A STUDY OF WOMEN'S INFORMAL AND ALTERNATIVE LEARNING PATHWAYS TO IT JOBS

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In preparation for the Annual Conference
Work and Lifelong Learning Network
Ontario Institute for Studies in Education

June 17-19, 2004
(revised for SSHRC Mid Term Review September 21-22, 2004)

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Introduction

Women's informal and alternative learning pathways to information technology (IT) jobs is the focus of this investigation. It is important to examine these pathways and experiences for several reasons. Women constitute the minority of programmers and software engineers and they are the minority of students in traditional IT programs like computer science, mathematics, and engineering. Women also receive lower wages in comparison to men in equivalent IT jobs, although the difference in this sector is smaller than the overall wage gap for women (85% compared with 70% generally speaking). Finally, women's marginal status in this field is of concern given that these jobs are considered 'good jobs'—they pay a living wage, and there is growth, diversification, and opportunities for advancement. Furthermore, acquiring IT skills is considered central to participation in the 'knowledge economy'. As Stanworth (2000) explains, "A basic capability to use information technology is now becoming accepted as a 'key' or 'core' employment skill, which commentators feel will be needed in almost any job in the future" (p. 23).

The under-representation of women in IT has been noted and various programs developed to encourage young women to consider careers in IT and to enroll in formal computer science and engineering programs. Other initiatives have focused on creating women-friendly materials and curricula for IT training programs[1]. Most of these initiatives, however, are still oriented to a rather linear view of careers with little attention given to what could support women as they enter IT work later in their careers and through pathways other than the traditional computing science and engineering routes.

[1] See for example the WomenTech Educators Newsletter: enews@iwitts.com

There are two parts to this paper. In the first section, we outline our approach and goals for the study, followed by a discussion of some key concepts in relation to gender and learning that help frame our approach. This is followed by a demographic snapshot of the IT labour market. The third section of Part A introduces some of the studies that have investigated women's IT learning experiences, their IT career pathways and IT work experiences. In Part B, we describe our data collection, recruitment strategies, and research stages. This is followed by an overview of the demographics of the participants, their ages, education, family status, race, and employment positions. The third section of Part B offers the results of a preliminary analysis of participants' learning strategies and experiences. The paper closes with some discussion of implications and an outline of the next stages of the research.

Part A: Framing the Study

A.1 Research Orientation and Goals

This case study of women's alternative learning pathways to IT jobs is a partnership between a community-based agency and the academy. The community partner is ACTEW (A Commitment to Community Based Training and Education for Women), an organization committed to supporting high quality community-based education and training opportunities for women through policy advocacy, curriculum and resource development, and research[2]. Jen Liptrot, co-investigator of this study, is the Executive Director of ACTEW. The academic partner is Shauna Butterwick, Assistant Professor of Adult Education at the University of British

[2] See their website for more information: http://www.actew.org

Columbia. Two research assistants, Danielle Thibodeau and Kaela Jubas, have also been hired to work on this project, undertaking literature reviews and work histories of the participants[3].

This study's focus on women's informal and alternative learning pathways to IT jobs was identified as an issue by members of ACTEW who felt a disjuncture between the picture of women's minority status in the IT field, as outlined in the introduction to this report, and their own sense as educational providers that women *were* contributing and working in this labour market. While women may still be the minority of programmers and software engineers, these educators and career counselors had observed that women are definitely involved in other aspects of the IT field--a not surprising claim given the rapid differentiation of the field. *If women were indeed present in much larger numbers than earlier studies had found, what kinds of work were they doing? If, as studies have shown, they were not taking the traditional formal educational route to IT jobs, how were they acquiring their knowledge and skills? Furthermore, were the skills and knowledge acquired through alternative routes recognized and rewarded?* These are the key questions that have framed this case study.

In order to address these questions and to create a more inclusive picture of women's contribution to the IT sector, a wider lens in relation to what constitutes an IT job was employed. A wider lens can help disrupt the dichotomous thinking that sustains a gender divide in the IT field (e.g. the divide between 'creators' and 'users'). In addition to bringing a wider lens to what constitutes an IT worker, this study situates women's IT learning and work within the broader context of their life and work histories. Women's career pathways (and those of many men) are

[3] Kaela Jubas has written her graduating paper as part of this larger project. *Dyeing the Pink Collar Mauve: Understanding Technical Communication as a Gendered Solution to Learning, Career and Information Technology Demands* (2004). Unpublished graduating paper. Department of Educational Studies, University of British Columbia. Kaela undertook the bulk of the literature research that is outlined in this paper.

neither linear nor straightforward--the shape of these pathways reflects women's double and triple arenas of responsibility to work, family and community as well as the vagaries in the IT labour market (Ahuja, 2002, Betsworth and Hansen, 1996).

This report is being prepared as we reach the end of the first stage of the project which has focused on developing an expanded literature base and conducting interviews and focus groups with women working in the IT field as well as those in IT training programs. In this project our aim is to offer both descriptive and conceptual information. One of our goals is to provide information about what kinds of IT work women *are doing* (and how they learn to do these jobs) in order to create a more comprehensive picture of women's contribution to the IT field. As noted above, another key aspect of this study is to challenge and disrupt some of the gender divides that persist in conceptualizations of what constitutes an 'IT worker'. In gathering women's work and learning histories, we also want to better understand what hinders as well as enables their learning and the recognition and reward they receive for their skills and knowledge.

A feminist action orientation informs this project, one that "requires us to expose and unsettle gendering and silencing mechanisms wherever encountered and however they intersect with other oppressions. It pushes us to define and share power for the tasks at hand" (Maguire, 2001, p. 66). This is not a dislocated 'view from nowhere', but one informed by our specific location as community and academically located feminist researchers. Our goal is to conduct respectful and reciprocal research where we share our findings throughout the project with our participants and women's IT advocacy organizations, as well as with academics.

We hope that this wider and deeper understanding can, first of all, help the women who participate in our study. Listening and honouring their experiences and locating their experiences in a larger context can help break the isolation that many women working in the IT field

experience. Documenting and sharing women's experiences and strategies can help create a community of practice (Wenger, 1998) among those women who are isolated in their positions. We are also sharing the findings of this study with women's IT organizations in the hopes that it will enhance and support their advocacy efforts. Connecting with other researchers who are also investigating some of these issues will help create a web of understanding regarding women's access to the jobs in the 'knowledge economy'. Government policy makers will also be sought out; our goal is to have our findings inform the development of a constellation of policies--some focused on education and training and others on labour practices--policies that can more effectively support women's equal participation in the IT field.

A.2 Conceptualizing Learning

In the academic study of adult education and other fields of inquiry concerned with learning, there are numerous terms used to qualify this key concept: informal, formal, non-formal, experiential, social, transformative, good, bad, self-directed, deep, surface, tacit, situated, on-the-job, workplace, reflexive, and so on. Theories of learning are also numerous: neuro-physiological, behavioural, cognitive, and constructivist, to name a few. Sorting learning into categories is both useful and problematic as the boundaries and distinctions among and between forms and contexts of learning are often blurred.

Given the focus on informal learning that is central to the larger research network that this case study is part of, we begin with definitions of informal and formal learning. Livingstone (1999) defines formal schooling as: "an age-related, hierarchically organized, formally constituted system that … provides the major credentialing programs to certify our knowledge competencies" (p. 50). Informal learning, in contrast, "… occurs outside the curricula of institutions providing educational programs, courses or workshops … the basic terms of informal

learning are determined by individuals and groups who choose to engage in it" (p. 51). There are problems with making these distinctions, as Colley, Hodkinson, and Malcolm (2003) point out in their recent study of the conceptual terrain of non-formal learning:

> Seeing informal and formal learning as fundamentally separate results in stereotyping and a tendency for the advocates of one to see only the weaknesses of the other. It is more sensible to see *attributes of informality and formality* as present in all learning situations….The challenge is to identify such attributes, and understand the implications of the interrelationships between them. (p. 8) (emphasis added)

For the purpose of this study, these definitions of formal and informal learning are part of the backdrop that informs how we listen and make sense of women's stories of work and learning. Other conceptualizations of learning, have also been sough to inform this inquiry, particularly those that attend to *social participation* as a significant aspect of learning. Wenger (1998) clarifies his notion of social participation: "participation here refers not just to local events or engagement in certain activities with certain people, but to a more encompassing process of being active participants in the *practices* of social communities and constructing *identities* in relation to these communities" (p. 4) (emphasis in original) . Wenger further articulates a set of assumptions about learning and knowing (p. 4). First, because we are social beings, social participation is a central aspect of learning. Second, "knowledge is a matter of competence with respect to valued enterprises". Third, "knowing is a matter of participating in the pursuit of such enterprises". And fourth, "meaning … is ultimately what learning is to produce". Lave and Wenger emphasize that they are not suggesting their approach *replace* other theories, instead, they offer what they believe is a conceptual framework that can lead to "general principles and recommendations for understanding and enabling learning" (p.4). These assumptions fit well with our study's orientation to informal and alternative learning pathways to

IT jobs. We, like Wenger, assume that learning must be understood in context, as situated and integral to other activities of life.

Gender plays a powerful role in organizing relations and as such, the role it plays in learning cannot be overlooked. Given that our study is also about women's learning, we look to the work of feminist scholars who have challenged the gender-neutrality of some discussions about adult learners. While drawing attention to the significance of gender, we are also mindful of the crucial need to recognize how women are differentiated by other categories of social location such as race, class, age, culture, sexual orientation, disability and so on. As Stalker (2004) points out: "in earlier days….the concept [women's learning] was hailed … because it inserted female perspectives into adult learning theories" (p. 2). Current efforts to explore how gender matters to learning "… are attempting to recognize and value the uniqueness of women's learning without tying it to rigid models" (Stalker, p. 3).

How gender (race and class) is operating and structuring relations and experiences of learning is central to this study. In an effort to avoid the problems of race and class-blind orientations to women's learning and of applying a rigid template onto the complexities of women's learning, we bring a relational and integrated approach. As Hayes and Flannery (2000) have argued, "gender [is] a type of social relation that is constantly changing, created and recreated in daily interactions as well as on a broader scale through such institutions as school, work and the family" (p. 4). Gendered knowledge systems, they continue, also differ "… by society, culture, ethnic group, locality" (p. 5). Focusing on 'gender/race/class in action' means that attending to how power is operating must be a key element of our analysis (and we argue of all the case studies in this network). An integrated approach to studying women's learning, one which acknowledges both similarities and differences, is the aim of this study (e.g. Miles, 1996).

A. 3 Demographics of IT Workers

Like other industrialized countries, Canada is undergoing a transition in which IT is playing an important and increasing economic and societal role (Bowlby & Langlois, 2002; Habtu, 2003). As a relatively new field which has had a sudden and substantial impact on society, there is still a lot to be explored in relation to who works in the IT field and what tasks they perform. As Habtu explains,

> Except for anecdotal evidence, little is known about the people who design, produce, and service the technology we use every day. Who works in these occupations? What is their education? How many women are there? Or immigrants? Do workers in these occupations prefer self-employment? Do they work longer hours, and how much do they earn? In which industries, provinces and urban centres are they concentrated? (p. 5)

Habtu also reminds us that it was only in 2001 that the Canadian Census began collecting information about IT workers, with its inclusion of IT work in the National Occupational Classification for Statistics (Statistics Canada, 2001a). An examination of this classification tool indicates that IT work is officially considered to be a part of the natural and applied sciences. Census data from 2001 indicate that 2.6 per cent of Canada's labour force (or approximately 406,700 people) were located in the IT sector[4]. The small portion of the labour force involved with this work, at least in relation to how it has been defined, stand in contrast to the attention it has received as a key aspect of the knowledge economy.

Habtu found that in 2001 the IT sector was classified into the following professional and technical occupations: computer engineers (6.9%), information systems analysts and consultants (26.2%), database analysts and data administrators (3.5%), software engineers (6.6%), computer programmers and interactive media developers (25.1%), web designers and developers (5.9 %),

computer and network operators and web technicians (11.8%), user support technicians (12.2%), and systems testing technicians (1.7%). This type of work classification complicates the identification of IT workers. While some credentials and jobs carry titles which clarify their central place in the IT field, others have titles and duties which appear to be more peripheral to the field.

The naming of IT training programs, credentials, work and workers has implications for the recognition of a job's demands and workers' skills and knowledge. There are many ways in which demands, skills and knowledge may be recognized formally and informally. Formalized recognition is evident in, for example, earnings and opportunities for career advancement; informal recognition is implied in job security and employee relations practices. As other demographic research shows, issues of recognition surface particularly during downturns in the economy, to which information and communications technology (ICT) seems especially vulnerable. In their review of the "boom and bust" of the computer and telecommunications (CT) industrial sector, which incorporates almost 90% of the wider ICT sector, Bowlby and Langlois (2002) conclude that, "It appears that during economic expansion, employment, and hours worked in the CT sector increase more rapidly than in the total economy; conversely, during economic slowdown, they decrease more rapidly" (p. 13).

Bowlby and Langlois identify the boom years as 1997 to 2000, and the bust year as 2001. Throughout the boom years, the sector was based in larger urban centres, especially Toronto, Montreal, Ottawa-Gatineau and Vancouver. It was characterized by a workforce with a higher than average formal educational level, in which men were over-represented relative to other

[4] There is a distinction made between the IT sector and the IT field. The former refers to jobs located in the companies focused on IT production and service, while the latter refers to jobs whose IT focus is peripheral to a company's or organization's primary purpose.

industrial sectors. Over the course of 2001, the bust of the sector had a particularly strong impact on workers with the lowest levels of education and women, as they experienced the greatest threat of job loss (Bowlby & Langlois, 2002; Bowlby, 2003). While Bowlby's most recent article suggests that the sector has emerged from the bust period, it also implies that workers' educational credentials and sex are important determinants of opportunity in the IT field. It appears that employers' reliance on credentials in selecting and hiring workers varies according to the growth or contraction of this fairly volatile sector.

A. 4 Women's Participation in IT

> The mathematician Lady Lovelace (1815-1852), daughter of the English poet Lord Byron and associate of Charles Babbage, is often considered along with Babbage as the inventor of the modern digital computer. American computer scientist Grace Murray Hopper (1906-1992) was a navy officer and mathematician assigned to the computation laboratory at Harvard University where she worked as a programmer in 1944 on the Mark 1, the first large-scale US computer….Throughout the swinging 1960s, there were considerable numbers of women involved in software development, data processing and data entry activities required to support the basement-sized machines then in use. These women were valued for the range of skills and understanding that they brought to the situation….So why, when these large, cumbersome basement-filling machines became the compact, computer equivalent of white goods, did they become toys for the boys? (Ordidge, 1997, p. 30)

The early contributions of women to the development of the computer and information technology are rarely mentioned in studies investigating women's involvement in the IT sector. Indeed, as already noted, most studies have found women to be under-represented across the IT field of work (Millar & Jagger, 2001; Breidenbach, 1997; MacInnis, 2003; Rola, 2003) although the precise proportion of female workers varies from study to study. Because women are under-represented in the educational and training programs which are most linked to the IT field, specifically computer science and engineering, the issue of who is identified as an IT worker has particular currency. Within their own networks and publications, if not in formal research, IT

practitioners and organizations have acknowledged their encounters with this problem. As Liam Lahey notes in his *Computing Canada* article,

Just how many women are working in IT positions seems to be a point under dispute. On one hand, a survey of the Ontario IT labour market by the Information Technology Association of Canada (ITAC) last May revealed that women make up a disproportionately small segment of the IT workforce – only 28 per cent. Statistics Canada, meanwhile, says almost half (46 per cent) of Ontario's IT workers are women. *(Lahey, 2002, p. 26)*

Most reports indicate that women constitute approximately 27% of workers in the IT sector. Millar and Jagger also note that, as a group, women have higher than average levels of education, whether or not this education is in the applied sciences, engineering or mathematics, and lower median earnings, in relation to all employed women (Habtu, 2003; Information Technology Association of Canada (ITAC), 2002). While the overall picture of the IT labour market indicates that women are a minority (about one quarter), when the IT labour market is disaggregated into specific jobs, the picture of women's participation shifts. For examples, two fifths (41%) of database analysts, data administrators, and systems testing technicians are women. One third (33.1%) of web designers and developers are women. They are less commonly found in the more generally popular but male-dominated jobs such as systems analysis or computer programming.

For the most part, the picture of women engaged in IT education and work in Canada resembles that of women and IT workers in other countries. In their report on a large scale international study which included data from the United Kingdom, the United States, Canada, Ireland, Taiwan and Spain, Millar and Jagger (2001) found that, overall women were under-represented in information technology, electronics and communications (ITEC) courses and

careers[5], with better representation in some fields such as computer analysts/programmers and computer systems managers. Notably, these researchers found that in Taiwan, 1999 statistics indicate that 66 per cent of the workforce in IT Service jobs was female. Excluding Taiwan, women's presence in IT service jobs ranged from 21 per cent in Spain to 34 per cent in Ireland (p. 14). The wage gap has also been the focus of research with women's salaries equivalent to 85% of what men earn (American Association of University Women (AAUW), 2000). It has also been noted that women who enter the IT sector through informal or nonformal learning pathways have different experiences compared with men with professional credentials (AAUW, 2000).

How women end up working with IT is related in some way to what they study after high school. Two areas of study are particularly associated with preparation for careers in the IT field: computer science (referred to as "computing" in the Millar and Jagger report) and engineering. While the proportion of women graduating from engineering programs seems to be climbing slightly in all six countries except the UK, it remains low in all countries. The proportion of women graduating from computing programs[6], while slightly higher than the proportion graduating from engineering programs, is declining across these countries (Millar & Jagger, 2001). Woodfield (2000) further distinguishes between degrees earned in British polytechnical institutions offering undergraduate degrees only, and universities which extend the possibility of post-graduate degrees. Although she agrees that women are, overall, under-represented among graduates of IT educational programs, she outlines how women are more

[5] The IT occupations included in their work included computer systems managers, software engineers, and computer analysts/programmers; technical communication was not included.
[6] The report's authors note that figures for computing are combined with those for mathematics for Spain and Taiwan. The proportion of women graduating from mathematics programs is highest in the US, and Canada, and is relatively low in Taiwan and Spain (even with the addition of the computing studies) and in the UK where it is declining.

likely to complete an IT-related program at a polytechnical institution rather than a university. As she explains,

> Females, as a group, become increasingly under-represented in computing…as institutional prestige increases, given the lower status endured by polytechnic universities (or new universities in the UK). Unsurprisingly, this tendency is also to be found in the US where the percentage of women taking computer science classes in the more illustrious institutions approaches only half of the national average. *(p. 4)*

Even among those few young women who had the science and math courses and who had entered sciences programs in university, many are not completing their engineering and science degrees (Trache, 2003). Despite the presence of women in technology's early years as well as contemporary efforts of governments and post-secondary institutions to recruit more women into education programs, there is both Canadian and international evidence that women's registration has actually dropped in recent years (Kerr, 2003; Millar & Jagger, 2001). The dean of Humber College's School of Information Technology in Ontario describes an example of this drop in enrolment: "In the 2000/2001 academic year, 21 per cent of the students at Humber were female. For the current academic year, only 15 per cent of the students enrolled in technology programs are female" (MacInnis, 2003, p. 23). This is in distinct contrast to the overall increase in women's participation in universities and colleges and the overall increase in students studying computer science generally. Furthermore, the widening gender gap can be found in many countries throughout the world, not just in North America.

It is important to note that in the above mentioned studies, while the gendered aspect of the labour market and of educational participation was considered, these investigations did not attend to other factors such as race, class, sexual orientation, or disability. We can assume, with some caution, that given the resources required to participate in formal education and to engage in a relatively higher paying labour market this group of workers is more likely to be or come

from middle to upper class backgrounds. How race and disability operate to form barriers to work and learning opportunities is also likely at play.

A. 5 The Gendered Culture of IT

The character of women's career pathways is another important area of research in relation to women's participation in IT jobs. Ahuja (2002) and Betwsworth and Hansen (1996) point to the non-linear career paths of women and how their caring responsibilities figure prominently in their choices. The culture of many IT workplaces expect employees to put in long work hours in order to 'get the job done'. Studies of what motivates women to pursue IT careers have pointed to exclusionary practices that discourage women for these arenas. Other studies, however, pointed to the significant role that men can play in inspiring women to pursue these jobs (Carter and Kirkup, 1990; Margolis and Fisher, 2002). A UK study of the career paths of women taking an IT training program (Miscrosoft Certified Systems Engineer – MCSE) [7], found that most of the participants worked in traditionally female sectors such as education, public sector, and service industries, with very few women working in what has traditionally been identified as the IT industry (Herman and Ellen, 2004).

Herman and Ellen speculated that women were drawn to work in these sectors because of they more likely have work-life balance/family friendly employment practices. The IT work these women were involved with challenges the traditional gender boundaries in IT such as 'users and technicians', 'outside and inside the machine', and between design and application. Half of the jobs these women were doing were crossing these gender boundaries. For example, they were undertaking clerical roles that had expanded to include network administration and data management. These researchers found, like other studies, that work-life balance was a

[7] This program was specifically set up to support women's access to IT jobs.

significant factor in women's career choices such that "career progression is not prioritized amongst women with children - it is put on hold and decisions about jobs revolve around the impact on the family rather than career development" (Herman and Allen, p. 7). The length of time it took some participants in this study to enter the IT field was also notable; many of the participants introduction to IT came much later in their working life with several having not encountered IT at school. Another feature of these participants' routes to IT jobs was serendipity. "Working in IT was not planned, rather they had 'fallen into IT' in one way or another" (p. 9).

Feminist research has also focused on women's approaches and preferences to learning IT and how this relates to the dominant IT culture. Turkle and Papert (1990) found that women tend to be bricoleurs using pluralistic, alternative and non-conventional approaches to problem solving. Such approaches, however, are discouraged in favor of formal rule-bound paths to solving problems to the extent that women keep their pluralistic approaches hidden from view. Within formal training programs, it has been noted that peer interaction is common to programs where women are the majority (Clegg, Trayhurn and Johnson, 2000). Other researchers have also noted how gender operates in the identification of IT skills. Mahony and Van Toen (1990) found that women are often highly skilled 'end users' of IT, but are not considered to be 'real' computer people (i.e. computer programmers).

An ethnographic study conducted by Woodfield (2000) explored the research and development unit of a British corporation providing software development and systems integration products and services. In this study a relatively high proportion of female staff held scientific degrees, primarily in computer science, mathematics, engineering, electronics or physics (p. 90). Despite the presence of an uncommonly high proportion of women with science

degrees, the workplace displayed anticipated gender differences. Women tended to describe their interest in computers and technology as only one of several interests, while men described a now familiar type of obsessive interest in computers. Female participants were more often described by in-house instructors as being better able to adopt the corporation's newly preferred strategy of seeing "the broader picture" in their problem-solving, in contrast to male participants who were more often seen as remaining narrowly focused on "software solutions which grew out of specific technical detail" (Woodfield, p. 98). The instructors also appreciated the relative ease with which women were able to share credit for successful problem-solving with colleagues.

A. 6 Re-imaging of IT Careers

Campaigns have been developed by governments, post-secondary institutions and industry, and aimed at girls in school and young women contemplating their further educational and career options. Typically, these strategies attempt to convey information to girls and young women about the wide range of occupations in and educational pathways into the IT field, as well as to dispel the image of IT as a field populated by so-called computer "nerds" or "geeks". As Karen Lopez, a spokesperson for Canadian Information Processing Society, explains, "'Most girls think IT careers are isolating. They'll work alone, they'll work in a basement, sit around a glowing terminal and, sometimes, even do evil things'" (Rola, 2003, p. 27). A local study in Vancouver's public schools surveyed students in grades eight, ten and 12 in 1998 about their impressions of computers and IT work. With a response rate of approximately 56%, the researchers had a sample size of 7,411[8]. This study's results indicate that the girls surveyed were less interested in the subjects of computer science and engineering than the boys were and

[8] The study's authors caution that, for logistical reasons, it was not possible to use a random sampling process.

perceived themselves as less capable in these areas, whereas the boys were more interested in computer science and engineering than other subject areas (Chan, Stafford, Klawe & Chen, 2000). The results also indicate that most of the youth surveyed, but especially girls, were unaware of some of the key skills and personal qualities in demand by IT employers, including communications skills and being a team player, even though these are regarded as particularly female, rather than male, strengths in North American culture. Among the researchers' recommendations is "improving parent, student and teacher knowledge of computer-related careers through workshops, job-shadowing, mentoring and the media" (Chan et al.).

McDill, Mills and Henderson (2000) list several examples of Canadian projects that have attempted to address women's under-representation in IT educational programs and occupations through early socialization. In the 1980s through the mid 1990s, popular interventions included computer camps and other special programs addressing the gender imbalance. The WISH program – Women Into Science, Hopefully – was operated in the early 1980s by the Department of Physics at Toronto's York University. In New Brunswick, the Worlds Abound summer camp offered a gender-balanced environment for children in grades five to eight.

Some projects bring together researchers, educators and industry. One of these, the GenTech Project, "studies non-school based environments in which women experience unusual levels of success with ICTs. The results of this are fed into the development of a model for the implementation of 'micro-climates' within schools that is encouraging and supportive for girls and their female teachers" (Millar & Jagger, 2001, p. 23). A collaborative undertaking of the University of British Columbia, Simon Fraser University, the Richmond School District and Hewlett-Packard (Canada), funded by the Social Sciences and Humanities Research Council, the GenTech Project opened a "Girls First" computer centre at one Richmond elementary school,

offered learning opportunities to students and staff in website design and multi-media authoring, and developed an on-line guide for GenTech teachers and a project website for other educators and the general public (Millar & Jagger)[9].

Part B: Methodology and Findings

B. 1 Methodology

Stage one of this study has focused on gathering data from women's work and learning histories through face to face interviews and focus groups with the different 'populations' of women including women participating in community-based IT training programs (some of whom had previously worked in IT), women in clerical and administrative jobs where IT is a substantial portion of their responsibilities, women involved with both paid and unpaid advocacy and activist work where IT has become a central piece of their activities, and women who are using IT as a central aspect of their work in the humanities and arts. We have also spoken with a few women who have acquired IT credentials from traditional IT education programs.

We have used a purposeful sampling approach in order to recruit the different populations of women. Given that many of the workers we want to speak to are not organized in one place, we have faced some challenges in finding participants. Several of the initial participants were recruited rather serendipitously as we spoke about the project to friends, neighbours, and colleagues. Links with women's IT organizations such as Wired Women and Digital Eve have also been established and these organizations have been sent posters about the project and asked to distribute this information to their memberships. An ad was placed in a Vancouver office newspaper and notices about the project have been mailed to public and private

[9] Information about the GenTech Project is available online at http://www.educ.sfu.ca/gentech

IT training programs. We sent flyers to a list of IT companies that were identified in a Vancouver Sun news article that discussed the up and coming IT companies. Posters were also sent to an on-campus program at UBC geared to exploring women and technology issues. Information about the study was also placed on Shauna's website as well as the ACTEW website. While these efforts produced some results, a substantial portion of our participants were identified through snow-ball sampling. Many of our participants were referred to us by interviewees we had already spoken to.

We began interviewing in May of 2003 and to date we have conducted 45 interviews including a focus group with women participants in an IT program. Several areas were explored with each participant. Demographic information was collected along with work histories and early experiences with computers and IT. We then focused on their experiences in IT-related jobs and how they acquired their skills and their preferred learning strategies. We explored their perspectives on the IT field as a labour market for women and asked for their advice regarding the project. Most of these interviews lasted 1 to 1.5 hours and were conducted face to face, with a few conducted over the phone. Interviews have conducted in Toronto, Vancouver and Victoria. Transcripts (and when requested copies of the audio tapes) were made and sent to participants. In order to give something back to the participants as we proceeded with the project, we created a flyer which outlines a list of resources (see Appendix A) such as the contact information for various women's IT organizations. A research bulletin (see Appendix B) that gives an update on the study has also been sent to each participant. We will be sending other updates at regular intervals in order to keep in touch with participants. Participants are encouraged to look at Shauna's and ACTEW's webpages for copies of presentations and papers written about the project.

In addition to recruitment challenges, we have also realized the advantages as well as the limitations of using semi-structured interviews as our main data collection strategy. We have noted how participants struggle on occasion to articulate and bring to consciousness their informal and on-the-job learning experiences. This is not surprising if, as this study argues, we understand learning as an integral aspect of everyday social interactions. Asking them to tell us a story about their IT careers and to recall specific moments that involve solving a problem were often more effective that simply asking "tell me about how you learn", although this question also elicited interesting reflections. Ideally, a study that understands learning as a social phenomenon and one that seeks to illuminate learning that occurs outside of formal educational contexts would include observations. This would be fruitful, but 'shadowing' participants at their places of work may not be welcomed. Furthermore, in this case study we want to hear from women working in diverse situations, therefore observing each participant's worksite was beyond the scope of this study.

Stage two will involve further interviews, and the development of an online survey and analysis of policy documents (informed by the stage one interviews). An advisory network is also being established and making links with this network is a key objective for the next stage of the project. This network, currently in development, will consist of individual women we have interviewed who have a breadth of IT experiences and who are interested in serving in an advisory capacity. We are also linking with women's IT organizations. Given the difficulty of organizing a meeting across the two locations (BC and Ontario), we plan to use an outreach approach, meeting individual network members, and when possible in small groups to talk about the overall study goals, what themes are emerging, and what issues are most salient. We have

also established links with researchers in the US, UK and Europe who are conducting similar investigations and we will continue to link with these and other ongoing projects.

B.2 Demographics of Participants

Age: The women in our study range in age from 24 to 60. There are important generational aspects to these women's work and learning histories. Most, but not all, of the older participants acquired their IT skills through on-the-job experiences, short-courses and self-directed study. These women noted that when IT began to occupy more of their work responsibilities, few if any, IT training programs existed. In contrast, the younger participants had access to and participated in more formal IT training programs. Younger participants also indicated that they had encountered computers during school, while few of the older women had had such experiences. A few of the women noted that they were always interested in technology and computers, often being the first one of their family or cohort to buy a personal computer. Others spoke of feeling awkward and even fearful in relation to their initial encounters with computers, but spoke of feeling more confident as they grew more familiar with technology.

For most of the older women who were working in IT related jobs, serendipity played a key role in their IT career stories. Most of the older women who came to IT later in their careers had to learn their computer skills on the job as technology became a central aspect of their work; many of these women encountered technology and computers through their clerical and office administration roles.

Race and Class: Race is a significant issue when examining women's work histories. Of those women already working (not currently in a training program), most were Caucasian. In this group several noted their Jewish ancestry. Only a handful of the BC-based participants working in IT were women of color. All of the women in the Toronto-based focus group who were taking

a women-only IT training program in Toronto were immigrant women, most of them women of color, some of whom came to Canada with IT credentials that were not recognized. Although we did not specifically probe the participants' social/economic backgrounds, the life and work histories of those already working in the IT field reflected a mostly middle class status. Class was a more mobile factor for the immigrant women in the Toronto training program, many of whom were experiencing a loss of economic security as they moved to Canada and struggled to have their overseas knowledge and work experiences recognized by employers. 'Never show them how hungry you are' was a phrase used by the women in the training program to reflect the delicate dance they undertook as they sought out jobs in Canadian firms. Some of the immigrant women of color also commented that they had similar experiences as they attempted to connect with women's IT organizations.

Not all of the women with overseas IT credentials experienced barriers to having their skills recognized. Two of the women of color living in BC had recently immigrated to Canada and had managed to acquire well paying IT jobs. Both commented that their IT skills acquired overseas were recognized by immigration officials and they were able to easily acquire work visas. One of these women, however, had recently lost her job when the firm she worked with was merged with another company. In hindsight, she felt that her racialized identity had played a factor in being laid off.

Disability: Two participants identified themselves as having a disability. One woman had suffered multiple injuries in a car accident leaving her with ongoing fatigue and limitations to her mobility. Another woman indicated that she has multiple sclerosis that was in remission at the time of the interview.

Family Status: The challenges of working in the IT field while caring for children, as outlined in other studies, surfaced in this project as well. Most of our participants had no children. Of those with children, very few had children still in school, most were now young adults. One third of the women in the Toronto IT training program had children and several of them spoke about how the expectations of employers for long work hours were not family friendly.

Education: These participants were well educated with most having completed a post-secondary degree or certificate, including college or poly-technical diplomas or certificates. Four of the participants had completed master's degrees and one had a PhD. The disciplinary focus of their post-secondary education included Anthropology, Applied Science, Commerce and Business Administration, Education, English, European Studies, Library Science, Mathematics, Psychology, and Science. Only two had completed a degree in computing science and one woman had finished 3 out of 4 years of her undergraduate computer science degree. Of those without computer science degrees, all had participated in some kind of formal IT training ranging from short courses to 6 months Microsoft Certification.

Employment and Career Pathways: These women worked in the public, private and non-profit or voluntary sector with two thirds working in the private sector and very few (only one to date) who is working in the not-for-profit or voluntary sector. Only three participants, all with positions in government, were working in unionized sites. Four of the participants identified themselves as self-employed IT consultants. All of these 'self-employed' consultants, however, continued to work part-time as employees in order to make a living wage. Some of these participants' job titles reflected the significant role IT played in their overall work responsibilities: one woman was a software engineer, one is a professor of computing science, one is a network support coordinator, one is an internet system administrator, and four are web

developers or website managers. In the job titles of the remaining participants IT did not figure prominently: communication managers, senior managers, library technicians, marketing manager, director of accounts, business analysts, secretary, director of operations, sales manager, project managers, librarian, travel consultant, and creative director.

A few of the participants' career pathways-- those who had acquired formal IT education credentials immediately following high school--reflected a fairly straightforward and 'upward' trajectory. These women began their careers in the IT field and remained in the field, making job changes that placed them in higher paying and more responsible positions. For the majority of participants, however, their career pathways reflected more of an image of 'snakes and ladders' with upward moves, lateral moves and downward slides, often occurring during downturns in the IT sector economy.

B.3 Learning Pathways

What is reported here is *very* preliminary analysis offered as a broad summary of two key issues: participants' learning experiences and their learning strategies. A more detailed documentation of these general observations is ongoing—one that will include the words of our participants in order to illustrate the nuances and complexities of their IT work histories. As noted earlier, all participants had participated in formal IT learning ranging from short courses to computer science degrees. They had also acquired their knowledge and skills through other routes and contexts, most notably, on-the-job. As noted, this study takes up women's informal and alternative learning pathways as a primary focus of investigation. Women have told us that they were drawn to the study because it highlighted these alternative routes. Many participants were cautious about applying the label 'IT worker' to themselves, although a few felt they fit that category. Those that were cautious or resistant to being identified as an IT worker, felt it was

more accurate to say they were working in the IT field. Further exploration of these workers' identities is an important area for future analysis. Working with IT has become common to many jobs and delineating what is and what is not considered IT work is becoming more difficult.

Mixed Approach: What is clear even at the early stage of analysis is that most of these participants' learning pathways involve a complex blend of formal, informal, non-formal and on-the-job learning, shaped by both serendipity and intentional efforts to learn IT skills. We are reminded of the words of Colley, Hodkinson, and Malcolm (2003) who point out how the boundaries of learning are blurred and that using neat categories to explain learning experiences is both useful and problematic. What also struck us as we submerged ourselves in their stories was how social participation is central to these women's work and learning histories. These participants learned their IT skills within a variety of contexts with the workplace taking up a central role. Some stories also pointed to significant learning experiences that had occurred through voluntary activities. There were a variety of views regarding the value of IT credentials. Not surprisingly, for some participants, their lack of formal IT training credentials had not been a problem or barrier to employment during the boom period, but became one when the bottom fell out of the dot.com market. Others noted that certain IT credentials had lost their value as the field became flooded with different kinds of training programs.

Resources: These women used a variety of resources as they learned on-the-job. Not surprisingly, the internet was a very significant source of information for many of the participants. Some also referred to computer magazines, IT texts and computer manuals for information; the latter were often regarded as minimally useful. Work colleagues and networks of individuals outside of the work place played a central role in all participants' narratives of

how they learned their IT skills. Several women spoke of the significance that mentors had played in their initial foray into IT work with some of these participants continuing to stay in touch with their mentors. Mentoring was mentioned quite frequently by these women as an important factor in their success.

Quality of Formal Training: Participants had mixed reviews of the quality of the formal IT training programs they had taken. Several commented that their learning needs were hard to predict and sometimes they were able to take a relevant training program but other times, they could not find a specific program to meet their immediate needs. One participant who had dropped out after three years of computer science found the experience very troubling. She had excelled in math and computers in school but had quite a different experience at university. She, like many others, noted that learning in teams and making what she was learning applicable and practical were better approaches than learning the theory or science of computers. After this participant shifted to a poly-technical institute where the learning was practically oriented, she excelled in her IT studies. Another who had taken a Microsoft Certification program commented that what she learned in that program was the 'Microsoft Way' and the approach she used to solving problems once she was working was broader and less formalized and rigid.

Collaborative Learning: Many participants emphasized the significance of a team approach to learning or problem solving. They spoke about how no one person can have all the knowledge and skills especially given the rapid development of new technologies. It was essential for most of these women, especially those working as project managers and in technical communication, to problem solve within a group. A few commented that if you think you've got all the answers, you will not survive in the field, relating stories of some colleagues who operated from this perspective. Several of the participants we spoke with all worked in one company, a mid sized

firm that provided IT system development and management to both the private and public sector. They described a work place where the ongoing need to learn was respected and supported. They held 'lunch and learn' sessions almost every week where a staff member who had participated in a workshop would present to the group. Other approaches at this firm included breaks from work where a newer staff member would take a day or two and sit with a more experienced colleague to learn a specific task or piece of information.

Many of the women in this firm, as well as other participants, commented on how 'soft skills' were important aspects of their learning strategy. They described these skills as listening, watching, questioning and probing other colleagues like programmers, in order to pull out these individuals' IT knowledge. The importance of observing others while they worked on a problem was frequently mentioned as was brainstorming. The notion of intuition emerged spontaneously in early interviews, so we decided to continue to ask all participants about this, always probing for what they understood by that concept. When we asked this question, almost all participants quickly responded that yes, indeed, intuition played a key role in their approach to problem solving.

Attraction and Disruption: Several participants spoke about how they 'clicked' with computers. "What I found was that my brain liked it, that's the only way I can describe it, my brain liked it." As they became excited about computers, several proceeded to buy their own personal computer at a time when the costs were high. These participants enjoyed playing around, often for hours, and figuring out how things worked. In contrast to some women's initial strong and positive connection to learning about computers, other participants described those encounters as more disruptive. Several were 'thrown into the deep end' and described their experiences as a steep learning curve that was both exciting and anxiety producing. Several noted how they worked in

smaller firms where they had to learn to do everything, commenting on how this macro view and their ability to see links was something they and their employers valued.

Understanding Self: Many women spoke about learning not only IT and other job-specific skills but also learning about themselves. Some noted moments in their careers when they had been overlooked and their IT skills rendered invisible. They learned from these experiences to become more assertive and to fight to have themselves be recognized and to participate in decision making. They described these assertiveness skills as both essential and problematic. When they did articulate and insist on being heard, some experienced backlash, commenting that they felt male employers were uncomfortable with their direct approach. Several noted how good they felt to look back and realize how much knowledge about IT they had acquired.

The Dialectic of Teaching and Learning: A striking theme that emerged early on in these stories was the relationship between teaching and learning with many participants commenting spontaneously that once they learned something they would quickly help others or share their new skills and knowledge. They spoke of how the process of teaching/helping others was part of, not separate from, their learning. Teaching others helped them to cement their learning. It also broadened and deepened their understanding and often brought new questions and issues to the surface which then led to further learning explorations. Several participants whose job responsibilities involved training others and preparing manuals, also commented on the importance of maintaining a learner's perspective. Having occupied that location at one time (and throughout their work in the field), they believed that this perspective had helped them to be effective in their creation of materials. Those who were involved with IT training and the creation of IT learning materials, as well as women who worked as project managers and in

technology communications, often described themselves as 'translators', as being able to take unfamiliar IT codes and terms and create a bridge for those having to use the technology.

Lifelong Learning: Another issue we asked about was the constancy of learning given the rapid and ongoing changes in the IT industry. This state of constantly upgrading was commented on by many participants as exhilarating and an important reason they stayed with this field; for these participants, if they weren't constantly learning something new, they would be bored. At the same time participants, noted that this constant demand to upgrade their skills was also worrying, frustrating and tiring. One way to deal with this constant state of not-knowing and knowing was to specialize and put limits around their skill set. When asked who should be responsible for their learning, almost all of the participants indicated they were responsible with a few making reference to their employers' responsibility.

Barriers to Learning: When we explored barriers to learning a couple of themes emerged. The lack of time was frequently the response to our questions. As already mentioned, working in a team and problem solving with others was a dominant theme in their learning stories. When women found themselves working in isolation, often as the only one in their office knowledgeable about IT, they struggled to learn on their own and sought out others beyond their immediate workplace to discuss their learning needs. Participants who were working as consultants found the self-employed status a challenge in relation to taking time off from work to take a course. The cost of training was also a barrier to some women.

Closing Comments:

A few threads have stood out for us as we reach the end of our initial analysis. There is much to be learned from talking to workers in IT given the constancy of learning required.

Lifelong learning is certainly a characteristic of this sector of the economy. These women's learning pathways involved a complex mix of formal and informal learning, each feeding into the other in reciprocal ways. These women's stories were not just about how they were learners, but how they were also involved with others learning. Indeed, helping others learn and sharing their IT skills and knowledge was an important *learning* strategy for these participants. For some of these women, their effectiveness as IT workers was strongly connected to their ability to keep the learner's perspective in their minds' eye.

For the most part, our participants occupy relatively privileged locations. How gender, race and class are operating in their narratives requires a closer reading. Much deeper analysis of these initial conversations will continue as more data is gathered.

References

A Career in Technical Communication: What's In It for You? (no date). Retrieved January 15, 2004 from the website of the Society for Technical Communication: http://www.stc.org/PDF_Files/aCareer.pdf

Ajuha Ahuja, M. K.(2002) Women in the information technology profession: a literature review, synthesis and research agenda *European Journal of Information Systems* 11 (1) pp. 20-34.

American Association of University Women. (2000). *Executive Summary: Tech-Savvy: Educating Girls in the New Computer Age*. Retrieved January 19, 2004, from http://www.aauw.org/research/techexecsumm.cfm

Bentz, V. M. & Shapiro, J. J. (1998). Phenomenological inquiry. In *Mindful Inquiry in Social Research* (pp. 96-104). Thousand Oaks, CA, London & New Delhi: SAGE Publications.

Betsworth, D and Hansen, J, (1996) The Categorization of Serendipitous Career Development Events *Journal of Career Assessment* , 3 pp 91-98.

Bowlby, G. (2003). High-tech – two years after the boom [Electronic version]. *Perspectives on Labour and Income* (Statistics Canada, Catalogue 75-001-XIE), November 2003, 14-17.

Bowlby, G. & Langlois, S. (2002). High-tech boom and bust [Electronic version]. *Perspectives on Labour and Income* (Statistics Canada, Catalogue 75-001-XIE), April 2002, 12-18.

Breidenbach, S. (1997). Where are all the women? [Electronic version]. *Network World*, October 13, 1997, 68-69.

Casey, C. (1995). *Work, Self and Society: After Industrialization*. London & New York: Routledge.

Chan, V., Stafford, K., Klawe, M. & Chen, G. (2000). *Gender differences in Vancouver Secondary Students' Interests Related to Information Technology Careers*. Paper presented at the 6th Conference of the Canadian Coalition of Women in Engineering, Science and Technology, New Frontiers, New Traditions, St. John's NF, July 6-8, 2000. Retrieved January 15, 2004, from http://www.ccwest.org/DBSearchEngine/Conf2000Papers/ChanVania.pdf

Clegg, S. (2001). Theorising the machine: Gender, education and computing [Electronic version]. *Gender and Education*, 13(3), 307-324.

Clegg, S. & Mayfield, W. (1999). Gendered by design: How women's place in design is still defined by gender [Electronic version]. *Design Issues*, 15(3), Autumn 1999, 3-16.

Colley, H., Hodgkinson, P. & Malcolm, J. (2004). Informality and Formality in Learning. Lifelong Learning Institute, Leeds University, UK. http://www.lsrc.uk

Collins, P. H. (1997). Comment on Hekman's "Truth and method: Feminist standpoint theory revisited": Where's the power? [Electronic version]. *Signs: Journal of Women in Culture and Society*, 22(2), 375-381.

European Technology Assessment Network Expert Working Group on Women and Science (2000). *Science Policies in the European Union: Promoting Excellence Through Mainstreaming Gender Equality*. Retrieved March 7, 2004, from the website of the European Commission: http://www.cordis.lu/rtd2002/science-society/women.htm

Habtu, R. (2003). Information technology workers [Electronic version]. *Perspectives on Labour and Income* (Statistics Canada, Catalogue 75-001-XIE), July 2003, 5-11.

Hayes, Elizabeth and Flannery, Daniele (2000). *Women as learners: The significance of gender in adult learning*. San Francisco, CA: Jossey-Bass.

Harding, S. (1997). Comment on Hekman's "Truth and method: Feminist Standpoint theory revisited": Whose standpoint needs the regimes of truth and reality? [Electronic version]. *Signs: Journal of Women in Culture and Society*, 22(2), 382-391.

Hayes, E. & Flannery, D. (2000). Women as learners – The significance of gender in adult learning. San Francisco: Jossey-Bass.

Henwood, F. (2000). From the woman question in technology to the technology question in feminism: Rethinking gender equality in IT education [Electronic version]. *The European Journal of Women's Studies*, 7, 209-227.

Henwood, F. (1998). WISE choices? Understanding occupational decision-making in a climate of equal opportunities for women in science and technology [Electronic version]. *Gender and Education*, 8(2), 199-214.

Herman, C. & Ellen, D. (2004). I would say I've fallen into it. Career paths of women network technicians participating in the JIVE project. Paper presented at the Gender and ICT Symposium, Brussels.

High Technology Professionals and High Technology Companies in British Columbia. Employment Standards Factsheet. Retrieved January 20, 2004, from the website of the British Columbia Ministry of Skills Development and Labour (Employment Standards Branch): http://www.labour.gov.bc.ca/esb/facshts/pdfs/high-tech.pdf

Huws, U. (2000). The changing gender division of labour in the transition to the knowledge society. In K. Rubenson & H. G. Schuetze (Eds.), *Transition to the Knowledge Society: Policies and Strategies for Individual Participation and Learning* (pp. 341-354). Vancouver: UBC Institute for European Studies, University of British Columbia.

Information Technology Association of Canada (ITAC), *Meeting the Skills Needs of Ontario's Technology Sector*, May 6, 2002

Jubas, K. (2004). *Dyeing the pink collar mauve: Understanding technical communication as a gendered solution to learning, career and information technology demands*. Unpublished graduating paper. Department of Educational Studies, University of British Columbia.

Kerr, A. (2003). Group moves to boost women in IT – Program aims to reverse trend that is seeing falling interest in sector by females. *The Globe and Mail*, Monday, May 26, 2003, B14.

Kirkup, G. (2002). ICT as a Tool for Enhancing Women's Education Opportunities; and New Educational and Professional Opportunities for Women in New Technologies. Paper presented at the United Nations Division for the Advancement of Women's Expert Group Meeting on Information and communication technologies and their impact on and use as an instrument for the advancement and empowerment of women, Seoul, Korea, November 11-14, 2002. Retrieved January 5, 2004, from the United Nations website: http://www.un.org

Lahey, L. (2002). Band of sisters [Electronic version]. *Computing Canada*, December 13, 2002, 26.

Lipsett, B. (2000). The impact of the knowledge-based economy on women's participation. In K. Rubenson & H. G. Schuetze (Eds.), *Transition to the Knowledge Society: Policies and Strategies for Individual Participation and Learning* (pp. 322-340). Vancouver: UBC Institute for European Studies, University of British Columbia.

Livingstone, David (1999). Exploring the icebergs of adult learning: Findings of the first Canadian survey of informal learning practices. *Canadian Journal for the Study of Adult Education*, 3(2), 49-72.

MacInnis, P. (2003). The gender gap [Electronic version]. *Computing Canada*, June 6, 2003, 26.

Madan, P., Brown, D., Schoeneman, J., Mai, T., Sethi, M., & Dimler, L. (2002). *2002 workforce: Connecting today's youth with tomorrow's technology careers*. Retrieved January 14, 2004, from the website of the Joint Venture: Silicon Valley Network: http://www.jointventure.org/workforce/Workforce_Final.pdf

Maguire, Patricia (2001). Uneven ground: Feminisms and action research. In P. Reason & H. Bradbury (Eds.) *Handbook of Action Research – Participative Inquiry and Practice*. London: SAGE.

Mahoney, K. & van Toen, B. (1990). Mathematical formalism as a means of occupational closure in computing – why 'hard' computing tends to exclude women. *Gender and Education*. 2(3), 319-331.

Margolis, J. & Fisher, A. (2002). *Unlocking the Clubhouse: Women in Computing*. Cambridge, MA and London: The MIT Press.

Margolis, J., Fisher, A., & Miller, F. (no date a). *Computing for a purpose: Gender and attachment to computer science* (work in progress). Retrieved December 15, 2003, from the website of the Carnegie Mellon Project on Gender and Computer Science: http://www.cs.cmu.edu/~gendergap

Margolis, J., Fisher, A., & Miller, F. (no date b). *Women in computer sciences: Closing the gender gap in higher education* (work in progress). Retrieved December 15, 2003, from the website of the Carnegie Mellon Project on Gender and Computer Science: http://www.cs.cmu.edu/~gendergap

McDill, M., Mills, S., & Henderson, Y. (2000). Tracking the gender barrier: A 1990's follow-up study (Draft/preprint). Presentation from *New Frontiers, New Traditions* (6th Annual Conference), St. John's, NF, July 6-8, 2000. Retrieved January 15, 2004, from the Canadian Coalition of Women in Engineering, Science and Technology website: http://www.ccwest.org/DBSearchEngine/Conf2000Papers/McDillMoyra.pdf

Millar, J. & Jagger, N. (2001). *Women in ITEC Courses and Careers. Final Report*. Retrieved January 7, 2004, from the Government of the Department for Education and Skills, United Kingdom website: http://www.dfes.gov.uk/research/data/uploadfiles/ACFE89.pdf

Miles, Angela. (1996). *Integrative feminisms: Building global visions 1960s-1990s*. NY: Routledge.

Ordidge, I. (1997). IT's for girls – or is it? [Electronic version]. *Education and Training*, 39(1), 30-35.

Orr, J. E. (1996). Talking About Machines: An Ethnography of a Modern Job. Ithaca, NY: ILR Press.

Panteli, N., Stack, J. & Ramsay, H. (2001). Gendered patterns in computing work in the late 1990s [Electronic version]. *New Technology, Work and Employment*, 16(1), 3-17.

Rola, M. (2003). Girls turned off by image of life in IT [Electronic version]. *Computing Canada*, March 14, 2003, 27.

Stalker, J. (2004). Women's learning. In L. English (Ed.) *Encyclopedia of Adult Education*. London, UK: Palgrave Macmillan. (forthcoming)

Stanworth, C. (2000). Women and work in the information age [Electronic version]. *Gender, Work and Organization*, 7(1), 20-32.

Statistics Canada. (2001a). *National Occupational Classification – Statistics (NOC-S) 2001. Natural and Applied Sciences and Related Occupations*. Retrieved January 10, 2004, from the Statistics Canada website: http://stds.statcan.ca/english/soc/2001/nocs01-title-search.asp?cretaria=c

Statistics Canada. (2001b). *National Occupational Classification – Statistics (NOC-S) 2001. Occupations in Art, Culture, Recreation and Sport*. Retrieved January 10, 2004, from the Statistics Canada website: http://stds.statcan.ca/english/soc/2001/nocs01-title-search.asp?cretaria=f

Statistics Canada. (2001c). National Occupational Classification - Statistics (NOC-S) 2001. Occupations in Social Science, Education, Government Service and Religion. Retrieved January 10, 2004, from the Statistics Canada website: http://stds.statcan.ca/english/soc/2001/nocs01-title-search.asp?cretaria=e

Trache, Maria (2003). *Post-secondary paths in science for B.C. young women and men*. Unpublished Masters Thesis, Department of Educational Studies (Higher Education), University of British Columbia.

Turkle, S. & Papert, S. (1990). Epistemological pluralism: Styles and voices within the computer culture [Electronic version]. *Signs: Journal of Women in Culture and Society*, 16(1), 128-157.

Turner, S. V., Bernt, P. W., & Pecora, N. (2002). *Why Women Choose Information Technology Careers: Educational, Social, and Familial Influences*. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA, April 1-5, 2002. Retrieved December 17, 2003 from Educational Resources Information Center (ERIC Document Reproduction Service No. ED 465878).

Wenger, E. (1998). *Communities of Practice – learning, meaning, and identity*. Cambridge University Press.

Woodfield, R. (2000). *Women, Work and Computing*. Cambridge, UK: Cambridge University Press.