GENDER DIFFERENCES IN VANCOUVER SECONDARY STUDENTS' INTERESTS RELATED TO INFORMATION TECHNOLOGY CAREERS

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ABSTRACT

This paper presents results from a survey of Vancouver secondary school students on their interests and perceived abilities in a range of subjects, the factors they felt would influence their career choices, and a number of issues related to computer use and perceptions of computer professionals. Females indicated substantially lower interest and perceived ability than males in three subjects, namely computer science, engineering and physics. Females also reported spending less time on most forms of computer activities at school and at home, and gave lower estimates of their computer skills. The survey also revealed that both male and female students have little knowledge of the skills and personality characteristics needed for success in information technology careers. These findings may help explain the low participation of women in information technology areas in university and the work force.

Keywords: high school survey, computer science education, women in computing

1. INTRODUCTION AND BACKGROUND

Although the intense demand for highly trained people in information technology areas is predicted to continue for at least the next decade, participation by women is currently low in all levels from undergraduate training to the workforce. SWIFT (Supporting Women in InFormation Technology) is a five-year project to increase the participation of women in information technology careers. SWIFT is engaged in researching, creating and disseminating resources and strategies to encourage sustained interest and achievement by girls and women of all ages in areas related to information technology. Centered around the NSERC/IBM Chair for Science and Technology for BC and the Yukon established in 1997, SWIFT's five-year goal is to increase the percentage of female students in these areas by 50%.

The university program areas most commonly leading to careers in information technology are those related to computing (e.g. computer science or computer engineering). Almost every area of science and engineering has experienced substantial increases in the enrollment of female undergraduates over the last few decades. However, the percentage of undergraduate majors in computer science (CS) who are female has declined from 30-40% in the 1980's to 15-20% today [2, 4]. Since this trend is unique to computing, it is important to understand the factors behind the decrease. Researchers at Carnegie Mellon University [3, 5] are conducting a very interesting longitudinal study of female and male CS majors to investigate gender differences in student preparation for, experiences in, and orientations towards studying CS. During the last decade, however, there has been little data gathered on secondary school students' perceptions of computer-related subjects and careers. In order to gather such data, the SWIFT project conducted a survey of students enrolled in grades 8, 10, and 12 in the Vancouver School District (VSD). The

age of the students in these grades is approximately 13-14, 15-16, and 17-18 respectively. In addition to seeking information that might be helpful in designing SWIFT activities to encourage the participation of young women in post-secondary computing programs, the data from the survey forms a baseline data set that will be useful in evaluating the impact of SWIFT initiatives. This paper summarizes the main results of the survey. A more detailed report can be found on our web site [7].

2. METHODOLOGY

An initial survey form was designed with input from the researchers at Carnegie Mellon University who have been studying gender differences in undergraduate majors in CS. A pilot survey was then conducted with approximately 200 secondary school students and 300 undergraduate students. Based on the experiences with the initial survey, a number of revisions were made to the form. Questions with open-ended write-in answers (e.g. "what skills are required for success in computer-related careers?") were replaced with the corresponding multiple choice questions, and a number of other questions were added (e.g. "first language spoken at home?"). A copy of the final questionnaire is included in the more detailed report [7]. We then produced the survey on a two-sided one-sheet SCANTRON form, and distributed the forms to the secondary schools in Vancouver.

The VSD was composed of 57,000 students in kindergarten to grade 12 who reported the most common primary languages spoken at home as follows: English (41%), Chinese (34%), Vietnamese (5%) and Punjabi (5%) [1]. Our goal was to survey all grade 8, 10, and 12 pupils in the VSD, a total of over 13,000 students. Following a recommendation from the VSD, survey packages were given to all Grade 8, 10, and 12 English teachers. Each class package contained passive consent forms and survey questionnaires. Teachers were asked to distribute the consent forms to their students, and then have the surveys completed by their students during class time a few days later. The VSD recommended the use of English classes because English is the only course that is mandatory for all secondary school grades. Unfortunately, for the same reason, the English teachers had already been asked to give up class time for other surveys, and some teachers who felt they could not afford to lose any further classroom time declined to have their classes participate. A few schools solved this problem by finding alternative ways of reaching the students, such as distributing the surveys in homerooms or having all grade 8, 10, and 12 classes complete the survey at the same time in a chosen timetable block. Since the survey was distributed on a per class basis rather than to individual students, the sample cannot be regarded as random for the purposes of rigorous statistical analysis. However, a significant portion of the target population was surveyed, and we believe the results are interesting and useful.

3. RESPONSE RATES

During the fall term of 1998, 7,411 surveys were completed and collected. This represented approximately 56% of the 13,249 students in grades 8, 10, and 12 of the VSD at that time. All 18 Vancouver secondary schools participated in the survey, with participation rates ranging from approximately 30% to 80%. There was little variation in the results across the grade levels [7] and for this reason we did not include the results by individual grade levels in this paper. Of the 7,411 surveys returned, 6,543 (88%) students indicated their gender: 3,144 (48%) respondents were male and 3,399 (52%) were female.

4. FINDINGS

4.1 Interest and Perceived Ability in Subjects

Questions 1 and 2 of the survey asked students to indicate their level of interest and perceived ability in the following subjects: biology, business, chemistry, CS, engineering, English, fine arts, geography, history, mathematics, physics, and psychology. Students were asked to respond using a 7-point scale: 1 represented very little interest or very poor perceived ability, whereas 7 indicated very high interest or excellent perceived ability. Figures 1 and 2 show the average responses by gender.

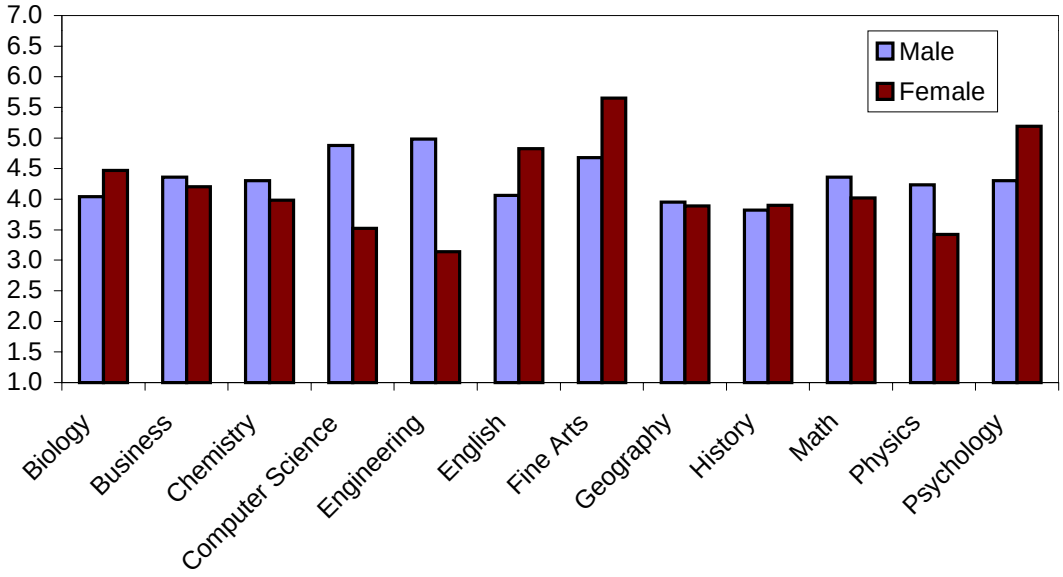

FIGURE 1. INTEREST IN SUBJECT AREAS

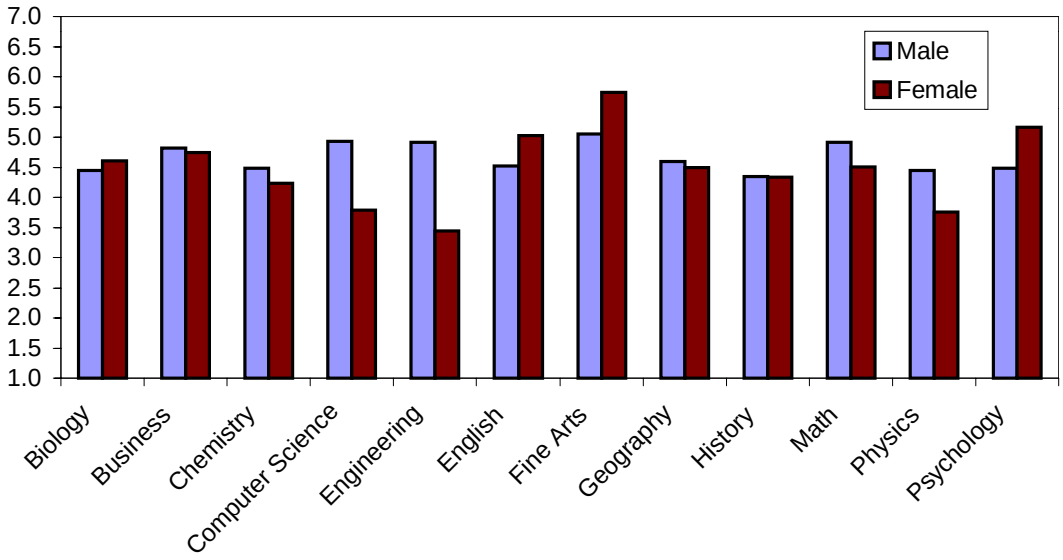

FIGURE 2. PERCEIVED ABILITY IN SUBJECT AREAS

Looking over the range of subjects, the averages of the scores given by females for interest were similar to the averages of their scores for perceived ability. This was also true for males; however, the average scores given by females showed much greater variation among subjects. There were strong gender differences, however, in the subjects that received the highest and lowest scores. In particular, CS and engineering received the highest average interest scores by males, but CS, engineering and physics received the lowest average scores by females for both interest and perceived ability. English, fine arts and psychology received the highest average scores by females for both interest and perceived ability. The female scores for mathematics in both categories were slightly lower than for biology, but approximately the same as chemistry, geography and history, and well above the scores for CS, engineering and physics.

There was no subject for which the average score for perceived ability given by males was less than 4.0 (the mid-point on the 7-point scale), whereas females gave scores under 4.0 for CS, engineering and physics.

4.2 Career Influences

Question 3 asked students to rate the importance of the following possible influences on their choice of career path: friends, parents, teachers/counsellors, job opportunities, personal interests, personal abilities, financial rewards, challenge, flexible hours, ability to combine career and family, and ability to make the world a better place. Figure 3 shows the average responses using the same 7-point scale described above.

The average responses for females and males were similar with slightly higher female scores for all items except financial rewards and flexible hours. The items that received the highest scores were personal interests and personal abilities. Friends and teachers/counsellors received the lowest scores, whereas parents received approximately the same score as the remaining items. The greatest gap between female and male average scores was for ability to make the world a better place.

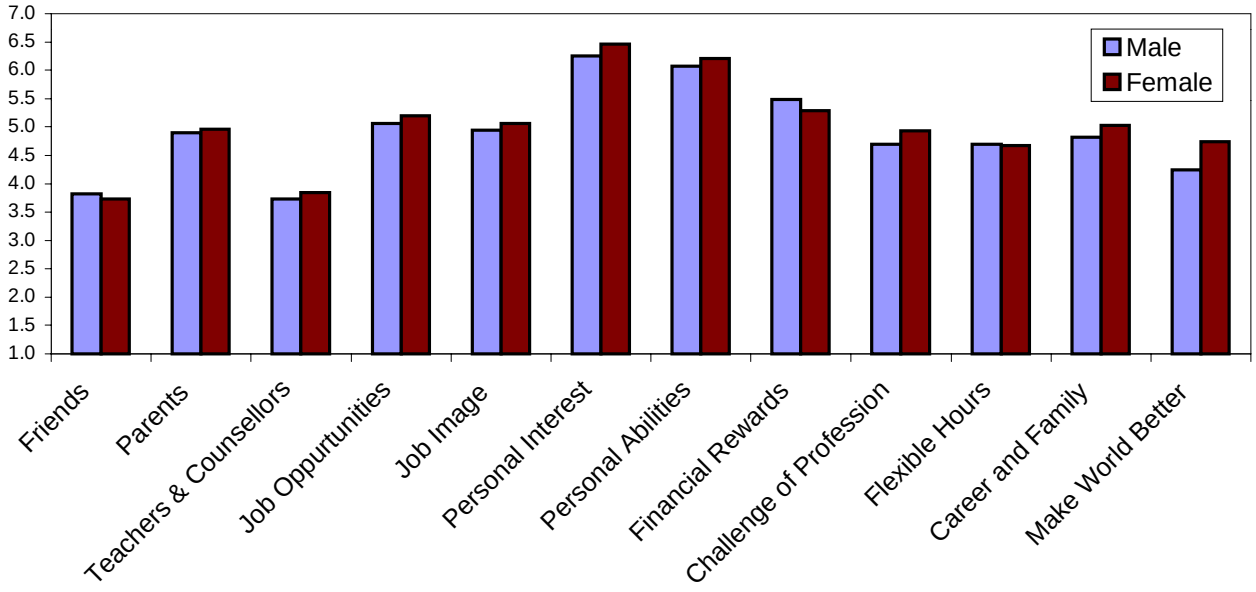

FIGURE 3. INFLUENCES ON CAREER DIRECTIONS

4.3 Computer Use and Proficiency

Question 9 asked students to rate their time spent on the following computer activities, both at school and outside of school: e-mail, surfing the internet, assignments/work, programming, and playing games. Question 10 asked students to rate their computer skill levels in four areas: basic operation (e.g. turning the computer on and off), using software applications, programming, and systems & hardware. A similar 7-point scale was used for the responses to these questions: 1 represented the least time devoted to a particular activity (very low skill level), 7 represented the most time (very high skill level), and 0 indicated no participation in the activity (no skill at all). Figures 4a, 4b and 5 show the average responses to these questions.

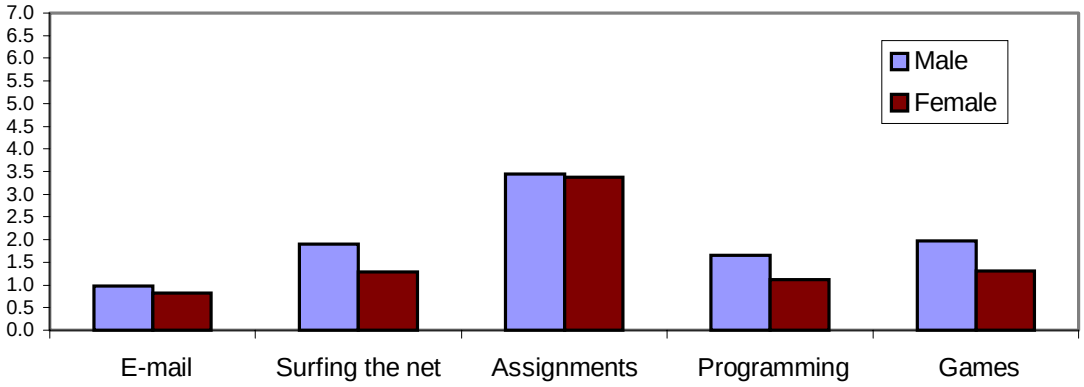

FIGURE 4A. COMPUTER USE AT SCHOOL

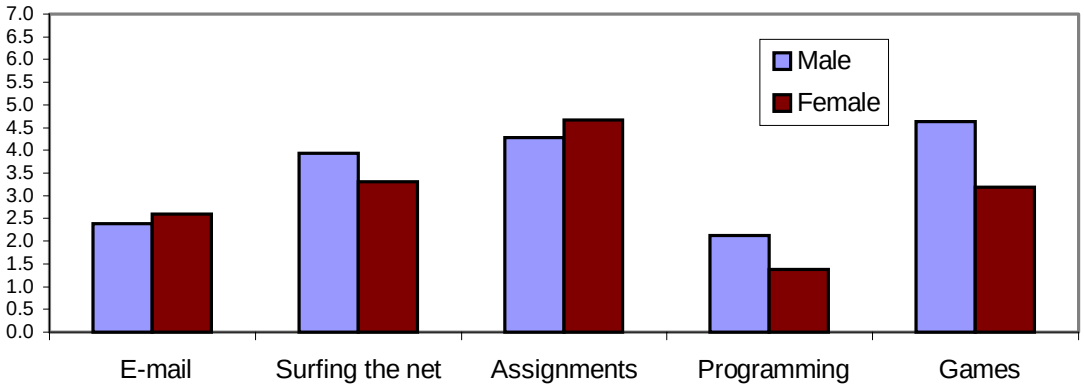

FIGURE 4B. COMPUTER USE OUTSIDE OF SCHOOL

Both genders reported spending more time on computer activities outside of school than at school. Males reported higher scores for playing games, programming and surfing the internet than females for both the at-school and outside-school questions. The female scores for e-mail and assignments/work were slightly lower than males for at-school use and slightly higher than males for outside-school use. Assignments/work received, by far, the highest at-school score from both genders. Playing games received the highest outside-school score from males, whereas assignments/work received the highest outside-school score from females and the second highest outside-school score from males. Programming received the lowest outside-school score and the second lowest at-school score from both genders. E-mail received the lowest at-school score from both males and females.

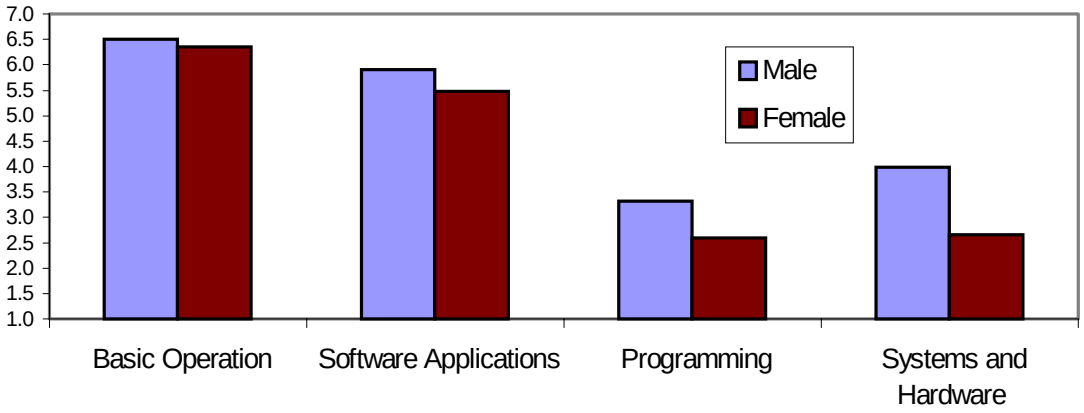

FIGURE 5. COMPUTER PROFICIENCY

Although males rated their skills higher in all four areas, the largest differences were in programming and systems & hardware.

4.4 Perceived Skills and Personality Characteristics Needed in Computer-Related Careers

Question 13 asked students to indicate which of the following skills were required to be successful in a computer-related career: mathematics, graphics, problem solving, basic computer skills, logic, communication, creativity, fast typing, and business knowledge. Question 14 asked the analogous question with respect to the following personality characteristics: smart, patient, analytical, knowledgeable, hard working, good memory, team-player, organized, outgoing, and eager to learn. The sets of skills and characteristics were chosen as the items most frequently appearing as answers to the corresponding write-in questions in the pilot survey. Figures 6 and 7 show the percentage of positive responses to each of the items listed by gender.

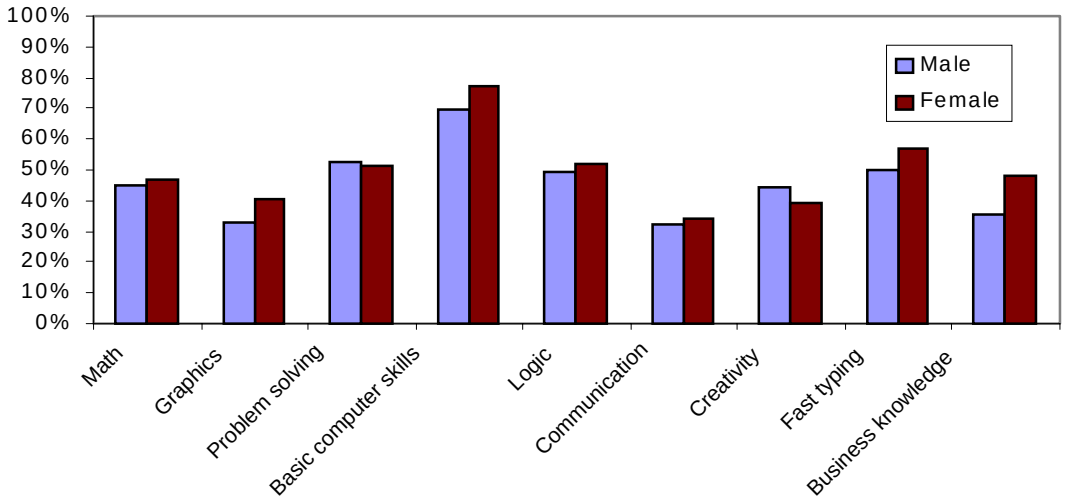

FIGURE 6. SKILLS FOR COMPUTER CAREERS

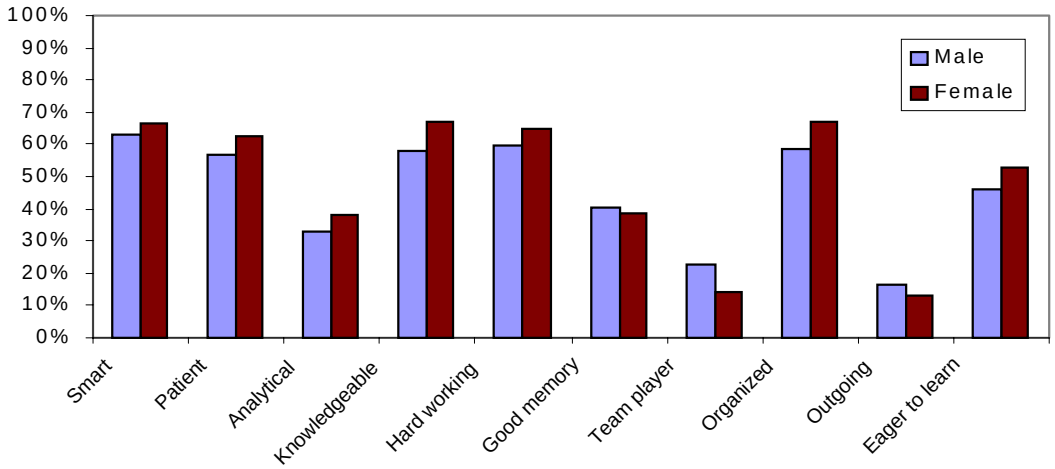

FIGURE 7. CHARACTERISTICS FOR COMPUTER CAREERS

The average responses by males and females for most items were similar. The only gender difference in relative scores for pairs of items was for creativity and business knowledge. Females selected business knowledge more often than creativity, whereas males did the reverse. Both females and males chose communication least often among skills, and outgoing and team-player least and second least, respectively, among personality characteristics.

5. DISCUSSION

The low female scores for interest and perceived ability in CS and engineering combined with the scores on career influences, namely that females and males view personal interest and personal ability as the most important items influencing their career choices, provide persuasive evidence that low interest and perceived ability are strong factors underlying the low participation by women in CS and engineering courses at university. These findings are consistent with those of researchers at the University of Colorado [6] who conducted a study of 335 undergraduate students on seven U.S. campuses offering four-year college or university programs. Analysis of the students' stated reasons for their choice of a science, mathematics or engineering (S.M.E.) major, together with the students' persistence in their chosen major led the authors of the study to conclude that "the best foundation for survival and success is to have chosen one's major because of an intrinsic interest in the discipline and/or in the career fields to which it is leading." Again, consistent with our findings, they also observed gender differences pertaining to perceived ability:

> …men were almost twice as likely as women to cite 'being good at mathematics and/or science in high school' as a reason for choosing an S.M.E major. Whether they were actually better prepared or skilled than women entrants is not the issue. What matters is that many more young men than young women felt confident in their readiness to undertake higher level science and mathematics.

The next obvious question is what is responsible for the low interest and perceived ability in female students. The results from our survey indicate a number of possibilities. While females reported spending as much computer time as males on e-mail and assignments at-school and outside-school, they reported spending less time playing games, programming, and surfing the internet. The lower time reported could be due to a number of factors such as less interest in comparison to other activities or more pressure to spend time on other responsibilities. Nevertheless it seems likely that spending less time using computers is correlated with lower perceived ability in CS and engineering, though we have not yet performed this analysis.

Another likely factor in the low interest and perceived ability by females are the students' perceptions of what skills and characteristics are necessary for success in computer-related careers. It is particularly interesting that communication skills and being a team-player, two items at the top of the information technology industry's recruiting wish-list, are rated so low – especially as both are areas in which, within the North American culture, females are viewed as having particular strength. In general, the responses to the questions about skills and personality characteristics reveal students' lack of information about these aspects of computer-related careers. For example, it seems probable that the high rating given to patience as a characteristic is due to the slowness and "bugginess" of much of the software, hardware and communication networks available to students in school and at home.

One encouraging sign is the relatively positive female scores for interest and perceived ability in mathematics. This may be the result of efforts by many organizations in BC and elsewhere to raise girls' interest, confidence and achievement in mathematics.

6. CONCLUSION AND RECOMMENDATIONS

There are many aspects in which the survey reported on here could be improved, and we feel it is important that further research in this direction be conducted. For example, the method of selecting the sample population should be improved so that more sophisticated data analysis can be done. Students should be asked to report on computer usage using specified units of time (e.g. hours per week) instead of using a 7-point scale that could be interpreted in widely differing ways. It also would be valuable to conduct a similar survey in different parts of North America to evaluate the extent to which the results are local to Vancouver. (A survey of smaller communities around BC with a different demographic than in Vancouver is planned for the spring of 2000.) Despite these limitations, it seems clear that a primary goal for SWIFT and other organizations interested in increasing women's participation in CS and engineering should be to increase girls' interest and confidence in these areas. Specific actions we feel are likely to be useful include:

- increasing girls' access to computer activities and games that appeal to them;
- having more parents and teachers clearly articulate the expectation that female students can and should spend time on and excel in computer activities;
- improving parent, student and teacher knowledge of computer-related careers through workshops, job-shadowing, mentoring and the media; and

- providing appealing opportunities for girls to increase their programming and other computer skills.

Acknowledgements

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7. REFERENCES

[1] British Columbia Ministry of Education (1998). Headcount by Primary Language Spoken in the Home by Grade and District/Authority. <http://www.bced.gov.bc.ca/>.

[2] Tracy Camp (1997). "The Incredible Shrinking Pipeline." Communications of the ACM, October.

[3] Allan Fisher, Jane Margolis and Faye Miller (1997). Undergraduate women in computer science: experience, motivation and culture, ACM SIGCSE Technical Symposium.

[4] D. Kozen and S. Zweben (1998). "1996-1997 CRA Taulbee Survey: Undergrad Enrollments Keep Booming, Grad Enrollments Holding Their Own." Computing Research News, March.

[5] Jane Margolis, Allan Fisher and Faye Miller (1999). Caring about connections; gender and computing, to appear in IEEE Technology and Society.

[6] Elaine Seymour and Nancy M. Hewitt (1997). Talking About Leaving: Why Undergraduates Leave the Sciences. Westview Press. Boulder, Colorado.

[7] Katie Stafford (1999). SWIFT career choice survey: a summary report <http://taz.cs.ubc.ca/swift/>.