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ICT and Women

Research Paper
by
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The Information Technology Association of Canada (ITAC) is the voice of the Canadian information and communications technologies (ICT) industry. ITAC represents a diverse ICT community spanning telecommunications and internet services, ICT consulting services, hardware, microelectronics, software and electronic content. ITAC's community of companies accounts for more than 70 per cent of the 592,600 jobs, $149.4 billion in revenue, $6.22 billion in R&D investment, $22.6 billion in exports and $11.8 billion in capital expenditures that the ICT industry contributes annually to the Canadian economy. ITAC is a prominent advocate for the expansion of Canada's innovative capacity and for stronger productivity across all sectors through the strategic use of technology.

Introduction

Recruiting and retaining women to work in the information and communications technology industry is a persistent challenge for the industry. Yet we know we must do better. For one, our sector faces constant shortages of highly qualified people to keep our enterprises operating. And, as a knowledge-based sector, we know that being able to access diverse points of view and experience is a key to successful problem-solving and innovation. Quite simply, the ICT industry needs women.

In 2009, ITAC's Board of Directors launched a major initiative to systematically address this challenge – beginning with the composition of our own Board of Directors. In order to provide this initiative with a firm foundation of fact, we asked the authors of this paper to review current literature and to help us understand the barriers we face in building an industry that draws more effectively on the riches of the total labour pool. The production of this short paper is the first step in an industry-wide attempt to improve its performance in inclusiveness, and in the process, improve our long-term chances for success.

Bernard Courtois
President and CEO

The 'Perfect Storm' and its Opportunity Cost

North America remains in the midst of a serious employment shortage in the information and communications technology (ICT) industry.[1] In the late nineties, more than 900,000 jobs went unfilled in the United States where the labour shortage cost the economy up to $4 billion a year (Margolis and Fisher 2002). According to The American Association of University Women (AAUW), the dearth of ICT talent risks the country's ability to compete and innovate. The AAUW further notes that by 2014, the United States will have added at least one million ICT jobs to the labour force. The National Center for Women and Information Technology (NCWIT) notes that there are currently even more ICT positions than during the peak of the dot-com boom (NCWIT 2007:19). The potential for sustained growth in the sector is there, but who will fill these positions?

In Canada, the picture is likewise bleak. Despite above average wages, the ICT sector struggles to fill many positions with more than 89,000 jobs possibly going unfilled in the next three to five years (Industry Canada 2009).[2] According to a recent report of the Conference Board of Canada, there is an average economic contribution of $120,000 per ICT worker. The cost to the national economy if these jobs go unfilled could be as high as $10.6 billion per year based on an average yearly contribution per employee of $119,335 (Fennessy, Burt and Kitagawa 2008: 23). As Dr. Michael Bloom notes in the *Financial Post*, "A *perfect storm* of socio-demographic factors, negative perceptions of the tech sector following the bubble burst of 2002 and a significant drop in university enrolment in IT programs across Canada has all come together to create this dire scenario" (George-Cosh 2008). Currently there are 600,000 Canadians in the ICT field with 31,000 on the cusp of retirement and an additional 58,000 required to fill in upcoming productivity gaps (Fennessy, Burt and Kitagawa 2008). It is clearer than ever that a paucity of skilled ICT labour seriously threatens Canada's leadership role in the industry both in the short- and long-term.

Where Women Come In: Opening the Door Still Wider

> *Companies that have made progress in terms of women's representation understand that it's just smart business to play with the full deck of talent. And it's diverse talent that reflects the marketplace that will drive the creativity and innovation that will improve the bottom line and offer corporations a source of competitive advantage in the global marketplace (Immen 2009).*
>
> *Deborah Gillis, Toronto-based vice-president, North America, Catalyst*

> *Technology-oriented and knowledge-intensive enterprises are engines of Canadian development and economic growth. Yet, numerous reports attest to a shortage of skilled and educated technology workers as being a key obstacle to business development and job-creating expansion. At the same time, there is a decrease in university enrollment in such fields as Computer Engineering, Computer Science, and Software Engineering. Potentially, women are a source of talent that could help fill these gaps in that Canadian women are under-represented within many advanced technology sectors (Orser 2009:4).*

[1] Both ICT and IT are used interchangeably in this literature review.
[2] Scott-Dixon (2004) notes that gendered pay disparity appears in the IT industry as in other sectors with an average wage gap between men and women at about 80 per cent in 2000.

Time and again, literature on ICT and women's participation springs from the tenet that diversity strengthens work environments. Declining interest in ICT-related studies coupled with a meager 25 per cent participation rate by women[3] necessitates a closer look at the perceived lack of diversity in the field itself. Diversity as an organizational goal is crucial not only for its implications for equity and fairness in hiring and workplace culture, but also as a way to optimize operations and opportunities. Scott Page, professor of complex systems at the University of Michigan, argues that diversity in a group equals or even outranks ability and brainpower vis-à-vis performance: "The diverse group almost always outperforms the group of the best by a substantial margin" (Ernst and Young 2009:9). Arguably, corporations and organizations best serve their own interests by embracing diversity in all its forms. A broad range of organizations have concluded that increasing women at the top positively impacts financial performance (ibid). Companies that neglect diversity issues risk ongoing labour shortages.

Marked by a pressing need for ICT talent, the nineties and early years of the current decade led many corporations to more readily open the door to underrepresented groups such as women and visible minorities. In a sector plagued by skill shortages, many companies have responded with efforts to attract women. The *2006 Catalyst Member Benchmarking Report* states that 91 per cent of participating member corporations in ICT reported activities designed for women in America and many also targeted women for recruitment in overseas operations. The report notes that many leading companies have all made strides to recruit and retain technical women in their workforces.[4] In a more recent Catalyst report, Foust-Cummings, Sabattini, and Carter note that despite increased work satisfaction reported by women in ICT over the past decade, "recent employment trends indicate that the percentages of women in specific technical fields have remained flat or declined since the dot-com bust" (2008: 2).[5]

In a report commissioned by the Information and Communications Technology Council (ICTC), Cukier notes that males dominate most jobs in the Canadian ICT sector except for writers and graphic designers/illustrators. While the number of women is increasing, the rate is slower than for males, therefore resulting in a decline in percentage of women in ICT. The researcher also states that women's participation at board and senior management levels is lower than average (2007).[6] Interestingly, "while female enrolment in many technical disciplines has declined in recent years, computer science is the only discipline where the percentage of women is lower than it was in 1992-3" (Cukier 2007: 14).

In 2008, the Information and Communications Technology Council (ICTC) commissioned an analysis of labour force survey data for ICT occupations covering the period 2000 to 2007.[7] Researcher William G. Wolfson noted that men constitute 75 per cent of the relatively well-educated and youthful workforce, a figure that has remained stable for years. Representing just one quarter of the labour force, women are even less well-represented in engineering. [8] Only in the categories of "analysts" and "other IT" does gender parity appear within reach at 42 per cent

[3] See Wolfson's 2008 report for the Information and Communications Technology Council (ICTC).
[4] See www.catalyst.org/publication/60/2006-catalyst-member-benchmarking-report.
[5] Originally from Carmen Nobel, 'Why Are Women Exiting IT?', *Infoworld*, January 29, 2007, 34.
[6] Originally from a 2005 report of the Canadian Business for Social Responsibility Advisory Services Group (CBSR), *Corporate Social Responsibility Trends in the High-Tech Sector*, www.cbsr.ca.
[7] The Labour Force Survey (LFS) is a monthly survey of approximately 54,000 households undertaken by Statistics Canada.
[8] According to AAUW's 2009 position paper on women and girls in science, technology, engineering, and mathematics education, women comprise just 24.8 per cent of computer and mathematical professionals, a figure that has fallen from 27 per cent in 2006. See also *More Than Just Numbers: Report of the Canadian Committee on Women in Engineering*, April 1992, NSERC.

participation for females.[9] An understanding of the relatively minor participation of women in ICT work necessitates an uncovering of its roots.

Barriers to Women's Participation in ICT

It Starts with Girls: Misperceptions and Missed Opportunities

Despite the work done since the early nineties to at least recognize the dearth of women in the ICT industry and open the doors wider, barriers to their participation and retention remain. An examination of women's involvement requires a step back into the world of girls where career aspirations often begin. Even a cursory review of the literature reveals a fundamental misperception of ICT work. In 2000, the American Association of University Women released a report examining girls and technology. The AAUW research unearthed a dislike for computer culture which girls often described as 'boring'. Girls also reported that computer games were unappealing and there were few positive adult role models. The perception of the ICT field is likewise negative among Canadian youth. For instance, a 2009 report by The Conference Board of Canada confirms a gender difference in enthusiasm: "… while boys generally rate ICT as interesting, fun, and cool … girls generally rate ICT as not interesting, not fun and not cool" (Munro and Watt 2009: 2).[10]

The literature on women and ICT documents missed opportunities within the educational system, and society at large, to attract girls into the high tech world at any early age. Farmer argues that a lack of qualified instruction and access to technology for learning purposes - despite its increasing predominance in the lives of contemporary girls - compound their dislike of computer culture (2008: 20-24). She also suggests that while elementary school girls and boys hold similar attitudes towards technology, the onset of puberty often results in a greater self-consciousness and declining self-esteem in the absence of strong support from caring, involved adults. Farmer further argues that "stereotypes that masculinize technology will endure if not challenged" and girls who "are pressured to accent their femininity … will opt out of technology classes in high school and be unlikely to major in technology-related subjects in college"(30-31).

Meszaros, Lee and Laughlin (2007) echo the need for strong adult support for high school girls as well as improved access to a variety of ICT applications. In 'Information Processing and IT Career Interest/Choice among High School Students', the researchers also stress the need for gender-neutral ICT career materials that detail the "range of options beyond the male stereotype in isolation" (2007: 90-93). Their study of high school students underscores the crucial role of teachers, parents, peers, and counselors in girls' decision making around career choices. As for those young women who persist in technology beyond secondary school, they will be few in number. Surrounded by male students, and lacking same-sex role models, female students will be hard-pressed to continue in a technology major, let alone go on to pursue ICT as a career.

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[9] As cited in Foust-Cumming, Sabattini, and Carter (2008) and originally appearing in *Women in Technology: 2007 Report* WITI SAVVY, 19-23. See www.witi.com.

[10] See also "Because it's boring, irrelevant and I don't like computers': Why high school girls avoid professionally-oriented ICT subjects" (2008) and "Early Determinants of women in the IT workforce: a model of girls' career choices" (2005). AAUW's 2003 report Women at Work also documents the shortage of girls and women in science, technology, engineering and mathematics education. See http://www.aauw.org/research/upload/womenAtWork.pdf.

Programs with Promise

Programs with the most promise are those that reflect the needs of girls for strong support networks at home, school, and societal levels. Such programs place great emphasis on female role models and female instruction and seek to address misperceptions that ICT is dull, done in isolation, and does not include women. Munro and Watt (2009) highlight a series of week-long seminars held at the University of Waterloo.[11] At the school's Centre for Education in Mathematics and Computing (CEMC) Seminar in Computer Science for Young Women, girls from across Canada come together in a supportive environment with the seminar's underlying intention to generate interest in computer science in high school (Munro and Watt 2009: 46). Through various camp activities, girls in grades nine and ten discover a broader perspective on ICT than is normally presented at schools and in the media. Female faculty members and graduate students help to break down stereotypes of the lone, programming male. As well, participants work with mentors to develop confidence in their ability to pursue science.[12]

What is the impact of these week-long camps on girls' attitudes toward technology-related education? Results have been tracked since 2002 and show that when explored in a friendly, positive environment that stresses the breadth of information and communications technology, many girls change their ideas about the field. For instance, only 35.4 per cent of participants in the 2007 seminar reported beforehand that they planned to study computer science in high school whereas at the end of the program, 61.5 per cent said they expected to take such a course (Munro and Watt 2009: 47).

Other characteristics of the seminar address concerns regarding peer and parental messaging around ICT. For example, a family and faculty dinner brings parents, female role models and daughters together in a convivial atmosphere that goes some way to dispelling notions of computer science as a boys-only environment. As for the role of schools in promoting the program, applicants report that in addition to their parents, teachers and guidance counselors are instrumental in directing them to the University of Waterloo seminar (Munro and Watt 2009).

Stakeholders such as business organizations and government bodies are ideally situated to address ICT labour shortages by offering expertise and funding for similar programs directed at girls and young women. For instance, the CEMC Seminar receives funding from the Gates Foundation. Munro and Watt note that it is external support like this that keeps costs per participant at around $150. Current applications greatly outstrip room in the seminar so "there is obviously room for other corporate sponsors and universities to partner in creating programs with similar objectives and activities" (Munro and Watt 2009: 47).

[11] See also Catherine Teasdale, "Booting Up Girls' Interest in Computer Science," Imperial Oil Review 2, online, 2004. The original 2002 program was known at the J.W. Graham Seminar and then the Imperial Oil Seminar in Computer Science for Young Women from 2003-7.
[12] See http://cemc.uwaterloo.ca/events/csgirls.html for further program information.

What Women ICT Students Want:

Program Flexibility, Role Models, Mentors, and Support Networks

> *"The absence of women faculty and mentors in the classroom and elsewhere, few women peers in their classes, and the lack of supportive networks can create a "chilly climate" for women in non-traditional fields" (Wasburn and Miller 2006: 61).*

For those girls who do manage to stick with IT until the university level, considerable obstacles remain that can result in their eventual departure. In *Reconfiguring the Firewall: Recruiting Women to Information Technology across Cultures and Continents,* researchers Burger, Creamer and Meszaros bring together essays that explore the context and constraints of recruiting girls and women into IT majors and careers (2007). In the same volume, Cohoon and Lord (2007) use the United States' first nationwide survey of computer science departments to understand their gender makeup. The researchers observe that efforts "to recruit women are all associated with the gender composition of departments, but not necessarily in the predicted manner" (147). For instance, while interest and enjoyment are leading reasons men and women come to graduate studies in computer science, flexibility in program content is a much more important factor for women students (ibid: 147-148).

As for the practice of personal recruitment to address gender imbalance, the data suggests that this approach can sometimes be counterproductive if the recruiter is a male student or faculty member. Still, the researchers suggest that this popular practice may be effective under specific conditions and when implemented with sensitivity. In addition, Cohoon notes in 'Just Get Over It or Just Get On with It: Retaining Women in Undergraduate Computing' that it is faculty and same-sex peers who play crucial roles in the retention of women in post-secondary computing. The researcher further notes: "In departments where faculty members encourage students and mentor undergraduates because they want to eliminate under-representation, and where faculty emphasized homework and focus as the route to academic success in computing, outcomes for women approach those of men" (2006: 233).

Cukier (2007) notes that systemic barriers in post-secondary institutions include inflexible entry requirements, an emphasis on theory and traditional curriculum models, lack of experiential and cooperating pedagogy, and too few role models remain important barriers at the post-secondary level. The researcher suggests that the way to combat these systemic barriers is to be more responsive to employment trends in post-secondary institutions and government: track representations of female students, faculty, and administrators; review hiring practices, salaries, promotional policies, and research support and how these impact women in teaching roles; and investigate ICT women as role models for other women. Additional recommendations also call for the review of all ICT educational programs on female students and the implementation of "hybrid" programs that bring together minors and majors in ICT. Finally, Cukier suggests that post-secondary institutions incorporate diversity as a measure of performance in funding for research, projects, and programs (2007: 2-3).

Expanding the Talent Market by Re-branding ICT

As for the satisfaction associated with ICT work, this is an area that continues to influence women's involvement in the field. Bair and Marcus (2007) reveal a skepticism that computer-related careers are enjoyable that persists into adulthood. How can educators and potential employers counter the negative perceptions of ICT work and encourage greater involvement by women?

In response to the widespread perception of ICT careers as male-oriented and limited in scope, Bair and Marcus call for better marketing of ICT careers in order to boost women's participation in computer science-related programs and workplaces (2007: 161). As Cukier notes, industry, educational institutions, and parents all play key roles in how girls and young women perceive the field. She suggests that marketing efforts need to reach across this range of influences on girls' decision making. Focused and integrated efforts are required to encourage the participation of girls in math and technology courses. School boards can set up fact-based programming and ensure that curricula accurately reflect ICT career opportunities. Furthermore, information technology can be taught in a more applied manner to better demonstrate its breadth of applications and opportunities (2007: 3).

In thinking about how to improve marketing of ICT to women, it is helpful to begin at the beginning; in other words, how we define "information technology" may be inherently limiting. As Denning notes, while the field developed out of math and electrical engineering, its expansion into a broader discipline beyond a strictly technology focus necessitates a similar broadening of its definition.[13] For instance, as Cukier, Shortt and Devine (2002) suggest, narrow definitions of IT workers can exclude women who do not see themselves as "computer scientists" or "engineers." The mismatch between the limited definition of IT and the industry's actual skill requirements contributes to a serious talent gap and labour shortage. Certainly, a definition of IT that more accurately depicts the wide skill set required by much work in the field would suggest to women that there may in fact be room for their professional interests. Employers can also take steps to ensure that job descriptions accurately reflect job requirements, as highlighted in a 2008 report sponsored by the Information and Communications Technology Council (ICTC).[14] Organizations such as educational institutions need to recognize multiple routes to the sector if they are serious about attracting greater female participation. Furthermore, as Cukier, Shortt and Devine (2002) suggest, by simply expanding the definition, the number of women counted would increase automatically thereby suggesting to girls and women that the field is actually more female-friendly than imagined.

An AAUW report on educating girls in the computer age argues for the need to "respect multiple points of entry" into the field noting that children come across computing through art, design, and mathematics" (2000: xii). Indeed, the work of Napier, Shortt and Smith (2000) reflects the fact that women often come into the ICT field from myriad paths. The researchers interviewed leading North American women in the ICT field and discovered that most of them had liberal arts backgrounds before entering it rather than engineering or computer science.

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[13] See P. Denning, 'The Profession of IT: Who Are We?' in Communications of the ACM, 44 (2), 2001, 15-18.

[14] Barriers and Recommendations in Taking Action on Women in ICT: Women in ICT National Forums Action Report by Heather Turnbull for ICTC, 2008 but originally from the ICTC Study on Diversity – The Competitive Edge: Implications for the ICT Labour Market, Summary of Recommendations to Address Barriers to Women", by W. Cukier, 2007.

Arguably today's world of ICT work is more human-oriented and requires the communication skills women often bring to the table. Cukier, Shortt and Devine (2002) state that the discourse equates ICT with male-dominated computer science and engineering thereby marginalizing women who work, study, and research in the ICT field. Furthermore, the failure to recognize the multifaceted reality of contemporary ICT results in a persistent "skills gap" as women who often possess the requisite talents continue to bypass the sector when deciding upon a career.

By re-branding IT to reflect an expanded definition, and then by increasing IT's visibility among students at the secondary school level and beyond, it is likely that greater numbers of female students could be attracted to the field. At the same time, the strategic re-branding of IT careers in human resources departments could also expand the applicant pool to include more women since current HR practices often filter out applicants who lack strictly computer science and engineering backgrounds (Cukier, Shortt and Devine 2002).

What Factors Help Retain Women in ICT?

Role Models, Mentors, and Inclusionary Workplaces

A review of the literature on women and ICT clearly documents a long-standing gap between where girls and women are and where the sector needs them to be if labour shortages are to be addressed. What is the point of attracting girls to ICT studies only to disappoint them as professionals in the field? How can organizations avoid gendered attrition from the field? Research links women's professional satisfaction directly to their attachment to the ICT field. For example, Bartol, Williamson, and Langa (2006) document a lower level of attachment among women than men and especially among female ICT newcomers. Their research results link perceived organizational support and job satisfaction to professional commitment: "Organizations have much to gain by making sure to convey to female newcomers in particular that their contributions are valued and that the organization cares about their well-being, as well as by attending to their job satisfaction." The authors further note "that professional commitment is not only a strong predictor of retention in the profession but has also been found to be associated with a higher commitment to the employing organization and a lower intention to leave that organization" (Bartol, Williamson and Langa 2006: 433-5).

Many constraints to the full participation of women persist behind women's absence in the ICT industry. An earlier 2003 Catalyst report discovered four key factors that pushed female employees away from the field including an exclusionary culture, inflexible work environments, isolation of women, and the failure of high-tech corporations to identify and nurture talent. Five years later, in an attempt to understand women's continued underrepresentation in ICT careers, Catalyst researchers Foust-Cummings, Sabattini and Carter analyzed a Towers-Perrin-ISR employee survey data from 21 global high-tech companies. The subsequent report, *Women in Technology: Maximizing Talent, Minimizing Barriers* reveals persistent barriers to women's continued participation in ICT.

The constraints women articulate in the more recent report largely fall under three areas: a lack of role models with whom women in technology can relate; lack of mentors, sponsors, or champions to publicize women's accomplishments; and exclusion from key networks of decision-makers (Foust-Cummings, Sabattini, and Carter 2008: 6). The Catalyst report also notes a generational difference in the perception of barriers with older women feeling more excluded. Indeed, the overall message from Catalyst's analysis of barriers is "a lack of women

colleagues – who serve as mentors and champions, who act as role models, and who provide opportunities for the formation of networks – is a substantial and systemic obstacle to the advancement of women in technology (ibid: 30). The Catalyst report points toward two other salient points made by women working in ICT: the failure by organizations to consider supervisory relationships with technical women and women's perception of fairness and voice in a company greatly impacts retention. As the authors note, "In an age of increased corporate competition, companies cannot afford these risks" (Foust, Sabattini and Carter 2008: 4).

Action Steps Recommended by Female ICT Professionals: Advancement and Talent Management

In the area of promotions and talent management, high tech women employees have several helpful insights to share. Key concerns fall into three areas: advancement and promotion; representative leadership; and acceptance of diverse individual styles (Foust-Cummings, Sabattini and Carter 2008: 18). Under the primary concerns of supervisory relationships and fairness, respondents stress improved focus by companies on developing people skills among managers: "Supervisors need to be trained so that their ability to communicate with women, coach women, and provide career guidance is improved," otherwise they will end up depending on status quo models which inadequately address the concerns of women in ICT (ibid: 31).

Organizations seen to be responsive to the needs of their female staff stand a much better chance of retaining their services. Where supervisory relationships are positive and women feel that their contributions are seriously considered, they feel a greater stake in the company. According to survey participants, women develop greater attachment to the workplace if they feel their supervisors nurture career development by providing open and regular performance reviews. Feedback from women workers also links retention with access to more challenging assignments and career goal planning (Foust-Cummings, Sabattini and Carter 2008: 17). Additionally, female high tech employees articulate the importance of fair treatment particularly vis-à-vis advancement and promotion. Women also cite the value of representative leadership and the acceptance of diverse leadership styles. It is here that the absence of significant same-sex role models is most glaring with female employees encouraging employers to better track the promotion of women and ethnicities throughout the organization as well as their remuneration and retention. Promotion needs to be more transparent and remuneration equal across the board. Consistent and thorough monitoring of workforce statistics is required so that promotional biases can be checked (Foust-Cummings, Sabattini and Carter 2008: 17-19).

As the report notes: "there remain two critical areas that companies must address if they are to more fully develop, satisfy, and retain women in the field: companies must take steps to build and improve supervisor-supervisee relationships, as well as address procedural fairness and voice to increase the satisfaction and engagement of women" (Foust-Cummings, Sabattini and Carter: 20). [15] Aside from training of managers, female technical workers also call for an evaluation of the system for rewarding managerial staff. Survey participants suggested organizations reward innovation not only in products and services but also personnel development in order to underscore the value of the people they employ. Moreover, a broader range of working styles needs to be supported so that women and other underrepresented groups feel more valuable to the organization. Methods of evaluation that are inherited from

[15] See report for experiences of Intel and IBM in their diversity and inclusion practices.

traditional corporate cultures can also impede advancement as a recent catalyst study has illustrated. It notes "… gender stereotypes can create several predicaments for women leaders. Because they are often evaluated against a "masculine" standard of leadership, women are left with limited and unfavorable options, no matter how they behave and perform as leaders." (Catalyst 2007) and according to the ICTC report, feedback from women workers further suggests that the implementation of progressive policies for flexible work, job-sharing, parental leaves, and on-site daycare (Cukier 2007).

Conclusion

This literature review of women in ICT attempts to understand the constraints that underpin stagnant participation rates in the industry. We have looked at the impact on girls' perceptions of ICT when it is narrowly defined. Career aspirations often begin in early education when girls are still at home and exposed to the influences of peers, parents, teachers, and mainstream media. It is crucial that girls and the adults around them have a clear understanding of the wide range of ICT applications and the myriad skill sets required by the field. If persistent stereotypes of the sector are to be debunked, marketing campaigns around a re-branded and more accurate definition of ICT would help the public to better see what the field offers for career possibilities. By nurturing an interest in ICT early on, we open the door wider to ICT study at the secondary and post-secondary levels and, ultimately, greater workforce participation by women.

The literature clearly outlines the steps educational institutions need to take to keep female students engaged in computer-related studies. For instance, schools need to ensure a cooperative, supportive environment where female students can meet same-sex peers, instructors, and mentors. An educational atmosphere that makes real space for women's specific learning needs will have a better chance of keeping young women in ICT-related studies until graduation. The tracking and monitoring of women's representation will help ensure the presence of female role models and mentors.

As for women considering entering the computer-related workplace, organizations that understand the value of diversity and that support and nurture women's participation with female role models and mentors will secure the lion's share of female ICT talent. Human resources departments need to understand and exploit the various routes women take to the ICT field, understanding that computer-related education is not the exclusive route. Job descriptions must match the actual talent required. Often this means including communication, writing, and business skills in addition to technology skills (Cukier 2007: 3).

In their study of men and women in the American software industry, Kuhn and Rayman (2007) note the importance of balancing secure work with family life and argue that the retention of women requires policies that reflect their concerns. Companies interested in not only attracting but also retaining women, require working environments that reflect women's desire for services such as on-site daycare and career development programs. Such organizations reflect women's concerns for healthier lifestyles by allowing part-time work and flexible hours (Burger and Aspray 2007). As participants in the Women in ICT National Forums also state, women are more likely to stay in organizations associated with the right cause. In other words, women want their workplaces to promote community, economic and social well-being (Turnbull 2008: 5).

Clearly, from early education through to post-secondary institutions and organizational workplaces, there are ample opportunities for mass media interests, corporations, educational institutions, and governments to encourage the greater participation of girls and women in ICT. As the literature indicates, girls and women have articulated what the field lacks to make them feel welcome and engaged. Stakeholders need only take their cue from what women say. Of course, the research also indicates that there is no single antidote to curing the troubling lack of females in ICT. As Cukier (2007) suggests, however, barriers can be dissolved if we employ a multi-pronged approach to their dismantling. Success necessitates collaboration among all stakeholders. While many companies have opened their doors wider to encourage women's participation, a review of the literature shows that effective programs need to be strategic, integrated, sharply-focused, and evaluated. Researchers have been tracking the involvement of women in information and communications technology for some years now. The time to really take recommendations to heart is now as neither the ICT industry nor society as a whole can afford to lose the potential skills of women any longer. Indeed, as a recent Ernst and Young report on women and the global economy suggests, when women are underrepresented, we all lose:

> *At a time when our global economy is facing its greatest challenge in decades, we have to capitalize on the contributions women can make. While many corporations and governments have for years been making efforts to tap the hidden potential of women – and many have launched laudable initiatives to do so – now is the time to accelerate those efforts. It's time to place renewed emphasis on women as a resource to move businesses and economies ahead. The learning that comes from crisis is a terrible thing to waste (Ernst and Young 2009: 16).*

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