Motivating Women to Computer Science Education

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INTRODUCTION

The problem of disproportional representation of women in the computer science (CS) field in post-secondary education has become a major concern (AAUW, 2000; Camp, 2002; Carver, 2000; Varma, 2003). Currently, universities are increasing their focus on retaining women into CS programs. However, the number of women in that field remains low in proportion to males, and many women who are recruited often drop out or switch majors before completing their degree in CS (National Science Board, 2004, pp. 2-6, 3-17). In order to promote retention, it is important to compare possible differences in learning motivation between males and females in CS, examine changes in motivations across the span of CS study, and assess whether recruitment messages and program structures are matched (or mismatched) to the motivations of females. This article investigates the motivations for women to enter into, remain in, and continue the study of CS at the post-secondary level.

BACKGROUND

In recent years, a number of researchers (Chory-Assad, 2002; Kerssen-Griep, Hess, & Trees, 2003; Noels, Clement, & Pelletier, 1999; Postlewaite & Haggerty, 2002; Volet, 2001) have specifically concentrated on motivations for learning in the classroom and the factors that match teaching techniques with student success and satisfaction. Motivation, in the context of learning, refers to stimulation that drives students to derive academic benefits from classroom activities. In a learning setting, motivation can also be described as either trait motivation, a general level of desire to learn across all learning situations, or state motivation, a general level of desire to learn in a particular class, task, or content area (Anderson & Martin, 2002). The present study probes state motivations rather than trait motivations because of the focus on motivations that are particular to choosing and continuing study in the CS field.

Several scholars have posited a variety of theoretical constructs centred on state motivation. One such construct is the achievement goal theory (Dweck & Leggett, 1988), which reasons that goals are either ego oriented, wanting to gain favourable judgments of competence through social comparison, or task oriented, wanting to be competent and master a skill through effort based on internalized standards. In this construct, the general attitude towards reaching the goal is important. Another construct is self-determination theory (Deci & Ryan, 1985), which includes categories of intrinsic and extrinsic motivations. An educationally based construct is that of Pintrich, Smith, Garcia, and McKeachie (1991) who developed the Motivated Strategies for Learning Questionnaire. The bases for these scales are internal and external goal orientations. This instrument is currently the measurement standard for motivation in education.

Demonstrating how the interaction between internal and external attitude orientations and rewards might create a broader range of motivational categories requires a more complete explication. Vallerand and Bissonette (1992) posit a matrix which puts forward three types of extrinsic motivation: (1) external regulation (influences from means outside of the individual such as reward and punishment), (2) introjected regulation (results from outside pressure that the individual has internalized such as guilt or desire to impress others), and (3) identified regula-

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tion (whereby the individual feels that something is personally worthwhile and relates to their value system). This matrix has been related to second language learning, a learning situation similar to CS because it involves a very specific content area where motivational factors may be highly determinate in the success or failure of learning.

Volet (2001) modified Pintrichs et al.'s (1991) "Self-Efficacy and Expectancy of Success" as a measure of motivation. Self-efficacy describes a student making a judgment about his or her own ability to be successful in a learning task. Self-efficacy is posited to be an important motivation for both entering into and continuing in a particular learning context. The Williams and Ivey (2001) case study of motivations in math education also concentrated on an internal motivation orientation that includes self-efficacy as a factor. They highlighted an internal perception of usefulness as an essential part of the motivational matrix. A perception of usefulness is whether the student perceives that the particular skill to be learned will have a current or future utility for them. As with math, a perception of usefulness may also be an important motivational factor in continuing in the study of CS.

Margolis and Fisher (2002) posit that males and females have different motivations for entering the study of CS. They developed a set of seven motivational factors for the study of CS: enjoyment, versatility, math/science related, employment, encouragement by others, exciting field, and the quality of CS department. While both males and females list enjoyment as their top motivation, the most important difference is that females list the versatility (utility and purpose) of computing as their secondary reason, while male's rate this motivation as sixth. In programming, males and females named self-efficacy as a motivation, but males cited this to a lesser degree.

Yet scholars have not investigated the role of motivation in both the recruitment and retention of women in CS program. As a synthesis of the various literatures on motivation, and with the specific motivation for CS, this study offers a motivation matrix that can be utilized to measure motivations across time because it encompasses a broad range of state motivational behaviors within a restricted number of concepts. This matrix includes three intrinsic and three extrinsic motivations, listed as intrinsic-self**,** intrinsic-social**,** intrinsic-economic, extrinsic-self, extrinsic-social, and extrinsic-economic.

To analyze motivation in both the recruitment and retention of women in CS, it is essential to investigate possible changes in motivations over time, given the interaction of other factors such as success in the classroom or desires for challenge and fun. Time parameters in the present study are before enrolment and during CS coursework.

METHOD

The present study hypothesizes the following relationships:

- **H1:** Females and males will differ significantly on intrinsic-self motivation in CS study.
- **H2:** Females and males will differ significantly on intrinsic-social motivation in CS study.
- **H3:** Females and males will differ significantly on intrinsic-economic motivation in CS study.
- **H4:** Females and males will differ significantly on extrinsic-self motivation in CS study.
- **H5:** Females and males will differ significantly on extrinsic-social motivation in CS study.
- **H6:** Females and males will differ significantly on extrinsic-economic motivation in CS study.
- **H7:** Motivations to study CS will differ across time based on gender.

The participants in the present study were students in CS at four institutions of higher education designated as minority-serving institutions because existing studies have focused mostly on non-minority institutions. The total sample size was 66, which included 35 female and 31 male participants. The sample was ethnically diverse with 22 White (11 female, 11 male), 15 African American (seven female, eight male), 10 Hispanic (five female, five male), 10 Native American (eight female, two male), and nine Asian American (four female, five male) participants.

The data for this study was gathered in 2002-2003 through in-depth interviews, as part of a larger project on women in information technology. Each student was asked the same 61 questions and 15 of those questions provided the specific data about motivations to study CS. Each interview was audio

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