

PERCEPTIONS AND EXPERIENCES OF THE WORKPLACE AMONG CANADIAN COMPUTER SCIENCE AND ENGINEERING STUDENTS – A GENDER ANALYSIS

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Abstract: This paper presents an overview of selected results of a national survey on the career intentions of upper-year Canadian undergraduate students in computer science and engineering programs. The survey was conducted in spring and summer, 2010, by the regional Chairs for Women in Science and Engineering and included approximately 600 respondents. The paper offers gender and discipline-based analyses of the survey results, with particular attention paid to students' perceptions and experiences of the workplace. In designing the study, it was hypothesized that a higher proportion of female students might choose not to pursue employment in the field after completing their undergraduate program because of negative educational experiences and/or workplace expectations. While survey results reveal some gender differentiation in terms of educational experiences, similarly high proportions of male and female students intend to either pursue employment (~69%) or graduate programs in their field of study (~20%). However, a significant proportion of female students (63.3%) expect to face gender-based discrimination in the workplace, while only 5% of male respondents indicated similar concerns. An analysis of survey responses paint a concerning picture of experiences and expectations of hiring practices and workplace climate, one which warrants attention.

INTRODUCTION

Women continue to be underrepresented in the fields of engineering and computer science, both in post-secondary studies and in the workplace. In Canada, the most recent census data indicated that women represented 25.9% of the professionals in computer and information science and 12.2% of engineers (Statistics Canada, 2006). This study focuses on the experiences and career plans of those students who have chosen to pursue and complete post-secondary education in these fields. In designing the study, it was hypothesized that a higher proportion of female students might choose not to pursue employment in the field after completing their undergraduate program because of negative educational experiences and/or workplace expectations. While survey results reveal some gender and discipline differentiation in terms of educational

experiences, overall, respondents described their experiences in similarly positive rates. Further, similarly high proportions of male and female students intend to either pursue employment (~69%) or graduate programs in their field of study (~20%). At the same time, however, a significant proportion of female students (63.3%) expect to face gender-based discrimination in the workplace. While academic environments remain far from perfect, responses regarding the workplace paint a more concerning picture of expectations and experiences of gender discrimination in hiring practices and workplaces. This suggests that hiring practices and workplace climate may be significant barriers to attracting and retaining women who have completed post-secondary programs in computer science and engineering into employment in these fields in Canada. As such, attention to making further changes in these areas is vital. This paper provides an overview and analysis of selected survey results.

METHODS

The survey tool combines quantitative and qualitative measures, which assess educational experience, perceptions of personal strengths, skills and confidence, career motivations, and field and workplace expectations and experiences. The survey, which included both closed and open-ended questions, took approximately 15-20 minutes to complete and was made available in both an online and paper version. 604 students completed the study. However, as respondents were able to skip questions while remaining in the study, the number of responses analyzed for different questions varies somewhat. Respondents that indicated themselves to be students of a science other than computer science or engineering were excluded from this analysis, as were those that did not provide sufficient information to allow for a gender and discipline-based analyses. 586 respondents provided responses sufficient for the intended analysis. Approximately two-thirds of respondents were from engineering programs, while slightly more than a third came from computer science.

Tab. 1: Gender and Discipline

	Computer Science (CIS)	Engineering (ENG)	Total
Female	33.5% (68)	50.4% (193)	44.5% (261)
Male	66.5% (135)	49.6% (190)	55.5% (325)
Total	34.6% (203)	65.4% (383)	100% (586)

Participants included students with a wide range of traditional and newer engineering specializations. Solicitation of respondents involved a mix of approaches meant to include as many upper-year Canadian undergraduate students in engineering and computer science as possible.

Tab. 2: Location of Respondents

	Respondents (n=590)
Ontario	331
British Columbia	152
Open University	63
Atlantic Provinces	31
Prairie Provinces	13

Particularly because of the small number of women in some areas and programs, a random sample was neither feasible nor appropriate. As is evident in Table 1, the method used allowed the incorporation of 44.5% female respondents, which is significantly greater than the proportion of female students in either computer science (13.6% 2007-2008) or engineering (17.4% in 2009) programs, overall (CAUT, 2011/Engineers Canada, 2009). Students across Canada were informed of the study via emails to departments and student groups, and in-class announcements. All participation was voluntary. Respondents were entered in a draw for the chance to win 1 of 3 prizes of \$100. Data analysis involved comparative gender and discipline-based analyses using qualitative and quantitative approaches.

RESULTS

Educational Experiences

Respondents from both disciplines and genders indicated generally high levels of satisfaction with their educational experiences. When asked how they would rate their experience in their current academic program, the most common response was positive, with over 50% in each group indicating this response. Additionally, greater than 20% of respondents described their experience as very positive, with a slightly higher proportion of female respondents selecting both positive and very positive. A relatively small number of respondents, 6.1% of male and 4.3% of female respondents, indicated their educational experience to be negative or very negative. In comparison, when asked as part of the National Survey of Student Engagement (2009-10): “How would you evaluate your entire educational experience at this institution?”, on a four point scale, 44% and 29% of the 338 engineering student respondents answered good and excellent, respectively.

Tab. 3: Overall, how would you rate your experience in your current program?

	All Male (n=314)	All Female (n=256)	All CIS (n=193)	All ENG (n=381)
Very Negative	1.6% (5)	0.4% (1)	2.6% (5)	0.3% (1)
Negative	4.5% (14)	3.9% (10)	2.1% (4)	5.2% (20)
Neutral	19.4% (61)	17.6% (45)	21.2% (41)	17.3% (66)
Positive	51.3% (161)	52% (133)	53.9% (104)	50.4% (192)
Very Positive	23.2% (73)	26.2% (67)	20.2% (39)	26.8% (102)

This similarity in educational experience is dominantly reinforced by responses to the question of whether respondents would select the same field of study were they given the choice to do so again. As shown in Table 4, a majority of all respondents indicated an affirmative response.

Tab. 4: Given the choice to do it again, would you select the same field of study?

	Female CIS	Female ENG	Male CIS	Male ENG
Yes	57.8% (37)	70.5% (134)	71% (88)	69.7% (131)
No	14.1% (9)	10% (19)	12.1% (15)	10.6% (20)
Unsure	28.1% (18)	19.5% (37)	16.9% (21)	19.7% (37)

While overall satisfaction levels were generally similar, some variation in more specific areas of educational experience by gender and discipline were evident in the sample, as is suggested in Table 4. There was no clear gendered pattern that was consistent across responses on this subject, other than female respondents appearing more likely than male respondents to select the most positive response on a Likert scale, while male respondents were more likely to select the second most positive response. What did become apparent, however, was a discipline difference. In the case of Table 4, above, female CIS students were less likely than other respondents to state that they would choose the same field of study again, were they given the chance. Others responses of both male and female CIS students, when compared to those of male and female engineering students, suggest that the climate in CIS programs is less positive for both genders, when compared to engineering programs. This difference was evident on questions regarding the social environment, and friendliness and respect from other students. In addition to illustrating a disciplinary difference, Table 5 underlines the similar level of satisfaction with educational experience across gender.

Tab. 5: Gendered Similarity and Disciplinary Difference in Educational Experience (%)

	Strongly Agree or Agree			
	Female CIS	Female ENG	Male CIS	Male ENG
I find the social environment to be a positive one.	63.5*	80.4*	57.8	72.4
I feel like I fit in.	50*	74.9*	50.4	72.2
Extracurricular activities are important to me.	44.8	70.5	39.4	64.4
Support from friends and family is important to my academic success.	67.3	78.7	61.1	63.3
I find it difficult to balance school and other activities.	51.8	37.3	42.2	44.2
Students in my department respect my ideas.	47.3	71.6	60.5	68.5
Students in my department are friendly.	55.1	81.9	67.9	77.3
My department treats people equally regardless of gender, race and socioeconomic status.	84.5	78.7	67.9	81.2

*Female engineers were more likely to Strongly Agree with the statement than female CIS respondents.

This section has highlighted both areas of difference and similarity in educational experiences of undergraduates in engineering and computer science across Canada. In contrast to the expectation of significantly gender differentiated experiences, overall, the data suggests similar experiences across genders and a high level of satisfaction across respondent groups. The most significant differences seen appear when comparing students in engineering to those in computer science, regardless of gender.

Educational and Employment Plans

Not surprisingly, considering the generally positive educational experience described by both male and female respondents in both disciplines, a significant majority indicated the intention to seek employment in their field of study or to pursue graduate studies in their field. Across fields and disciplines, respondents' plans are quite similar, with 88.1% of male respondents and 90.1% of female respondents intending to seek employment or pursue further studies within their field. The intentions of the surveyed Canadian undergraduate students differ significantly from the actions of equivalent

students in the United Kingdom. Kirkup, Zaleyski, Maruyama and Batool (2010) noted that, “[i]n 2006/07, twice the proportion of men graduating with undergraduate qualifications in STEM entered SET professional or associate professional occupations (41.8 per cent) compared with women (21.0 per cent)” (12).

Tab. 6: Summary of Plans for First Year After Graduation

	All Male (n=269)		All Female (n=233)	
	#	%	#	%
Employment or studies in field	237	88.1	210	90.1
Employment or studies outside field	20	7.4	15	6.4
Unknown/Other	12	4.5	8	3.4

When Canadian respondent’s plans are broken down into more detail, it is evident that female engineering students are more likely to choose to pursue graduate studies in their field than their male counterparts, who were slightly more likely to pursue employment in their field. However, both male and female respondents frequently noted that they felt they needed more education to succeed in their field.

Tab. 7: Plans for First Year After Graduation

	All (n=502)		Male ENG (n=168)		Female ENG (n=177)		Male CIS (n=101)		Female CIS (n=56)	
	#	%	#	%	#	%	#	%	#	%
	Pursue additional undergraduate education	10	2	3	1.8	4	2.3	2	2	1
Pursue graduate studies in your field	99	19.7	30	17.9	41	23.2	19	18.8	9	16.1
Pursue graduate studies in another field	18	3.6	6	3.6	6	3.4	4	4	2	3.6
Seek or continue employment in your field	348	69.3	119	70.8	119	67.2	69	68.3	41	73.2
Seek employment outside your field	7	1.4	2	1.2	1	0.6	3	3	1	1.8
Other	20	4	8	4.8	6	3.4	4	4	2	3.6

When the plans of the small group that stated an intention to leave their field of study are examined in more detail, the data show that only a small minority expressed dissatisfaction with their program or field as a reason for changing fields. Additionally, of those who indicated that they intend to pursue employment or studies in another field, 77.8% of females, compared to 22.2% of male respondents, who specified their plans further, plan to stay in a science field. This includes a number of respondents who pursued biological or biochemical engineering programs as preparation for medical school. Male respondents intending to leave their field indicated plans to pursue business, law, aviation and a master of divinity.

In spite of the discipline differences in educational experiences, a corresponding difference is not borne out in respondents' plans for after graduation. Contrary to the initial hypothesis, male and female respondents are choosing to stay in their field at high and near equal numbers, suggesting that whatever differences in educational experiences exist are not leading to different career intentions. While not taking into account those who have chosen to leave these programs, the results still offer a positive picture of the educational environment, suggesting less women may be lost from the field at this stage than previously expected.

Expectations and Experiences of Gender Discrimination in the Workplace

In contrast to generally positive educational experiences of female students in engineering and computer science programs, responses to questions of experiences and expectations of the workplace in these fields, particularly around the issues of challenges due to gender, raise significant concerns about the workplace climate and hiring practices. As indicated in Table 8, a fairly high proportion of respondents have worked in their field in the past, many through cooperative education programs.

Tab. 8: Have you worked in your field in the past? (%)

	Female CIS	Female ENG	Male CIS	Male ENG
Yes	77.6	65.7	70.3	80.6

When asked how their workplace experience impacted their interest in pursuing employment in their field, a majority said that it made them more interested. However, a larger proportion of female computer science students indicated that they were less interested based on their experience. Almost double the number of female computer science students indicated that there were less interested in pursuing employment in their field based on their experience in the workplace than any other group.

Tab. 9: Did your experience in the workplace make you more or less interested in pursuing employment in your field of study? (%)

	Female CIS (n=52)	Female ENG (n=128)	Male CIS (n=81)	Male ENG (n=151)
More interested	50.0	62.5	59.3	66.9
Less interested	23.1	10.2	12.3	9.3
Unsure	26.9	27.3	28.4	23.8

Tab. 10: Female Expectations of Challenges in the Workplace Due to Gender (n=196)

	#	%
Yes	124	63.3
No	70	35.7
Unsure	2	1.0

When asked: Do you expect to face challenges in the workplace based on your gender, a majority of female respondents indicated the affirmative. Many of the issues noted in Roberts and Ayre's (2002) review of implicit and explicit discrimination in engineering

workplaces in Australia aligned with respondents' expectations of gendered challenges in the workplace.

Although female engineering students appeared more satisfied with various aspects of their programs than female computer science students, they were more likely indicate that they expect to face gender discrimination in the workplace. 66% of female engineering students, compared to 55.1% of female computer science students, indicated this expectation. 84 female engineering students specified the reasons that they expect to face gendered challenges in the workplace. Their reasons are described below in Table 11. The most common reasons relate to male dominance in the field and women being underestimated and needing to work harder to earn respect. Several times the notion of the 'Old Boys Club' was raised.

Tab. 11: Explanation of Expectations of Gender Based Challenges in the Workplace – Female Engineering Students

Yes (n=84)	#	%
It's a male dominated field/women are the minority	32	38.1
Women have to work harder to earn respect, are not taken seriously, are underestimated	30	35.7
Have experienced such challenges in work or school in the past.	10	11.9
If outside of the office (on site) or certain fields (construction/mining)	10	11.9
Concerned that I will be paid less, get less favourable jobs and advance less	7	8.3
Because of having children	6	7.1
I can handle it.	5	6
Yes, but it's improving, it's more with the older generation and varies with the company and specific people.	3	3.6

In explaining the reasoning behind their affirmative response, there were repeated comments such as, "Since it is still a male dominant field I'm sure I will encounter cases where my ideas may not be 'correct' on the basis that I am a female" and "I do believe there will be challenges because I am female in a male dominated industry. I am worried that people will assume I am not as smart so I feel like I will need to work harder than others to earn respect". Several respondents indicated, however, that they felt they were strong enough to deal with it. While some respondents indicated they felt being female to give them an advantage, stories like the one provided by another student, raise the issue of whether female engineering graduates are discriminated against in the hiring process:

We have all heard that overall women makes proportionally less than men in engineering and in business. Closer to home, when applying for internships last year, my good friend was actually told by someone in our career centre that although she was one of the strongest candidates, probably didn't receive an offer from a specific company because she was female. This was based on years of looking at the rankings the company provided of the candidates, and how they rarely ever (relative to the number of females in the program) made offers to women.

A few respondents even indicated that they have changed their career plans based on this expectation. For example, one female engineering student said, I "[p]refer [an]

office setting since there is lower chance of sexual harassment.” Both among those who indicated and did not indicate an expectation of facing gender-based challenges in the workplace, several respondents noted that they believe things are improving, particularly with the increased number of women in the field, supporting the *critical mass theory* (Danon-Schaffer, Dykeman, Bogan, Bennett, & Croft, 2006; Mattis, 2007).

Female CIS students expressed similar concerns to female engineering students. However, a higher proportion had experienced or heard of such issues in the past and, also, a greater number expressly identified that women were assumed to be technically weaker and job tasks were given accordingly.

Tab. 12: Explanation of Expectations of Gender Based Challenges in the Workplace – Female Computer Science Students

Yes (n=24)	#	%
Male dominated field/Women in the minority	10	41.7
Experienced in past or heard other's experiences	9	37.5
Women are assumed to be technically weaker and given jobs accordingly	6	25
Women have to work harder to earn respect, are underestimated	4	16.7
I can handle it	2	8.33
Yes, but it depends on the specific people	1	4.17
Women are paid less	1	4.17

The comment by one female computer science student duplicates the concerns expressed by several others:

I am afraid to work in an environment where there are few women for a number of reasons. I do not feel as comfortable asking questions of male colleagues for fear that I will be viewed as less competent than a man would be. I am afraid of working in a less professional environment of younger men where I may not be fully viewed as a team member because I do not play certain video games or have many of the same interests. I am concerned that I will have to work harder than a male colleague who has the same skill level because any mistake or lack of progress in my work might be seen as a weakness. I am afraid to work in an environment where they do not adequately address gender concerns as legitimate, but rather that I am a woman who does not know how to behave in a man's world.

In spite of this fear, others indicated, as among female engineering students, their belief that they could cope with the challenge. For example, one respondent wrote, “There are occasionally gender-based challenges in the workplace, but I stand up for myself if I feel gender is a potential barrier. I also work in a team that creates a culture that doesn't allow gender-based barriers to doing our work.”

Few male respondents, 6.7%, expect to face challenges in the workplace due to their gender. Those that expressed concern cited issues of reverse discrimination linked to gender equity programs and issues surrounding their sexuality as the causes for concern.

When asked if they had any concerns about pursuing employment in their field, male and female respondents gave generally similar responses, including the economy, high

expectations in terms of hours of work and so forth. However, female respondents did raise concerns about gender. Overall, this concern was less prevalent among responses by female computer science students. However, it was still evident. For example, one respondent stated, "It took years in my department to get to the point where my opinions are somewhat respected by male peers. I am not looking forward to starting from scratch somewhere else." Others expressed concern about whether they would not be hired because they were female and about how they would fit in to a male dominated environment. One female computer science student, for example, stated, "men are generally given preference over women for any specific computing science related job". The issue of a "male culture" has long been recognized as a potential challenge for females employed in the sciences and engineering in the literature (eg: McIlwee and Robinson, 1991).

Work-life balances issues have been identified in the literature as key challenges (eg: Ashraf, 2007). Engineering students were more likely to raise the issue of having a family, with one respondent stating, "I feel that if I have a family, I won't be considered as a serious worker because of it." Work-life balance and family issues were also raised by a few male respondents who indicated concern about the potential to need to move for a job and balancing spousal careers and proximity to family. Another respondent expressed concern about whether they would receive the training and mentorship that is desirable. Ghazzali and Myrand (2009) examine such issues of a lack of institutional and/or organizational support in their review piece. Responses across disciplines indicate a significant majority of female respondents expect to face, and many have already faced, challenges in the workplace because of their gender. These results suggest that hiring practices and the workplace climate remain barriers to attracting and retaining women to jobs in the fields of computer science and engineering and, thus, areas where change is necessary.

CONCLUSIONS

The survey data presented here suggest that, overall, the educational experiences of female students are similarly positive when compared to male students' experiences, though some gender differences and challenges remain. The positive experience helps to explain the high proportion of female students that intend to pursue further studies or employment in their field. However, an examination of expectations of, and experiences in, the workplace raise concerns about both hiring practices and workplace climate, as a majority of female respondents in both fields expect to face gender-based discrimination in the workplace. This suggests additional work needs to be done to address these issues. To that end, additional research is underway which seeks to better understand the intricacies and realities of these concerns. Incorporating the lessons learned from this study, an additional round of surveying is scheduled for the spring of 2011. This round seeks to incorporate a larger sample of students from across Canada and to delve further into issues surrounding gendered workplace concerns. Additionally, comparing these results to recent workplace studies will provide further insight.

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