YES: Women Do Have an Aptitude for Programming!

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Abstract

The ratio of women involved in computing has been historically moderate, and has receded at an alarming pace over the past decade, contributing to the critical labor shortage in the computing field. This paper investigates whether females lack aptitude for computer programming, or conversely whether they possess an aptitude for the discipline and could thus provide critical services within this high paying occupation if they chose to do so. Results demonstrate that females and males possess substantially the same level of aptitude for computer programming, and that for both groups a substantial portion of applicants from non-computing backgrounds demonstrated reasonable levels of programming aptitude.

Keywords: Career selection, women in computing, programming aptitude, self-efficacy

1. Introduction

The field of computer programming is not attracting sufficient recruits into its ranks to fill open positions. According to the U. S. Department of Commerce (1997, 1998), the Information Technology Association of America (ITAA), and others, the Information Technology (IT) arena is facing its toughest challenge ever. There are approximately 400,000 jobs in this occupation that are currently unfilled (ITAA, 1998). Government estimates suggest the need for about 138,000 new workers each year through 2006, resulting in the need for 1.3 million new IT workers between 1996 and 2006. At the same time, institutions of higher education are only producing 40,000 graduates per year who are skilled in related disciplines (ITAA, 1998). Curiously, this opportunity rich and high paying occupation is not a top choice of high school students taking the ACT college entrance exams as only 6% of males and 2% of females indicate an interest in computing related disciplines (ACT, 1998).

Of particular concern is the large disparity in the proportion of male versus female students demonstrating an interest in computing careers. Although women are more than half the population, they are a significantly underrepresented percentage of the population earning computing degrees, and hold only 31% of computer programming jobs (U. S. Department of Commerce, 1998). According to the National Science Foundation (Hill, 1997), during the past decade we have witnessed a 51% decrease in computing degrees awarded to women. Whereas Computer Science degree awards to women has declined, the critical labor shortage in the computing profession could be diminished if women were effectively encouraged to participate equally with men in the profession.

Distressingly, this pattern of declining female enrollment is counter to aspirations to promote gender equity in pay while also placing the national economy at risk in an era of increasing technological importance and global competition. Research on women and career choice suggests culturally induced lack of interest (Gollnick and Chinn, 1997) and low self-efficacy [Hackett and Betz, 1981] expectations affect the career choices of women. Along these lines, the Information Technology Association of America (ITAA, 1998) has convened special task forces to promote an enhanced public image of IT work and to

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attract under-represented groups, including women, to careers in IT. Similarly, prior research supported an association between academic self-efficacy and the selection of computing related majors by college females (Chrisman and Schambach, 1998). Efficacy expectations are beliefs concerning whether one has the ability to successfully perform a given behavior. These efficacy expectations determine whether or not behavior will be initiated, how much effort will be expended, and how long behavior will be sustained in the face of obstacles and difficult experiences. Self-efficacy helps explain why women of ample intellectual and academic ability may self-select out of an occupation or college major due to limitations in self-perception. Thus, women might avoid computing careers based on perceptions of inadequacy rather than based on actual deficiency in capability.

Could it be that females have less aptitude than men for programming, or other IT work? The basic premise in self-efficacy discussions concerning women in technology careers is that, in general, women inherently have the same intellectual ability and aptitude as men to perform the work. Documented support of job success and aptitude are potential interventions designed to persuade female students (or career changers) that they have the potential to be successful in IT occupations. The intention of this study is to evaluate and provide documented evidence regarding female aptitude for computer programming.

This research seeks to discover answers to the following question: Do women have the same computer programming aptitude as men? The research hypothesis is that no significant difference will be found between female and male programming aptitude.

2. Method

Participants: Participants in the study include 172 applicants (100 male and 72 female) responding to three newspaper advertisements that announced openings for a computer programming training program. The training program represented potential employment by one of three companies offering the training to people who had no experience with programming computers. The ad indicated that trainees would receive a salary and benefits while they were trained in a special fast-track career transition program at a large mid-western university.

Participants in this study were those applicants selected to participate in a programming aptitude test. Those selected to test, from a pool of over 700 applicants, were judged by application reviewers to have some demonstrated history of success in employment and some demonstrated ability to learn new concepts. Gender was not considered in the selection process.

Measurement: The Berger Aptitude Test for Programmers (B-APT) was used to measure applicants' aptitude for computer programming. The B-APT consists of three separate timed parts of ten problems each. The B-APT is designed so that examinees with no computer background can first learn the test's programming language and then use their new knowledge and base aptitude to solve the thirty problems. As such, the B-APT is a work sample test. It requires learning to write coded instructions to a "computer" in a logical sequence in order to implement program requirements. Examinees take the test by writing short "programs" in the test booklet. They are given a brief list of program language instructions, a brief overview of enacting the language instructions to solve problems, practice exercises, and examinees then apply the principles and syntax they have learned to solve the problems. By the time they reach the end of the B-APT, examinees have been taught to code, loop, increment, and branch. Total administration time is under 2 hours.

Predictive power of the B-APT exam has been previously established by its publishers. In a study involving 138 military officers and Civil Service employees the B-APT and sixteen other measures were administered to trainees at the beginning of a programming course, and the measures were later correlated with grades received in training. The correlation of the B-APT with training grades was .71, accounting for nearly all the predictive power of the battery of measures. Thus, the B-APT has shown to be a relevant predictor of programming aptitude.

3. Procedure

Selected applicants were invited to one of a number of testing sessions conducted at the conference center on a university campus. Test sessions consisted of up to 25 examinees, an administrator, and a proctor. The B-APT publisher provided administrator training along with standard exam instructions and procedures for the test sessions. Thus, there was little variation in testing environment. Completed examination booklets were sent to the publisher for standardized grading. Test scores captured included one for each of the three parts of the exam as well as a cumulative score for the three sections. The cumulative score was subsequently used in determining whether the applicant had demonstrated programming aptitude and if the applicants should be asked to participate in a face-to-face interview (the last step in selection process).

4. Results

Descriptive statistics, frequencies, and a one-way ANOVA were examined to evaluate overall group performance on the B-APT exam, and to determine whether there were any gender related differences in exam scores. Primary evaluation was conducted using the cumulative score (CS). CS could range from 0 (none correct) to 30 (perfect score) on the B-APT. Frequencies confirmed indications from prior exams that CS scores of applicants form a bi-modal distribution; a sizeable portion of examinees scored below ten, only a few scored in the teens, and then the largest

proportion score twenty or higher, but only a few obtain a perfect score.

Gender segmented frequencies demonstrated minimal differences in exam scores by gender. Table 1 illustrates a categorized view of the frequencies by gender. Although fewer males than females scored in the lowest category, there seems to be an equivalent proportion of females and males in the range typically considered to show reasonable aptitude (those scoring 20 and above). For the high aptitude candidates (scored 27 or above) the proportion of males and females is almost identical, and in the perfect score category females show superior representation. An interesting finding is that over 70% of both female and male examinees demonstrated a reasonable level of programming aptitude.

Score Category	% of Females	% of Males
Scored ten or less	18	10
Scored > 10 and < 20	10	16
Scored twenty or above	72	74
Scored 27 or above	31	32
Perfect score (=30)	6	2

Table 1. Score Category Frequencies by Gender (should not add to 100).

Table 2 (see attached) illustrates the mean, standard deviation, minimum and maximum scores for CS and the three component parts of the B-APT. Mean scores suggest a somewhat higher average score for males; however, the standard deviation suggest that increased variance may explain the difference. Recall from Table 1 that a larger proportion of females scored in the lowest category but that a comparable number of females and males rated in the reasonable aptitude and high aptitude categories.

A one-way ANOVA was conducted to determine whether significant differences existed in the average scores and variances between females and males. The cumulative score difference between females and males was non-significant, p=.314 (F=1.019, df=171). Similarly, non-significant gender differences were found for each Part Score on the B-APT exam. Thus, there were no statistically significant gender differences in aptitude.

Table 2. B-APT Score Descriptive Statistics by Gender. (CS: Cumulative Score)

	Females				Males			
	CS Score	Score Part A	Score Part B	Score Part C	CS Score	Score Part A	Score Part B	Score Part C
Mean	**21.11**	8.47	7.15	5.46	**22.26**	8.70	7.75	5.74
Std.Dev	**8.08**	2.17	3.46	3.36	**6.80**	2.03	3.00	3.03
Min	**1**	0	0	0	**0**	0	0	0
Max	**30**	10	10	10	**30**	10	10	10

5. Limitations

Some degree of self-selection took place regarding what type of candidates responded to the three ads used to gain applicant interest. While the overall results provided a reasonable representation from both genders we would have preferred female representation in proportion to the overall population. Furthermore, it is reasonable to assume that for both genders the self-selection factor, in combination with application review and selection procedures, is likely to have increased the level of capability demonstrated by examinees. Thus, it would be unrealistic to believe that over 70% of an unfiltered sample would achieve scores suggesting at least reasonable aptitude for computer programming.

6. Conclusions and Future Research

Based on the findings of this study a commensurate proportion of women and men demonstrate reasonable or high aptitude in regard to computer programming.
Differences in self-perceptions correspond to variance in career targets. Data in this study suggest that women are equal to men regarding their aptitude, thus insufficient self-confidence, interests, or some other personality factor is restricting females from entering the computing discipline. Thus, interventions that increase intellectual self-confidence may increase female enrollments in computing courses and majors. In a technology dependent global economy it is incumbent upon families, communities, and faculty members (advisors) in high schools and colleges to find ways to enhance the self-

confidence of female students especially in regards to their science, math and technological capabilities.

Furthermore, for both genders a relatively large (over 70%) proportion of examinees demonstrated at least reasonable degree of programming aptitude. This finding suggest the substantial possibility of transitioning persons to the computing professions even if their educational background is not in a computing related field. Although not detailed in this paper, the candidates who participated in this study came from a wide variety of occupational backgrounds. A future study will evaluate whether differing occupational backgrounds plays a significant role in predicting computing aptitude.

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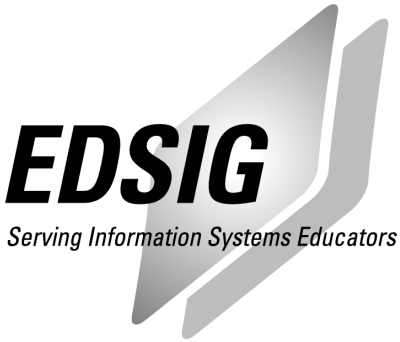

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