science or that science is difficult for their child than parents of sons.[8,9]

Research has demonstrated that parental perceptions, beliefs, and attitudes in turn influence their children's development and interests, and this relationship is particularly strong with respect to mothers. Tenenbaum and Leaper's research revealed that the more difficult that mothers believed science to be for their children, the lower the children's self-efficacy and interest. Likewise, the more interested mothers believed their children to be in science, the higher the children's self-efficacy and interest.[10]

Girls' perceptions, interests and experiences with science

By the time they reach adolescence, girls and boys report having different experiences with science-related activities. Boys report experiences such as making catapults, changing a car battery, playing with electric toys, or using a microscope; girls report experiences such as making bread or pastries, watching a bird make its nest, observing the stars, or planting seeds. When asked about their interests, boys prefer learning about planes, cars, atom bombs, nuclear power plants, or electricity; girls prefer learning about rainbows, healthy eating, animal communication, or AIDS.[11]

More girls than boys consider science to be a difficult subject.[12] One suggested reason for this is that at some point during the middle-school years, girls start to lose confidence in their abilities to learn science.[13] In a recent investigation of boys' and girls' perceptions of physics, girls reported poorer self-concept of their abilities than did boys, even though girls' grades did not differ significantly from the boys' in this subject. Girls perceived physics to be a typically masculine subject, and girls whose favourite subject is physics were perceived as more masculine than feminine. Both girls and boys held negative stereotypes (e.g., unattractive) of girls who like or do well in science. Girls perceived boys to dislike girls who excel in physics, and girls with very good grades in physics considered themselves to be particularly unpopular with boys.[14]

Do early experiences with science affect girls' scientific literacy and career choices?

Gender-based differences in parental attitudes and practices and in experiences with and perceptions of science may contribute to enhanced scientific literacy skills among boys relative to girls that are reflected in later performance differences between boys and girls. For example, although girls often outperform boys in school science courses, boys tend to perform better than girls in the School Achievement Indicators Programme (SAIP) science assessment.

The SAIP science test is designed to assess scientific literacy, "an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them."[15] Scientific literacy is not about having the knowledge and skills of an experienced scientist. It is about being able to understand science as it applies to everyday situations. For example, we do not need to know how to engineer foods genetically, but we do need to understand the health consequences of eating genetically engineered foods in order to decide whether or not to buy these foods or to be able to engage in intelligent discussions with friends or colleagues about genetically engineered foods.

One possible reason for the inconsistency in performance between girls' school science grades and their SAIP performance might be that girls' experiences with science-related activities and with less cognitively-demanding science language impedes the development of "scientific thinking" as well as their confidence in science.[16,17] This in turn may discourage girls from pursuing studies and careers in science and engineering.

A report recently issued by the Canadian Council on Learning, entitled *Who Likes Science and Why? Individual, Family and Teacher Effects*[18] investigated the relationship between students' science achievement as assessed by the SAIP and their attitudes toward science, such as whether science was interesting and useful to society and whether a career or further study in science was planned.

Gender was found to be a determining factor in planning for a science-related career. Although female students held more positive attitudes toward science than males, more boys than girls intended to use science in further studies or careers.

What is the SAIP?

The Student Achievement Indicators Program (SAIP) is a program of assessments in science, math, reading, and writing conducted with 13- and 16-year old students across the country. The assessment used in this report concerns the SAIP Science III Assessment conducted in 2004.

The SAIP is administered by the Council of Ministers of Education, Canada and is designed to assess program delivery in order to assist governments and policy makers in making decisions about science programs offered and resources allocated for schools.

Lessons in learning

If cultural and environmental factors, rather than biological predispositions, account for the gender gap in science, then young girls' disengagement with science can be prevented and their natural interests fostered. Parents can take a number of steps to foster their daughters' interest in science. As well, a number of programs have been developed to encourage girls to pursue studies and careers in science and engineering.

Suggestions for parents

Encourage girls' interests in science

Parental encouragement is positively correlated to children's participation in science activities.[19] Encouragement can take many forms. For instance:

- Parents can encourage their daughters' interest in science by asking about the day's science class at school or in the childcare setting. By discussing their children's science lessons, parents show their approval of the children's interests.
- If a child shows interest in learning more about a particular subject, parents can show encouragement by making plans to go to the library or to visit a relevant website for more information.

- Parents of high-school girls can encourage them to take science courses. If the child is hesitant or lacks confidence in the subject, parents can offer to provide a tutor.
- Parents can provide opportunities for daughters to meet women scientists and hear about their career paths.

Engage in science-related activities

Co-activity (especially mother-child co-activity) is positively related to children's participation in science activities.[20] Joint activities between parents and daughters expose children to more opportunities to hear cognitively demanding language, in turn fostering more developed scientific thinking. Here are a few suggestions:

- Parents can give their daughters early science experiences, such as visiting a local science museum.
- Parents can take advantage of the attractiveness of television for young viewers by watching a science-related program with their children.
- Parents can also take advantage of visitor tours offered by some manufacturing and engineering plants to expose their children to the applications of science in such settings.

Provide science-related games, toys and books

Children's participation in science activities is positively related to the provision of science materials in the home.[21]

- Parents can provide girls, as well as boys, with chemistry sets and microscopes.
- Parents can capitalize on girls' interest in reading by encouraging them to read science-related books. Studies show that although parents encourage girls to read, they do not typically encourage the reading of science books.[22]
- The internet provides hundreds of sites where kids and parents can learn about various science subjects or play science-related games (see below for a sampling of links).

Programs for girls in science

Sisters in Science Program

The Sisters in Science Program is an after-school intervention implemented and tested in a Philadelphia school district (Hammrich, 1997).[23] The objective was to give girls experiences in cooperative, exploratory, and hands-on science (and mathematics) activities. In addition to active involvement with science, the girls participated in self-reflection and discussions promoting female role models, demystifying science, and career choices. Fourth-grade girls participated in 20 weekly 90-minute after-school activities, ranging from developing a community environmental awareness campaign, conducting surveys of the school's and neighbourhood's recycling programs, testing for levels of pollution in their school

and homes, identifying pollutants found in garbage, air, or water, and creating an environmental newsletter for distribution to the school. The reflection and discussion activities were designed to help the girls better understand their personal learning, challenge stereotypical notions about science, and develop better thinking skills. At the end of the intervention, pre- and post-tests showed positive changes in the girls' interests, attitudes, and awareness of science and the possibility of pursuing a science career.

Girls in Science

For three years, the San Diego Zoo has been running an after-school Girls in Science mentoring program for girls between 12 and 14 years of age (McLaughlin, 2005).[24] For part of the program, the girls visit the zoo where they can see the zoo's operations from behind the scenes, meet with female scientists who talk to the girls about their careers and interests in science, and speak with various field researchers, behaviourists, geneticists, veterinarians, and zookeepers. The girls get to try out the scientists' equipment and learn its significance. Following each scientist's presentation, the girls are asked to review the concepts they learned as well as examine the scientists' careers and how they might fit into their future. The program ends with an overnight camping trip to the desert or the mountains where the girls meet more female scientists who introduce them to careers outside of the zoo. On these occasions, the girls get to participate in hands-on activities such as tracking endangered species and learn about environmental and conservation issues.

Alberta Science Literacy Association

Although not geared specifically to girls, the Alberta Science Literacy Association is a program that links scientists from industry, government, and post-secondary institutions to students and communities across Alberta. The scientists address scientific disciplines from aeronautical engineering to zoology and use hands-on activities, show and tell, questions and answers, and discussions to deliver their message.

Canadian Association for Girls in Science (CAGIS)

CAGIS is geared towards girls aged 7 to16 who meet regularly to explore science, technology, engineering, and mathematics with women (and men) who have chosen careers in these fields. The girls are given opportunities to talk about school, careers, and other issues that concern them when they think about their futures. Since 1995, CAGIS has a number of chapters across Canada, with new chapters in development. Chapter events are held on weekends or after school and last about 1 to 2 hours. They usually take place at the workplace of the scientist and consist of a mini presentation introducing a science, technology, engineering, or mathematics concept, followed by hands-on activities to consolidate the learning and make science fun.

Les filles et les sciences : un duo électrisant!

Les filles is an annual event devoted to showcasing science careers to girls aged 13 to 15. The girls participate in scientific workshops organized by women working in science and engineering fields. The project was developed by École Polytechnique's Marianne Mareschal Chair and is supported by over a dozen industrial partners and provincial government ministries.

While they are unlikely to erode the gender gap completely in science-related occupations or its attendant wage gap, parenting practices hold promise of increasing girls' interest in the pursuit of scientific study and employment. Further reductions in both the participation and wage gaps are likely when such practices are complemented by opportunities such as those provided by the Alberta Science Literacy Association and the Canadian Association for Girls in Science.

Online science sites for kids

www.awsn.com/girls.htm

dmoz.org/Kids_and_Teens/School_Time/Science

www.sallyrideclub.com/member_home.do

pbskids.org/zoom/activities/sci

www.nationalgeographic.com/kids/activities

www.wonderville.ca

school.familyeducation.com/science/parenting/33587.html?imode=1:375&wtlAC=ScienceSkills_Google,web-Google

www.cmec.ca/pcap/science3/pt/indexe.stm

www.cmec.ca/pcap/science3/links.en.stm

www.space.gc.ca/asc/eng/kidspace/kidspace.asp

www.onfjeunesse.ca/lamission/home_e.php

In French

www.lesdebrouillards.qc.ca/applicationWeb/pages/publique

mars.bw.qc.ca

References

1 Lindsay, C. & Almey, M. (2006). Education. In Women in Canada: A gender-based statistical report (5th ed.). Statistics Canada Catalogue no. 0010589-503-XIE.

2 Statistics Canada (2003). *Earnings of Canadians: Making a Living in the New Economy*, 2001 Census. Catalogue no. 96F0030XIE2001013

3 Hyde, S.J. & Linn, M.C. (2006). Gender similarities in mathematics and science. Science, 314, 599-600.

4 Crowley, K., Callanan, M.A., Tenenbaum, H.R., & Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. Psychological Science, 12, 258-261.

5 Tenenbaum, H.R. & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequities? Developmental Psychology, 39, 34-47.

6 Tenenbaum, H.R. & Leaper, C. (2003).

7 Simpkins, S.D., Davis-Kean, P.E., & Eccles, J.S. (2005). Parents' socializing behaviour and children's participation in math, science, and computer out-of-school activities. Applied Developmental Science, 9, 14-30.

8 Ford, D.J., Brickhouse, N.W., Lottero-Perdue, P., & Kittleson, J. (2006). Elementary girls' science reading at home and school. Science Education, 90, 270-288.

9 Tenenbaum, H.R., & Leaper, C. (2003).

10 Tenenbaum, H.R., & Leaper, C. (2003).

11 Jones, M.G., Howe, A., Rua, M.J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. Science Education, 84, 180-192.

12 Adamuti-Trache, M. (2006). Who likes science and why? Individual, family, and teacher effects. Canadian Council on Learning.

13 Dreves, C. & Jovanovic, J. (1998). Male dominance in the classroom: Does it explain the gender difference in young adolescents' science ability perceptions? Applied Developmental Science, 2, 90-98.

14 Kessels, U. (2005). Fitting into the stereotype: How gender-stereotyped perceptions of prototypic peers relate to liking for school subjects. European Journal of Psychology of Education, 20, 309-323.

15 Council of Ministers of Education, Canada (2005).

16 Crowley, K., Callanan, M.A., Tenenbaum, H.R., & Allen, E. (2001).

17 Tenenbaum, H.R., & Leaper, C. (2003).

18 Adamuti-Trache, M. (2006).

19 Simpkins, S.D., Davis-Kean, P.E., & Eccles, J.S. (2005).

20 Simpkins, S.D., Davis-Kean, P.E., & Eccles, J.S. (2005).

21 Simpkins, S.D., Davis-Kean, P.E., & Eccles, J.S. (2005).

22 Ford, D.J., Brickhouse, N.W., Lottero-Perdue, P., & Kittleson, J. (2006).

23 Hammrich, P.L. (1997). Confronting the gender gap in science and mathematics: The Sisters in Science Program. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching.

24 McLaughlin, R. (2005). Girls in science. Science Scope, 28, 14-15.