Attracting Females into ICT in Canada

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Abstract

Estimates have put the proportion of women in ICT at about 25% of total employment in that sector. Meanwhile, the proportion of women in other traditionally male-dominated fields such as medicine and law are set to become dominated by females if current trends continue. Given the current and projected shortages of ICT professionals, women represent a reasonably large yet untapped pool of talent for this sector. This research discusses the theoretical and empirical factors behind this underrepresentation of women in ICT as well as policies and best practices that could encourage women to enter these ICT professions. The conclusion is that ICT appears to have an “image problem” and industry and educators need to do more to accurately represent ICT to young people before they make education and occupation decisions. In short, the perception of ICT “culture” needs to be changed.

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I. Introduction

As of January 2013, about 25% employees in core Information and Communications Technology (ICT) occupations were women, a proportion which has not changed since 2000 (ICTC, 2009, 2013). This has been over a period when the number of young women at universities has surpassed the number of young men, and where the proportion of women in almost every field – including the sciences – has increased. We agree with a recent report by the Canadian Advanced Technology Alliance – Women in Technology (CATA-WIT, 2010) which says "an existing and underutilized human resource is Canada's women."

The situation is very similar in other countries. Speaking about the situation in the US, Gose (2013) notes: "The lack of interest among women in computer science is nothing new—government agencies, universities, and technology companies have plowed tens of millions of dollars into trying to raise the numbers for almost a decade, to little effect."

Why are so few women involved in ICT despite the fact that their presence has grown dramatically in other professions, even those once considered male bastions? There have been remarkable increases in the proportion of women becoming educated and working in traditional male-dominated fields such as medicine, law, and the pure and applied sciences. Even engineering is attracting more women. Is something happening – or not happening – in ICT that is preventing an equally dramatic increase in the participation of women, both in ICT education and in industry?

Although there is an increasing body of literature that focuses on the ICT sector specifically, much of what follows draws on the experiences and lessons from the literature that addresses the attraction, retention and mobilization of highly skilled labour, especially those in the STEM (science, technology, engineering and mathematics) fields, of which ICT can be considered a subfield.

The paper is organized as follows: the next section gives a brief profile of women in the ICT sector in both post-secondary education (PSE) as well as those employed in the industry. The third section discusses the various reasons put forward to explain low female participation. The next section discusses some of the ideas and programs that have been attempted to try to increase the proportion of women in ICT. The final section concludes and lays out what may be the most promising ideas and initiatives.

II. Women in the ICT Industry and Education

According to Industry Canada (2012) the ICT sector accounted for 3.2% of total employment in Canada in 2011, accounting for 555,978 jobs. These are distributed in the four main sub-sectors as follows: computer and software services (51%), communications services (21%), ICT manufacturing (15%) and ICT wholesaling (13%). In 2001, 45.8% of ICT workers held a university degree, much higher than the national average of 26.0%. They also earned more than the average Canadian worker in 2011: $67,911 versus $45,488. Still women represent fewer than one-quarter of all workers in ICT occupations (Industry Canada, 2010).

This is not a uniquely Canadian phenomenon, rather this underrepresentation of females in ICT education and careers is observed in a number of post-industrialized countries, and this is [ironically] happening as overall female participation in post-secondary education and the labour force is increasing (Lasen 2010). In the US, for example, Gose (2012) discusses the general decline in the number of females earning degrees in computer science degrees between 1985 and 2011. The numbers fell by almost 50% from 14,431 to 7,306, while the overall number of degrees awarded stayed flat at more than 39,000.

Data for Canada show a similar decline. Andres and Adamuti-Trache (2007) demonstrate that between the 1980-1 and 2003-04 academic years, the proportion of women enrolled in full-time undergraduate programs increased in all but three fields of study. One notable exception was computer science where the proportion of women decreased from 27% to 18%, compared to a general increase in the proportion of women from 46% to 58% of all undergraduates. In the sciences, the proportion of women increased from 40 to 48%, and more than doubled from 10% to 21% in engineering and applied sciences.[1] Internationally the trend has been the same. Anderson, et al. (2008:1305) cites a number of previous studies in noting: ". . . when female participation in other science and engineering areas has been growing consistently across industrialized countries, the trend has been the opposite in ICT subjects and careers, and the trend is widespread."

The question is: why has the ICT sector, both in terms of the proportion of female graduates and employees, been so stagnant while females have increased their representation in education and employment in almost every other field?

[1] The only other two subfields where the proportion of women fell were nursing (97% to 92%) and rehabilitation medicine (89% to 85%). Both of these declines were less than the one-third decline in computer science.

III. Reasons for Low Participation of Women

There have been several reasons advanced as to why the proportion of women directly involved in ICT is so low. These range from the way young females are socialized, to misinformation about what ICT careers entail, to innate differences in ability, to outright discrimination and hostility against females in the ICT workplace. Trying to catalogue these explanations is a difficult exercise since many overlap

There seems to be little doubt that the ICT sector suffers from an image problem. Jan Cuny, program director, National Science Foundation's Computing Education for the 21st Century, sums up this issue nicely (Cutler, 2012):

> The gender gap in computer science is partly rooted in long-held popular misconceptions: the computing is too hard for girls, that it's geeky, that it requires a singleminded 24/7 focus, and – maybe worst of all – that computer science equals programming and so provides little benefit to society. Why would this picture be attractive to girls – especially to girls who want to be creative, to make a difference, to change the world?

Cuny goes on to say that these misperceptions are often confirmed by the girls' peers, the popular media , the lack of role models to counter the stereotypes, and even advice from parents and guidance counsellors. Girls may find themselves uncomfortable in a male-dominated climate. More generally, Mangan (2013) discusses the image issue of the STEM fields in general. She cites a National Academies report from 2012 which said that the key to recruiting is "creating a culture where it's cool to be smart."

Using a survey of Australian high school students, Anderson, et al. (2008) identify two factors which are seemingly associated with aversion towards studying ICT subjects: the perception that these subjects were boring, and a strong aversion to computers. Indeed, the later point seems to be supported by Tømte and Hatlevik (2011) who study the link between self-efficacy (defined as how one perceives their own ability to solve a task) in ICT and use of ICT for both educational and leisure activity among 15-year olds in Norway and Finland. While the authors do not address causality, using the 2006 PISA results, they do find a strong positive correlation between self-efficacy and ICT use, but a stronger positive result for young men than young women. Furthermore, males in both countries tend to score higher on the self-efficacy metric than females. These results may suggest that exposure to technology at a young age may increase familiarity with technology and increase self-efficacy and (perhaps) the willingness to choose a career in ICT. Given this association, it still may be difficult to get young girls to use computers and technology if their perceptions are inflexible.

Although ICT may have an image problem, there may be larger obstacles to address. Changing the image of ICT may be relatively simple compared to changing the preferences of a large number of young women. Williams and Ceci (2012) note that surveys have documented that females (starting at a young age) are more interested in careers that involved living things – medicine, biology and psychology, for example – than fields such as computer science, mathematics, physics and engineering. Indeed, the Canadian data at the university level provided by Andres and Adamuti-Trache (2007) support this, with enrollments of females in full-time undergraduate university programs which involve "living things" up markedly between 1980-81 and 2003-04. For example, the proportion of women in veterinary medicine increased to 80% from 47%, and zoology to 71% from 38%. At the same time, as noted above, the proportion in computer science dropped from 27% to 18%.

Williams and Ceci (2012:144), discuss why more women are not found in certain sciences. While their focus is on academia, their comments reflect was has been said elsewhere:

> Women are not found in greater numbers in some fields, particularly math-intensive ones, due to a combination of factors. The two most significant reasons are that women are more likely than men to prefer other fields (such as medicine, biology, law and veterinary science, rather than mechanical and electrical engineering, computer science and physics), even when they have comparable mathematical ability, and that family-formation goals extinguish tenure-track aspirations in women more often than in men."

The same authors dismiss the other two usual explanations for the dearth of women in math-intensive fields: ability differences and sex discrimination but reject both as meaningful explanations.

Indeed the evidence does seem to support the assertion that abilities of young men and women are similar, thus casting doubt on ability differences as a reason for the gender imbalance in ICT. For example, Hill, et al. (2010) study the US data and argue that girls and boys leave high school equally prepared to pursue careers in STEM, but few girls actually major in these disciplines. That many girls are performing well on standardized math tests suggests that cultural factors, rather than innate abilities, may be at work. It is the negative stereotype of young girls' ability in math and science that can lower their aspirations to pursue the STEM fields. Girls also tend to internalize these stereotypes in underestimating their abilities and hold themselves to higher standards, again leading to less interesting in pursuing these fields. The authors also discuss problems with biases against women in math and the sciences, where people often hold negative opinions of women in these fields. Similar, Ceci and Williams (2011) also cast doubt on ability differences as a reason for the dearth of women in math-related fields. They do acknowledge that differences do exist (i.e., more men score at the very top of standardized tests such as the GRE-Q or the SAT-M, but these differences don't explain the wide gap in participation rates between men and women. (Although these results could (arguably) explain differences at the very top levels of some STEM professions.)

For Canada, standardized test results paint a strikingly similar picture: that young Canadians of either gender have similar abilities. Results for the 2009 mathematics and science PISA scores show that females at the age of 15 performed only slightly below males of the same age (12 points and 5 points, respectively). Given that the mean male score on these two tests was 533 for math and 531 for science, these are small (albeit statistically significant) differences. Compare this to the reading PISA score where the difference was over 30 points in favour of the girls (Knighton, et al., 2010).

While females enter the STEM fields in PSE at a lower rate than males in Canada, the good news is that they are more likely to persist in these fields and graduate from their programs (Finnie and Childs, 2010). Still, young women access these fields in lower proportions than males and this cannot be explained by lower high school grades or other observable factors. Rather – as suggested by many others – it appears to be a matter of choice. Whether or not these young women continue into ICT or other STEM fields following graduation is not known at this point.

A general lack of interest in ICT as well as changing the perception of ICT may be difficult given the lack of a critical mass of females in ICT who could provide appropriate mentoring to girls in primary, secondary and post-secondary education. Indeed, the lack of female role models – at all levels of schooling and in employment – is often citing as a reason for low female participation in ICT. To wit, a recent report by the Canadian Advance Technology Alliance – Women in Technology (CAT-WIT, 2010) cites the lack of female role models as a barrier to other females entering PSE science and mathematics programs and entering technology fields. The lack of role models could also be important, and indeed could be compounded for female minorities since minorities tend to be underrepresented in ICT professions. Jonecia Keels, a minority-female computer engineering graduate from Columbia University, sums it up nicely: "Bill Gates, Steve Jobs – all the influential people in the field didn't look like me." (cited in Gose, 2012).

Discussion of females in the labour market often brings up the discussion of labour market discrimination. Ceci and Williams (2011:3161) argue that discrimination against women in the sciences is yesterday's problem, but still women are underrepresented in the math-intensive fields, but this is due to sex differences in resources, abilities and choices (whether free or constrained). "In sum, the most salient reasons for women's underrepresentation today are career preferences and fertility/lifestyle choices . . . "

While the evidence of direct discrimination (as is almost always the case) is scant, there are nonetheless reports of women experiencing discomfort in ICT and other STEM occupations. In particular, male domination of the profession and the commensurate stereotypical male attitudes may be keeping women out of the profession and driving away those who do enter. More specifically, the lack of females in the workplace may result in women being excluded from information workplace networks (Cukier, 2007) and, related to this, those who do enter may have a difficult time because there is little female peer support (Cohoon, 2002). The recent report by CATA-WIT (2010) notes that barriers for women may be the result of their own lack of self-promotion, the "old-boys network," etc. Further, the report says that retention of women in these careers is also a problem with attrition rates very high and that this exodus is the result of feeling undervalued and marginalized, hostile macho cultures, isolation, systems of risk and reward that emphasize risk taking, etc. Stated somewhat differently, the "culture" of ICT – whether real or perceived – may be enough to dissuade women from taking a serious interest in the field or exiting prematurely after entry. Hewlett, et al. (2008) provide evidence that female attrition rates in technology are greater than those in both engineering and the sciences. Derived from a series of international surveys, the data show that over 52% of women leave their private sector jobs in science, engineering and technology (SET), a rate considerably higher than that for men. Furthermore, the female exit rate is highest for those in technology (56%), with one-half of those exiting abandoning their SET training altogether.

IV. Policies to Increase the Number of Women

The above review suggests a number of reasons for female underrepresentation in ICT and points to a number of changes that the ICT sector may be able to implement to better attract and retain women.

The first place to start the discussion is with employee compensation. A standard human capital model of profession choice would include a measure of expected earnings. All else equal, we expect individuals to be attracted to professions where the remuneration is highest. However, all else is not equal. It would appear that offering women more attractive salaries is likely to do relatively little to attract them into ICT professions, as they do appear to be less influenced by higher anticipated earnings compared to their male counterparts. Boudarbat (2008) studies field of choice by community college students in Canada and finds that – compared to men – women tend to put less weight on earnings when choosing a field of study. Boudarbat and Montmarquette (2009), find something similar for women and men when choosing university majors: showing that expecting a high income is not an important determinant of majoring in the sciences at university for females while it is for males.

Similarly, Goyette and Mullen (2006) review the US research and argue that future returns to fields of study play a role in a student's choice of major, but that men are more likely than women to enter fields with high earnings or status potential, while women are more likely to select an applied field of study. This basic result is confirmed in the empirical part of their paper where they show that both genders are about equally likely to enter arts and science fields, but that men choose the most remunerative majors within A & S – namely math and science majors.

This suggests that increasing expected salaries in fields such as ICT may not have the desired effect of attracting more women since higher wages may not motivate them to concentrate on the appropriate field of study at either the university or college level. Further, the premium to attract women implies that compensation in general would have to be increased which could cause its own problems.

Policies that may be more effective to achieve the same goal could be offering family friendly work environments in terms of part-time employment, flexible hours, the ability to telecommute, etc. While these work environments are not limited to the ICT sector, the ICT sector may be able to be leaders in offering such environments and be effectively able to compete with other industry sectors for talent. In her report to the Information and Communications Technology Council (ICTC), Cukier (2007) recommends that employers need to provide better supports in the workplace, such as job-sharing, parental leave, flexible work arrangements and on-site daycare, etc. In a phrase: a more family-friendly workplace. Even then, skills in rapidly advancing fields such as ICT may depreciate quickly, meaning that those who desire to take parental leave may feel that they will suffer deskilling (and, in fact may not enter the field in the first place). This suggests that retraining might be an integral part of parental leave.

Google – a company that is considered by many as a model female-friendly workplace – provides an interesting case study. Google has recently utilized its famous algorithm to figure out how to recruit and retain even more women. They discovered that women were less likely to flaunt their achievements, and thus less likely to make it past the initial telephone interview. Female candidates interviewed by male interviewers were also likely to make it past this first hurdle. The company responded by asking interviewers to report candidates' answers in more detail, and is now using more women as interviewers. Google has also lengthened parental leave and increased the pay during this period from partial to full. The results have been higher female recruitment and retention rates. The result is that Google's workforce is about one-third female (Miller, 2012). Part of this success (Hewlett, et al., 2008:60-61) is also due to the fact that " . . . Google hires 'super bright young talent' [from a variety of academic backgrounds] rather than 'narrowly gauged techies.' The company then commits to a great deal of on-the-job-training." This recruitment strategy, in essence, circumvents the problem of hiring from a limited pool of narrowly defined ICT graduates.

Following such protocols, however, could be a challenge for the ICT sector in Canada owing to the fact that so many ICT firms are small, and are thus less likely to have such policies and/or the necessary resources to recruit and retain females as Google (with 50,000+ employees) has done . Again, Cukier (2007) says that small and medium enterprises (SMEs) – which often have limited resources, less flexibility and shorter planning horizons – tend not to pay much attention to human resources management and planning. This means that they may not have many human resource policies in place, let alone policies to attract and retain women. In Canada, the ICT sector is in fact composed mainly of small firms with 83.4% having fewer than 10 employees in 2011, 12.9% with 10-49 employees, 2.0% with 50-100 employees, and only 1.7% with more than 100 employees (Industry Canada, 2012).

Perhaps a more promising and (arguably) cost-effective means of attracting and retaining female ICT employees is to address the misperceptions of these occupations that so many people seem to hold. As mentioned above, ICT education and occupations suffer from an image problem, and as such are in need of a change. Given the propensity of young women to want to work in meaningful occupations that deal with living things, Lasen (2010:1124) suggests promoting school girls' participation by focusing on ICT as essential tools in addressing the challenges in a number of fields from health to environmental management, rather than focussing on the mundane or highly technical skills "devoid of meaningful and creative contexts." In other words, an emphasis on applying ICT to other fields, rather than focusing on the ICT field itself. This could be considered an indirect way to increase female interest in ICT and, in turn, increasing their representation in these occupations.

Related to this, Cukier (2007) suggests that employers need to ensure job descriptions reflect their requirements for communications and other skills, and not just technology skills. Or, as an alternative, firms themselves could provide IT training to generalists with other high-demand skills such as the ability to communicate effectively. She also recommends that improving the understanding of careers in ICT is needed to overcome the negative stereotypes about boring jobs and high schools need to improve counselling about ICT career opportunities and education. Grant and Babin (2009) argue that there is too much emphasis placed on math as a screening mechanism in ICT even though these skills are not used by most involved in the professions. Again, an apparent mismatch between the skills required and those used which decreases the interest of females in the field.

Ceci and Williams (2011) note that often adolescent girls prefer careers focusing on people as opposed to things and this accounts for their increased numbers in fields such as medicine and their smaller presence in math-intensive fields (even when math ability is equated). The authors argue that a strategy of providing them with realistic information about career opportunities and exposing them to role models in math-based fields – not to dissuade them from medicine, biology, etc. – but to ensure they don't opt out of inorganic fields because of misinformation or stereotypes.

All of these suggest an indirect way to attract women into ICT professions. Reframing what is involved in ICT education and occupations may require few real changes, but may result in a more attractive option for young women.

Indeed, in recent years a number of organizations have appeared with the goal of ultimately increasing the participation of females in ICT at all levels of schooling and, ultimately, in ICT professions. And the earlier girls are exposed to ICT the better. Code.org in the US, for example, is an advocacy campaign which is focused on getting school-age children interesting in computer science, and coding in particular. Commenting on a series of short videos the organization has produced to which focus on the underrepresentation of groups in in computer science, the founder of the organization, Hadi Partovi (cited in O'Dell, 2013) says: "With the montage we did of different workplaces, we wanted to get across that these are really great jobs, but also show that these people are working together in the sunlight rather than the typical media impression of what an engineer is – a geeky guy working alone in a basement." In other words, the organization is trying to remove the misconceptions among young females regarding careers in ICT. These types of programs are certainly in-line with recommendations by Babin, et al. (2010) who argue that ICT industry representatives must speak directly with students and their parents to give a more realistic view of the ICT industry and its employment opportunities and job functions.

In Canada, similar programs exist with the goals of providing more accurate information and mentorship to younger females. TechU.Me is an Ottawa-area program that places employees from local technology companies as mentors in secondary school classrooms. Operation Minerva (run by the Alberta Women's Science Network) has a similar mandate to bring young women and female science mentors together to encourage more female students to choose science, mathematics and technical courses and careers. Cybermentor.ca is an online mentoring program that matches girls aged 11 to 18 with professional female scientists and engineers or female students at Alberta universities who are studying science and engineering.

These programs are consistent with one of the recommendations by Cukier (2007): socialization and early education – since the early years are the most critical in shaping an individual's self-perception – but this also means addressing teaching and curriculum, educating parents, teacher and guidance counsellors. Similarly, Cuny (cited in Cutler, 2012) says the dearth of young women in computing can be changed but the fixes won't be quick or easy. It is necessary to change the message that girls receive, to provide them with engaging computer-science related activities in elementary and middle school, etc.

Indeed, changes at all levels of education seem to be warranted. CATA-WIT (2010), for example, recommends such changes, but as part of a coordinated, integrated approach engaging a variety of stakeholders (educational institutions, associations, government and industry). In particular the organizations recommends developing a long-term initiative directed at girls at the earliest stage of their education (i.e., primary school) to convince them that mathematics and science-based courses are interesting and careers based on these rewarding and enjoyable, as well as changing attitudes about the negative perceptions of working in technology jobs. Also showing companies the benefits of diversity, mentoring young women to pursue careers in technology, and helping technology companies to increase the number of women.

Another option may be to offer more significant ICT offerings as the part of traditional college and university programs. For example, making ICT courses part of a nursing or biology curriculum rather than "applying" computer science to these or other fields that may be of interest to women. While some would argue that waiting until PSE is waiting too long, there have been some interesting programs that have been introduced to do just this.

Jan Cuny, a program director for the National Science Foundation, notes that some successes have occurred at US campuses such Carnegie Mellon, Georgia Tech and Harvey Mudd College, which have changed the cultural climate and had success in recruiting and retaining female computer science students. Maria Klawe, President of Harvey Mudd College said that broadening the introductory computer science course to frame it as computational problem-solving approaches across multiple fields rather than as programing has sparked enthusiasm among both female and male students. She said that her college takes a large number of female students to the Grace Hopper conference, the largest conference focusing on women in computer science to provide role models. They also have on-line mentoring programs with females in the industry and the academe as mentors (see Cutler, 2012).

It is not only universities that have a role in this transformation, colleges across Canada too have an important part to play. In the US, Mangan (2013) says that many community colleges are filling the STEM skills shortage gap, by alerting students to the STEM jobs available and offering training to those who could be financially strained and shy away from time-intensive STEM programs. Community colleges in the US often service a demographically diverse population and this may be a way to attract non-traditional students into these fields, especially since not all occupations require a university occupation. In Canada colleges – which educate a large number of young people – are also well positioned to address students' remedial needs in mathematics, for example. Furthermore, many community college graduates go on to complete bachelor's degrees while many university graduates go back to college to attain a vocational diploma.

V. Conclusions

Men and women are – at times – motivated by different factors in choosing a profession and, of course, in choosing a field of study that will ultimately lead to that profession. The review of the research shows that women and men weight a number of factors differently. The implication of this is that attracting women to choose ICT as a career path requires different incentives.

ICT professions suffer from a perception problem and this appears to have the greatest impact on young women. Whether this perception is accurate is not important, but its effect is being felt in recruitment by both educational institutions as well as industry. Perceptions are formed at a young age, and so changing perceptions to accurately reflect the reality of ICT education and employment should also begin at this age.

Similarly, the literature discusses the mismatch between the skills required and the education demanded by employers. This too could act as a barrier for women considering entering ICT. For example, math skills are used as a screening mechanism, but these same skills may not be utilized on the job. This suggests that screening may have to be changed to focus more on soft skills with technical skills used a secondary screening device. Alternatively, the ICT sector has a good record of supplemental training following college or university. This type of skills upgrading could be utilized to round out the necessary technical skills of those who have an otherwise appropriate skillset. Of course, this assumes that women can be recruited into the ICT industry in the first place.

Family-friendly workplaces may also be an important factor in attracting young women (and perhaps their partners) to ICT. While most firms are small and thus would be limited in their abilities to provide on-site daycare for example, they may be more flexible in offering opportunities for telecommuting, part-time work, etc.

It may also be instructive to look at industries that have been able to attract increasing numbers of women, especially those that were once considered male-dominated. What lessons (if any) can be learned from these fields – e.g., law, medicine, veterinary medicine, biology, agricultural sciences, atmospheric sciences, etc.? These professions may have taken measures to improve the number of females in the profession and, if so, there may be valuable lessons to be learned. These developments may be in contrast with the ICT sector which has done very little to change (Grant and Babin, 2009).

We end by citing Cohoon (2002:52) whose report concludes by saying: "The most important message offered here is that female under-representation in computer science [and indeed in ICT] is not an intractable gender difference."

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