Effect of Gender and Grade Point Average (G.P.A.) on Computer Science Enrolment

Kenneth Kim Student ID #262276 University of Calgary

Submitted to: Dr. Tom Gougeon EDER 603.02(L.60) August 13, 2002.

## **Table of Contents**

LIST OF TABLES AND FIGURES	III
ABSTRACT	IV
INTRODUCTION	1
STATEMENT OF THE PROBLEM	1
REVIEW OF RELATED LITERATURE	1
STATEMENT OF HYPOTHESIS	3
METHOD	4
Participants	4
INSTRUMENT	4
DESIGN	5
PROCEDURE	5
RESULTS	6
DISCUSSION	. 13
REFERENCES	. 14

# List of Tables and Figures

Tab	ble	Page
1.	Design of this Study	5
2.	2 by 2 Contingency Table	9
3.	Descriptive Statistics of Variable X and Y	11
Fig	ure	
1.	Enrolment by Gender	5
2.	Percentage of Female Enrolment in	7
	Computer Science	
3.	Percentage of Male Enrolment in Computer	7
	Science	
4.	Female Enrolment by G.P.A.	8
5.	Male Enrolment by G.P.A.	8
6.	Scatter Plot	9
7.	Phi Coefficient of Correlation and Chi-	10
	Square Ratio	
8.	Point Biserial Coefficient of Correlation	12

## Abstract

The purpose of this study was to see whether there was a relationship between gender and achievement on computer enrolment. This study was completed at a high school in West Vancouver, British Columbia using all the students (100 –females; 100 males) on the honour roll. A multiple correlation design was used to test the hypothesis that the majority of high achieving students (those with G.P.A.'s in the 3.0 - 4.0 range) took computer science as an elective course. Using the phi coefficient of correlation, the results indicated that there was a negligible relationship (.0081 - 0%) between gender and enrolment. The observed probability was 1.68. Results  $\leq .05$  are considered borderline statistically significant, but the probability of error is still high (5%). The chi-square value was larger than .05. The probability of error P value was .195 (20%). About 1.4% of the variance in the variable "choice" was accounted by the variable "gender". There was no significant relationship between the two categorical variables. Females and males enrolled in computer science not because of gender. Using the point biserial coefficient of correlation for achievement and enrolment, the results indicated a weak correlation of -0.218. It was concluded that gender and achievement did not play a role on who enrolled in computer science.

## Introduction

There has always been a low representation of women in the field of computer science. Despite the pivotal role that computers play in our economy and culture, and despite explosive growth in the job market, only 15-20% of undergraduate computer science majors at leading U.S. departments are female (Margolis, Allen, and Fisher, 2002). The low representation of women in computer science at the undergraduate level is inherited from the secondary school level, where girls do not participate in computer science courses and related activities as much as boys (Sanders, 1995).

While girls and women may be using the Internet for communication and the web for information retrieval, it is predominantly men (the majority in the U.S. being white and Asian-American) who are programming the computers, designing and fixing the systems, and inventing the technology that will affect all aspects of our lives (National Science Board, 1998). Only 15-20% of undergraduate computer science majors at leading U.S. universities and only 17% of the high school computer science Advanced Placement test takers are female (Kozen & Zweben, 1998). This gender imbalance is clearly seen on the Internet, video games, and other online communities. The under-representation of women among the creators of information technology has serious consequences, not only for those women whose potential goes unrealized, but also for a society increasingly shaped by that technology (Margolis, Allen, and Fisher, 2002).

#### Statement of the Problem

The purpose of this study was to investigate effect of gender and grade point average (G.P.A.) on computer science enrolment.

#### Review of Related Literature

It has always been difficult to attract females into computer science. In British Columbia, computer science is an elective from grades 9 to 12. It competes with other applied skills elective courses such as technology and design, art, foods, sewing, drama and music (British Columbia School Act, 2002). In higher grades, students must decide if their interest in computer science is strong enough and if it is part of their post secondary plan, for them to pursue it any further. There is a gap between male and female enrolment in high school computer science courses that increases as students progress from introductory to more advanced computer science courses (Schofield, 1995). In the Advanced Placement program, females have only been about 12% of AP computer science exam takers over the past five years (Margolis, Allen, and Fisher, 1997a). It is the same in the public school system as this study suggests.

"A 1994 Virginia study compared female enrolment in a variety of technology courses. Similar to the 1980 Montana study, one high school subject, Communication Technology, had nearly 50% enrolment. But in most other high school subjects the gender differences are alarming. There were 33 course titles listed. Analyses of the 32 remaining subjects (removing Communications Technology) indicate a similar pattern than the Montana 1980 study. Of the 32 remaining course titles listed 27 had less than 15% female enrolment and 17 courses had less than 10% female enrolment" (Gloeckner, 1997).

Females and males view computers differently. Males are drawn to the computer. Their love begins with games and moves on to programming. It is their ultimate toy designed to fulfill their need to be entertained. Their fascination often leads to self-exploration and eventually mastery. Male students' accounts of their earliest computer memories are filled with wanting to know how the computer works, tinkering, and self-initiated exploration (Margolis, Allen, and Fisher, 2002). Females, on the other hand, use computers for a purpose. When the first-year females talk about their personal history with computers, their narratives are not filled with long and detailed accounts of all the different activities they have done at the computer. They do not describe years of unguided exploration (Margolis, Allen, and Fisher, 2002). Adding to all of this is the stereotypical image people have of computer scientists; we see them as introverts whose role is computer coding. There is no romantic notion in this type of career. Having to be extremely intelligent and be good at math is also a turn off. This begins the underlying factors that deter women from entering this field at an early age, but are they short-changing themselves of a viable career?

Research consistently suggests that females demonstrate more verbal ability while men have stronger quantitative skills (Guss and Adams, 1998). This is an overgeneralization that many females come to believe. Most do not feel adequate about their skills in math and do not pursue computer science. In countries where upper level math is a requirement, there is less of a gender divide in enrolment in computer science (Margolis, Allen, and Fisher, 1997b). Researchers Astin and Sax of UCLA studied seventh graders and found that male and female students performed comparably in math and science courses, but the females consistently underestimated their abilities (Margolis, Allen, and Fisher, 1997b). Because of their lack of confidence the females begin to take fewer courses, a trend that accelerates as they move to the more advanced levels (Guss and Adams, 1998). Margolis et al (1999) interviewed international and American undergraduate female students and found that most had shaky self-esteem and low self-confidence when it came to comparing themselves with their male counterparts. Even a female who made it to the Dean's list still felt inadequate because she had to work harder to understand the concepts (Margolis, Allen, and Fisher, 1997b). This perception is what many academically successful female have to contend with thus making the gender gap in this field much more difficult to contend with.

Computer science is of a male-dominated hacker subculture whose members eat, sleep, dream about computers. Females view technology in a social realm. They want to use the technology to help others and to use it apart from just programming alone. In light of this, many brilliant female students are hesitant to join this "computer science world" in which they sense that the links to other interests in their lives will disappear (Margolis, Allen, and Fisher, 1999). Those who do are seen as pioneers who "enjoy challenging the roles expected of females" (Durndell et al, 1990). In order to counter the stereotypes of who can do computer science and bring a balance view into this field, schools need to attract high achieving females and keep them in the program.

#### Statement of Hypothesis

The field of computer science is a male dominated area. Many women are intimidated to pursue further studies in this area for this reason alone. The females that are attracted to computer science do so because of their interest in math and science. More often, they are academically successful and are confident of their math abilities, and enjoy activities associated with math skills such as solving puzzles, problem solving, and logical thinking skills (Margolis, Allen, and Fisher, 1999). Therefore, it is hypothesized that there will be strong correlation between females who are high achievers academically and a high enrolment of these females in computer science classes.

## Method

#### Participants

The participants for this study were high achieving 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup> 12<sup>th</sup> grade males and females at Rockridge Secondary in West Vancouver. West Vancouver is a community just outside of Vancouver with a population of 40,882. It ranks as one of the wealthiest areas in Canada. Rockridge Secondary was built in 1995 during the technology boom. The layout of the school was developed to accommodate the expansion of technology. The school had a population of 700 and was very homogeneous with Caucasian (90%) making up the majority of the student body. The remainder of the population (10%) were students of Asian descent, mostly international students. Females accounted for 40% of the school population. West Vancouver School District has a strong recruit of international students mostly to make up for the deficit in the school district's budget. Most of these students find themselves in computer science because it is an elective without pre-requisites and also because there is no minimum English language requirements.

All females and males with high Grade Point Average (G.P.A.) were selected from the honour roll. In total, there were 100 females and 100 males. For the purpose of this study, high G.P.A. refers to those whose achievement is in the 3.0 - 4.0 range. At Rockridge Secondary, the honour roll is made up of those who achieved "perfect" (4.0 G.P.A.), those who achieved "honour with distinction" (3.5 G.P.A. to 3.9 G.P.A.), and those who achieved "honours" (3.0 G.P.A. to 3.4 G.P.A.).

#### Instrument

The basis of this research was based on these variables: gender, G.P.A., and enrolment in computer science. The first term (January) honour roll was used to select the participants and the computer science class rosters (May) as instruments to gather data. The computer generated honour roll was reliable and valid as it only contained students who had G.P.A.'s in the 3.0 to 4.0 range taken from the calculation of the seven courses they took. Any students who did not fulfill this requirement or received an "N" (needs improvement) for work habit were not included in the honour roll. The computer science class rosters (May) were reliable and valid as it contained only students who registered for this course in September. Rockridge Secondary had a guideline in place that did not

allow for withdrawal from courses as it caused timetabling and staffing problems. This guideline was reinforced to the students and parents by the school counsellors during course selection. Mortality was not an issue in the design.

## <u>Design</u>

A multiple correlation design was used to test the hypothesis of the effect of gender and G.P.A. on computer science enrolment. A total of 100 females and 100 males were selected from the honour roll. The convenience sampling of subjects was done for cost measures and convenience. Since grade 8 computing was already part of the applied skills curriculum in British Columbia, we focused only on students in grades 9, 10, 11, and 12. A large sample was chosen to limit errors in validity and reliability as well as to increase statistical significance. A check of the computer class rosters in May gave us the necessary data to determine if there was a correlation between the variables.

Group	Assignment	Ν	Treatment	Outcome
1 - Females	Convenience	100	High G.P.A. – on	Yes / No – enrolled in
1 T Cinaico	Sampling	100	the honour roll	Computer Science
2 - Males	Convenience	100	High G.P.A. – on	Yes / No – enrolled in
2 - Maics	Sampling	100	the honour roll	Computer Science

Table 1. – Design of this Study

#### Procedure

This descriptive, non-experimental correlation study measured the effect of gender and G.P.A. on computer science enrolment. The length of this research was projected to be six months in length. After the sample school was selected in October 2001, a meeting was initiated with the West Vancouver School District Superintendent and the Rockridge Secondary principal to seek their cooperation and permission to carry out the research. They were assured of the confidentiality in the research. In January 2002, all students with high G.P.A.'s were selected from the honour roll and used as participants. In total, there were 100 females and 100 males. When the course selection process for the following year was finalized in May, we looked at how many of these high achieving students enrolled in computer science using computer generated class rosters. The statistical analysis used to write a report highlighting the effect of gender and G.P.A. on computer science enrolment was completed in June.

## Results

A variety of statistical tools were used to determine the relationship between the variables. The tools used include the mean, variance, standard deviation, phi coefficient of correlation, chi square ratio, and point biserial coefficient of correlation.

The phi coefficient of correlation was chosen to analyze the two binary (dichotomous – two choices) variables of gender and choice. It was used to determine the common variation in the two variables. The chi square ratio was used to determine statistical significance and reliability between them.

The point biserial coefficient of correlation was chosen to analyze the binary variable of choice and the interval variable of G.P.A. This type of regression analysis was used to determine the coefficient of correlation between the predictor and criterion variable.

#### Part 1 - Enrolment by Gender

For enrolment by gender, 55 out of 100 females chose computer science as an elective. In the case of the males, it was 64 out of 100 subjects (Figure 1).



Figure 1 – Enrolment by Gender

Of the 100 females on the honour role, 82% of them chose computer science as an elective. As for the 100 males on the honour role, 56% of the males made the same choice (Figure 2 and Figure 3).



Figure 2 – Percentage of Female Enrolment in Computer Science



Figure 3 – Percentage of Male Enrolment in Computer Science

The highest number of females (15%) who chose computer science as an elective were those with a 4.0 G.P.A. (Figure 4). The highest number of males (17%) who chose computer science as an elective were those with a 3.5 G.P.A. (Figure 5). The mean of the G.P.A. for females was 3.57 whereas the mean for the G.P.A. for males was 3.54. The mean for both genders was 3.55.



Figure 4 – Female Enrolment by G.P.A.



Figure 5 – Male Enrolment by G.P.A.

#### Part 3 - Enrolment by Gender Correlation

For the variables gender and choice, we used a scatter plot (Figure 6) and a two by two contingency table to determine the direction the relationship (Figure 7). From the scatter plot, the relationship between gender and choice was negligible.







		Females (0)	Males (1)	Row Total
x	No (1)	45	36	89
Χ	Yes (0)	55	64	119
		100	100	200
		Y		

Table 2 – 2 by 2 Contingency Table

The phi coefficient of correlation equalled -.09 (Figure 8). This coefficient was used to demonstrate its properties and to gain insight into some additional meanings of the Pearson product moment coefficient of correlation.

The coefficient of determination was .0081 ( $r^2$ ). The magnitude of the coefficient of determination indicated the proportion of variance in one variable, explained from knowledge of the second variable. .0081 indicated a weak correlation. About 0% of the variance in Y was accounted by the variable X.

The coefficient of alienation (coefficient of non-determination) equalled .9919  $(1 - r^2)$ .

			Х			Expe	cted Cell
		0	1	Totals		Frequ Null H	encies per lypothesis
~	1	45	36	81		40.5	40.5
Ĭ	0	55	64	119	Reset	59.5	59.5
Γot	als [	100	100	200	Calculate		

	Chi-Square		
Phi	Yates	Pearson	
-0.09	1.33	1.68	
Р	0.248805	0.194924	

Chi-square is calculated only if all expected cell frequencies are equal to or greater than 5. The Yates value is corrected for continuity; the Pearson value is not. Both probability estimates are non-directional.

Fisł	her Exact Pr	obability Test:
Б	one-tailed	Sample size too large
-	two-tailed	for the Fisher test.



#### Statistical Significance – Chi-Square Ratio

The observed probability was 1.68 (Figure 8). Results  $\leq$ .05 are considered borderline statistically significant, but the probability of error is still high (5%). The Chi-Square value was larger than .05. The probability of error P value was .195 (20%) (Figure 8). About 1.4% of the variance in the variable "choice" was accounted by the variable "gender". There was no significant relationship between the two categorical variables. Females and males enrolled in computer science not because of gender. Gender and choice was not related.

## Part 4 – Enrolment by G.P.A. Correlation

Point biserial coefficient is a coefficient of correlation between a binary (dichotomous) variable and an interval (continuous) variable. The predictor variable was choice (X) and the criterion variable was the scores on the G.P.A. (Y). The point biserial correlation is conceptually important, as it helps to understand the main principles of the tests of statistical significance, especially how the coefficient of correlation can be used to measure a difference between two means. Values of the point biserial are numerically equivalent to those that could have been obtained by the Pearson <sub>r</sub> product moment correlation.

## Descriptive Statistics of the Variables X and Y

#### Predictor Variable X

The mean, true variance, and true standard deviation was computed for both these groups. The mean of the female scores (0) was 3.60 and the mean of the male scores (1) was 3.47(Table 2).

	V Choico	VCDA	Y0 – female	Y1 – male	Y <sup>-</sup> group	Y <sup>∧−</sup> error
		1 – G.F.A.	scores	scores	mean	variable
M – mean	0.4050	3.5495	3.6034	3.4704	3.5474	0.0021
true						
variance –	0.0897	0.2422	0.1017	0.0619	0.0041	0.0855
$\sigma^2$						
true SD – σ	0.2996	0.4921	0.32	0.2487	0.0640	0.2923
Table 3 – Descriptive Statistics of Variable X and Y						

The regression on the categories was computed using the predicted variable (group means)  $Y^{I}$  and the error variable  $Y^{\Lambda}$ . This was computed as Y-  $Y^{I} = Y^{\Lambda}$ . The error variable was 0.0021 (Table 2).

The true standard deviation variance of the predictor variable was 0.0897(Table 2).

The true standard deviation variance of the criterion variable was 0.2422 (Table 2).

The slope of the regression line was an obtained score of -0.133. This was computed as b =  $^{(Y1-Y0)}/_{1-0}$ .

The correlation between enrolment by G.P.A. was -0.218 (Figure 9). This was computed as r =  $b(\sigma_x/\sigma_y)$ .

Data Summary	X=0	X=1	Total
n	119	81	200
ΣY	428.8	281.1	709.900000
$\Sigma \gamma^2$	1557.18000	980.470000	2537.65000
$ss_y$	12.0587	4.9489	17.86
mean <sub>Y</sub>	3.6034	3.4704	3.5495
r <sub>pb</sub>	t	df	

<b>'р</b>	b	u
-0.22	-3.15	198
	one-tailed	0.000943
P	two-tailed	0.001886

Figure 9 – Point Biserial Coefficient of Correlation (rpb)

## Criterion Variable Y

The mean of the predicted scores  $(Y^{l})$  equalled the mean of the criterion scores (Y). The mean of the error scores  $(Y^{\Lambda})$  was zero. The variance of the criterion scores was 0.0897.

The variance of the predicted variable  $(Y^{I})$  was 0.0041. This was computed as the weighted square difference of the two group means.

The variance of the error variable  $(Y^{\wedge})$  was 0.0855. This was computed as the sum of the variances of the two groups.

About 1% of the variance in the criterion variable (G.P.A.) was accounted for by the choice (enrolment in computer science) factor and about 35% of the variance in the criterion variable was likely due to other unidentifiable sources (errors). This was computed using this formulae  $\sigma^2/\sigma^2 = Y^1/Y + Y^A/Y$ .

## Discussion

The result of the study did not support the original hypothesis that gender and achievement were related to enrolment in computer science. Using a multiple correlation design, the results indicated that there was a negligible relationship (.0081 - 0%) between gender and enrolment. About 1.4% of the variance in the variable "choice" was accounted by the variable "gender". There was no significant relationship between the two categorical variables. Females and males enrolled in computer science not because of gender. The results of the point biserial coefficient of correlation for achievement and enrolment indicated a weak correlation of -0.218. It was concluded that gender and achievement did not play a role on who enrolled in computer science.

Overall, the results indicated that 82% of the females on the honour roll chose computer science whereas only 56% of the males chose this same elective. A 1995 study by Durdell et al. gives reason for this increase in female enrolment due to "the gap of attitude towards computers growing narrower as females grow older." The majority of the females (15%) who chose computer science had 4.0 G.P.A.'s. As their grades indicated, they were also especially strong in math and science. The stereotypical notion of computers being masculine and having to relate to math was seen in this set of data. About 17% of males with a 3.5 G.P.A., chose computer science as their elective. A 3.5 G.P.A. is not exceptional, yet this is the largest group that chose computers. On the other hand, only 5% of the females with 3.0 G.P.A enrolled. Computer science is a male dominated subject. Females are quick to remark to the harassment they face and the feelings of inadequacies they encounter from the opposite sex in computer science (Gardner et al., 1986).

Gender and achievement appear to have no influence on enrolment in computer science. The results cannot be generalized to all schools, because this study took place in a school with little diversity. The population of Rockridge Secondary is very homogeneous with Caucasians making up the majority. In a more multicultural school, the results would have been different. Females in North America see computers as important, but don't use the opportunity to study computers (Gardner et al., 1986). In countries such as Singapore, India, and Sweden, where computing increases job options and higher-level math and science are requirements, there is a higher enrolment of females in computer science (Durndell et al, 1990). Computer science needs to attract new people, especially females and low achieving student, because as an elective course, there are other options. Moreover, we need to encourage students to study computing because of the earning potential and the job options (either as a vocation or in higher learning) it offers.

## References

- British Columbia Ministry of Education (2002). *Graduation Requirement Orders Authority:* School Act Section 168 (2) (B). Retrieved July 03, 2002, from Ministry of Education Web site: <u>http://www.bced.gov.bc.ca/legislation/schoollaw/e/m205-95.pdf</u>
- Durndell A., Siann G. and Glissov P. (1995). Gender and Computing: Persisting Differences. Educational Research, 37, 219 – 227.
- Durndell A., Siann G. and Glissov P. (1990). Gender Differences and Computing in Course Choice at Entry into Higher Education. *Journal of British Educational Research, 16*, 147 – 162.
- Gardner J.R., McEwan H. and Curry C.A. (1986). A Sample Survey of Attitudes to Computer Studies. <u>Computer Education, 10(2)</u>, 293 298.
- Gloeckner, Gene W (1997). Gender Facts: A Moral Dilemma. Paper presented at the American Vocational Association Convention (Las Vegas, NV, December 1997). (Report No. CE – 075 - 692). (ERIC Document Reproduction Service No. ED 416 325)
- Guss, Thomas O. and Adams, Lyndel (1999). Gender Orientation and Career Maturation among Rural Elementary School Students. Published in IEEE Technology and Society, December, 1999. (Report No. CG – 028 - 320). (ERIC Document Reproduction Service No. ED 417 364)
- Margolis, Jane, Allan Fisher, and Faye Miller (2002). *The Anatomy of Interest: Women in Undergraduate Computer Science*. Published in Women's Studies Quarterly, Spring/Summer 2000. Retrieved July 03, 2002, from Carnegie Mellon University, School of Computer Science Web site: http://www-2.cs.cmu.edu/~gendergap/papers/anatomyWSQ99.html
- Margolis, Jane, Allan Fisher, and Faye Miller (1999). *Caring About Connections: Gender and Computing*. Published in Women's Studies Quarterly, Spring/Summer 2000. Retrieved July 03, 2002, from Carnegie Mellon University, School of Computer Science Web site: <a href="http://www-2.cs.cmu.edu/~gendergap/papers/IEEE99.html">http://www-2.cs.cmu.edu/~gendergap/papers/IEEE99.html</a>
- Margolis, Jane, Allan Fisher, and Faye Miller (1997a). *Geek Mythology and Attracting Undergraduate Women to Technology*. Presented at *Impacting Change Through Collaboration*, proceedings of the Joint National Conference of the Women in Engineering Program Advocates Network and the National Association of Minority Engineering Program Administrators, March, 1997. Retrieved July 03, 2002, from Carnegie Mellon University, School of Computer Science Web site: <u>http://www-2.cs.cmu.edu/~gendergap/papers/wepan97.html</u>
- Margolis, Jane, Allan Fisher, and Faye Miller (1997b). Undergraduate Women in Computer Science: Experience, Motivation, and Culture. Presented at the ACM SIGCSE Technical Symposium, February, 1997. Retrieved July 03, 2002, from Carnegie Mellon University, School of Computer Science Web site: http://www-2.cs.cmu.edu/~gendergap/papers/sigcse97/sigcse97.html
- Kozen, D. and Zweben, S. (1998). "1996-1997 CRA Taulbee Survey: Undergrad Enrolments Keep Booming, Grad Enrolments Holding Their Own." <u>Computing Research News</u>, March.
- National Science Board. (1998). <u>Science & Engineering Indicators 1998</u>. Arlington, VA: National Science Foundation (NSB 98-1).

- Sanders, Jo. (1995). <u>Girls and Technology: Villain Wanted in Teaching the Majority</u>. Sue V. Rosser, ed., Teachers College Press, 147-159.
- Schofield, Janet Ward. (1995). <u>Computers and Classroom Culture</u>. Cambridge University Press, New York.