International Journal of Arts & Sciences,
CD-ROM. ISSN: 1944-6934 :: 10(01):129–136 (2017)

GENDER GAPS IN UNDERGRADUATE COMPUTER TECHNOLOGY PROGRAMS: DEVELOP A THEORETICAL RESEARCH FRAMEWORK

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This paper presents a study conducted to identify factors that contribute to the gender gaps in undergraduate computer technology programs. In this study, the existing literature was extensively reviewed to examine, analyze, and synthesize the factors that contribute to this gender gaps. A theoretical research framework was developed from an exhaustive in-depth review of the literature and compiling statistical data gleaned from the literature on psychological and societal factors that contribute to the aforementioned gender gaps. This research will initiate future empirical research on gender gaps in undergraduate computer technology programs and will provide a general foundation for future research on gender gaps in interdisciplinary technology programs.

Keywords: Gender gaps, Computer technology, Undergraduate program, Theoretical model.

Introduction

The gender gaps in the Science, Technology, Engineering, and Mathematics (STEM) in higher education has become a vital issue in recent years. Women have surpassed men in graduation rates in many academic programs, yet they lag in some STEM programs. In particular, their representation is lowest in undergraduate computer technology programs – one of the STEM fields. According to a National Science Foundation report (2014), since the year 2000 women's graduation in bachelor's degree declined by 10% in computer sciences, 5% in mathematics, 2% in physics, and 2% in engineering. In this increasingly technologically advanced world, women's underrepresentation in undergraduate computer technology programs is widely considered as one of the obstacle in women's advancement in higher education and career. Given the persistent underrepresentation of female students in computer technology programs, understanding the cause is crucial. The gaps in knowledge exist because of variations in research results found in literature about different contributing factors and their level of significance on female students' underrepresentation in undergraduate computer technology programs. Additionally, not many researchers examine female students' underrepresentation in undergraduate computer technology programs.

Purpose of the Study

In this context, a study conducted to identify factors that contribute to the gender gaps in undergraduate computer technology programs. The purpose of this study was to examine the factors that contribute to the significant level of inequity in male and female students' representation in the undergraduate computer technology programs. The study seeks to better understand why female students are less likely to enroll and persist in undergraduate computer technology programs such as Information Technology,

Information Systems, Information Security, Information Assurance, Computer Science, etc. The study focused on contributing factors to gender gaps in undergraduate technology programs from the following two perspectives:

- *Psychological* - the effect of psychological factors such as computer self-efficacy, attitude.
- *Societal* - the effect of social factors such as traditional gender roles, demography.

Research Objective

The goal of this study was to develop a theoretical research framework addressing the inconsistencies observed in the literature on gender gaps in undergraduate computer technology programs. The developed theoretical research framework will: 1) Initiate future empirical research on gender gaps in undergraduate computer technology programs, 2) Provide a general foundation for future research on gender gaps in interdisciplinary technology programs.

Literature Review

Psychological Perspective

A variety of theoretical models has been developed, with varying levels of theoretical and empirical support, to explain the psychological factors that contribute to the adoption of computer technology. Based on these cognitive theoretical models, numerous studies focused on the contribution of psychological factors on people's adoption of computer technology (Venkatesh, Thong, & Xu, 2012).

Theories on Computer Self-Efficacy

Computer Self-Efficacy (CSE) is one of the psychological factors consistently supported in literature as an important construct to predict people's computer technology adoption (Hasan, 2003; Lewis, Agarwal, & Sambamurthy, 2003). According to Kim and Kim (2005), the relationship between self-efficacy and behavior has been empirically validated in diverse domains such as education, health, and organizational tasks. Since self-efficacy is a dynamic construct that varies across domains, the concept of self-efficacy has been applied to various domains including technology (Hassam & Ali, 2006). CSE is derived from the self-efficacy construct of Bandura's (1986) Social Cognitive Theory. Technology researchers have found that self-efficacy construct of Social Cognitive Theory can be adapted to technology context, and this construct is an important determinant of people's adoption of technology (Compeau & Higgins, 1995). Consequently, in the realm of computer technology, CSE regarded as a determinant of people's use of computer technology; and researchers considered CSE to understand people's intention to use and actual use of new computer technology (Kim & Kim, 2005).

According to Compeau and Higgins (1995), CSE refers to a judgment of people's capability to use the computer. CSE is a specific self-efficacy that defined as belief in people's ability to "mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands" (Compeau & Higgins, p. 408). This belief has an influence on the choice of activities, the degree to effort expended, and persistence of effort. Thus, CSE exerts a significant influence on people's emotional reactions to computer technology, their intention to use the technology, and their actual use of the technology (Hayashi, Chen, Ryan, & Wu, 2004). Personal, subjective feelings and beliefs toward computers have a stronger impact on people's computer competency than objective measures of computer experience and intensity of computer use.

The continuing research efforts on CSE in computer technology literature have solidified the belief that CSE plays a critical role in understanding people's use of the technology (Chau, 2001; Hong, Thong, Wong, & Tam, 2001). CSE demonstrated positive effects on many computer-related behaviors (Hassam & Ali, 2006). In the computer technology acceptance literature, a number of studies have found that high CSE is related to the use of a variety of advanced computer products (Compeau & Higgins, 1995; Fagan & Neil, 2004). As a result, CSE has become an important variable in the computer technology research.

Theories on Attitude

"Attitude toward behavior is defined as a person's favorable/unfavorable evaluation of the behavior in question" (Venkatesh & Brown, 2001, p. 73). According to Allport (1935), "An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (p. 810). Attitude represents a "summary evaluation of a psychological object captured in such attribute dimensions as good-bad, harmful-beneficial, pleasant-unpleasant, and likeable-dislikeable" (Ajzen, 2001, p. 28).

According to Theory of Planned Behavior, attitude results from people's beliefs (expectations) that a behavior will result in a particular outcome and people's evaluation of that outcome. According to Ajzen, each belief associates the behavior with a certain attribute, and it is the subjective summation of these attributes which results in an attitude. Ajzen further explained that people may possess multiple different beliefs about a behavior; however, it is assumed that only salient or readily accessible beliefs influence attitudes at any given moment.

Ndubisi (2004) explained that attitude is related to behavioral intention because people form intentions to perform behaviors toward which they have a positive feeling. According to Selim (2003), people's behavioral intention is said to be determined by their attitude concerning the behavior - whether they feel that performing that behavior is good or bad. Mathieson (1999) found that people's attitude is statistically valid for explaining their intention to use computer technology, a key dependent variable in computer technology research.

Societal Perspective

The effect of social factors such as traditional gender roles, demography, family, peer, etc. play the vital role in people's adoption of technology. According to Fouad et al. (2010) Taxonomy of perceived barriers and supports of those societal factors affect college students' education in STEM. The positive and negative contributing factors from following four different groups play the vital role in female students' study in STEM (Fouad et al., 2010).

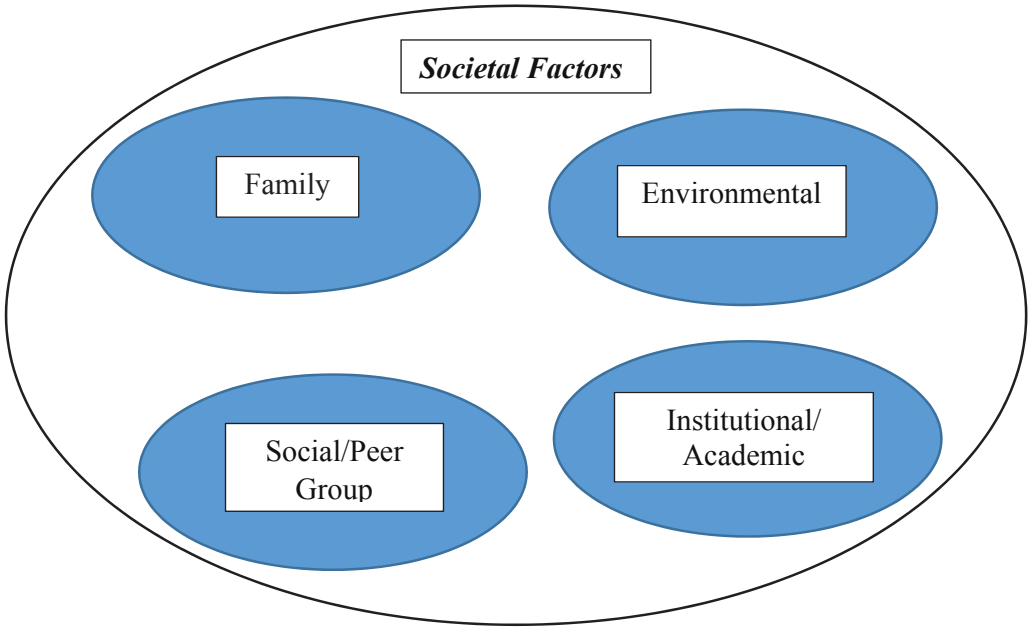

Figure 1. Societal factors contribute to college students' technology adoption decision.

Positive Contributing Factors

Family: Family help and knowledge base, strong STEM role models in STEM in the family; encouragement, involvement, and engagement in education and career decision-making, support for career choices, etc.

Social/Peer group: Perceived as competent by social/peer group, feels attached and maintains close relationships and integrated into a social group, peer group involved in STEM, discusses career aspirations with a social group.

Environmental: Exposure to STEM role models of same gender/ethnicity, exposure to STEM enrichment (tutor, STEM camp, computer, etc.)

Institutional/Academic: Encouragement and inspiration from instructors, interested and engaged in career goals, effective teaching method, quick help when needed, challenging coursework available, etc.

Negative Contributing Factors

Family: Little help and encouragement in STEM fields from parents, lack of role models in family, disengagement or disagreement in career plans, low aspirations or expectations for educational attainment, no STEM knowledge among family members, etc.

Social/Peer group: Lack of peer support, perceived peer rejection, desire to *fit in,* little to no social integration, no career plans, minority group, etc.

Environmental: Gender role stereotypes, lack of opportunities and resources for STEM education, lack of STEM role models of the same gender and/or ethnicity, etc.

Institutional/Academic: Ineffective teaching method, little to no encouragement or extra help from instructors or academic environment, annoyance or frustration from the poor learning environment, lack of guidance, lack of educational opportunity, inadequate academic preparation, etc.

Psychological and Societal Factors

According to Ajzen (2001), perceived behavioral control, which refers to perceptions of internal and external behavioral constraints, is a subjective belief in personal control over goal-directed human behavior. Internal behavioral constraints include the personal skills and knowledge required to perform a specific behavior, while external behavioral constraints include the resources and opportunities available to individuals for engaging in this specific behavior.

Ajzen and Fishbein (2005) developed a conceptual model that depicts the antecedents of people's intentions and behavior. This model implicit assumptions that different psychological and societal factors under Individual, Social, and Information categories play the vital role in how people intend to behave and actually behave. At the core of this model "is a causal chain of effects starting with the formation of behavioral, normative, and control beliefs. These beliefs assume to influence attitudes, subjective norms, and perceived behavioral control which, in turn, produce intentions and behavior" (Ajzen & Fishbein, 2005, p. 195). According to Ajzen and Fishbein, this model implicit following assumptions:

1. Intention is an immediate antecedent of actual behavior
2. Intention, in turn, is determined by attitude toward the behavior, subjective norm, and perceived behavioral control
3. The determinants are themselves a function, respectively, of underlying behavioral, normative, and control beliefs
4. Behavioral, normative, and control beliefs can vary as a function of a wide range of background factors.

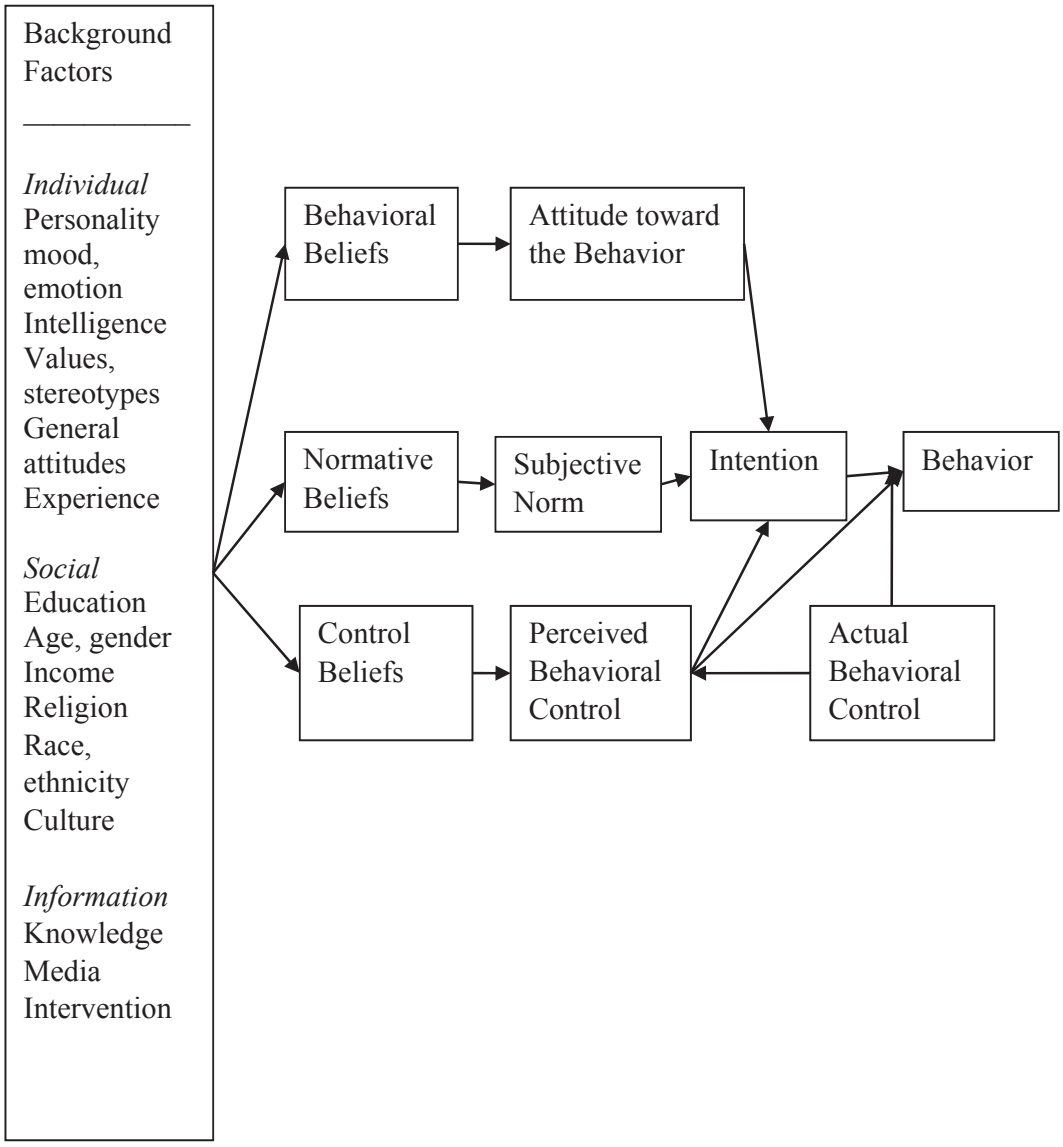

Figure 2. The theories of reasoned action and planned behavior (Ajzen & Fishnein, 2005, p. 194)

Methodology

In this study existing literature was extensively reviewed to examine, analyze, and synthesize the factors that contribute to gender gaps in undergraduate computer technology programs. The study examined contributing factors in order to develop a general theoretical research framework. A theoretical model developed from the exhaustive in-depth review of the existing literature and compiling statistical data gleaned from the literature on psychological and societal factors that contribute to the aforementioned gender gaps.

The following inclusion criteria were used in selecting research from literature:

- The empirical research published in peer-reviewed journals focusing on contributing factors to gender gaps from the following two perspectives:

- *Psychological perspective* - the effect of psychological factors such as computer self-efficacy, attitude.
- *Societal perspective* - the effect of social factors such as traditional gender roles, demography.

- The reports of the National Science Foundation and National Center for Science & Engineering Statistics (2013, 2014) that published statistical data on gender gaps in STEM programs for the 2000-2012 time period.

A descriptive statistical analysis was conducted based on the data and research findings published in peer-reviewed journals mentioned above.

Theoretical Model Developed

Based on the literature review on computer technology adoption, this study developed a theoretical model that predicts that female students' societal and psychological factors affect their intention to enroll and persist in undergraduate computer technology program. Figure 3 provides the theoretical model developed from the literature on societal and psychological factors' contribution people's technology adoption.

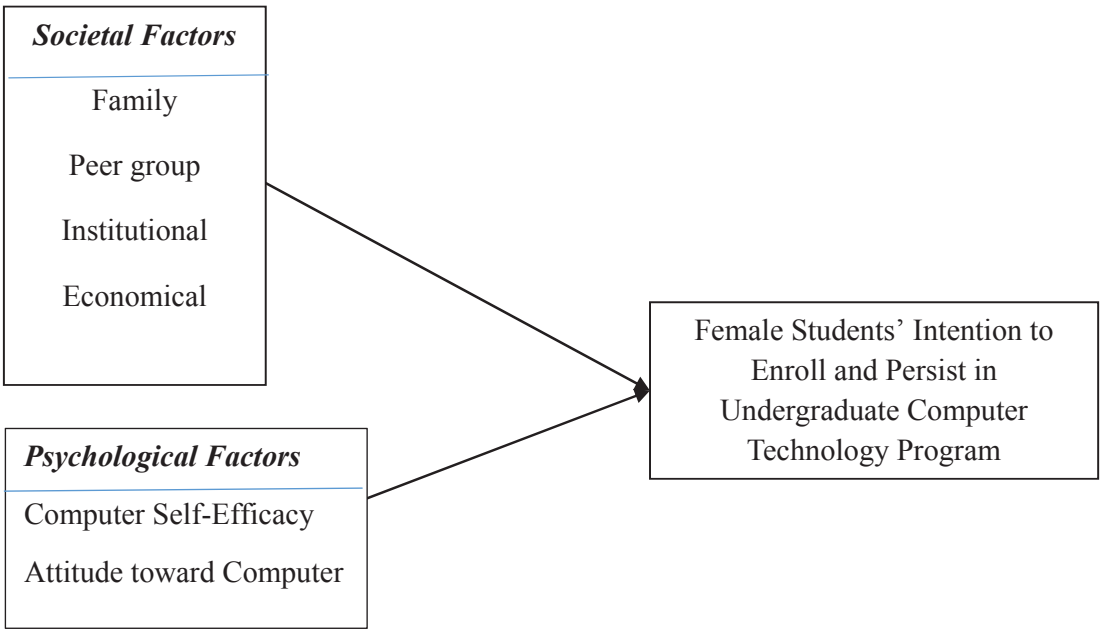

Figure 3. The conceptual model of different societal and psychological factors and their effects on female students' intention to enroll and persist in undergraduate computer technology program

The above theoretical model developed in this study synthesizing multiple theoretical models in the literature on people's technology adoption. Different well-established theoretical models such as Theory of Reasoned Action, Theory of Planned Behavior, and Social Cognitive Theory were applied in analyzing contributing factors from literature. The reason for this integration of different theoretical models was the complexities of the psychological and social context within which female students with varying individual characteristics take their decision regarding perusing education in computer technology.

Conclusions

The purpose of this study was to improve the understanding of the factors that affect female students' enrollment and retention in undergraduate computer technology programs. The research seeks to better understand why female students are less likely to enroll and persist in undergraduate computer technology programs such as Information Technology, Information Systems, Information Security, Information Assurance, Computer Science, etc. Given the persistent underrepresentation of female students in computer technology programs, understanding those factors is crucial. The theoretical model will help to gain a better explanation in this regard.

Research Implication

This study extended prior research on technology adoption by offering a conceptual model of constructs that synthesized multiple theoretical perspectives. Consequently, the study will:

- Provide an in-depth understanding of psychological and societal factors that contribute in the gender gaps in undergraduate computer technology programs.
- Provide academic administrators, advisors, and faculty with strategies to address the issue that keeps female students from pursuing majors in computer technology programs.
- Finally, support the academic goal of increasing female students' enrollment and retention rate in undergraduate computer technology programs.

Future Research

The proposed theoretical model will be used in future empirical research to explain female students' underrepresentation in enrollment and retention in undergraduate computer technology program. More specifically, the proposed theoretical model developed from this study will:

- Provide the foundation of future survey-based empirical research on gender gaps in undergraduate computer technology programs.
- Provide a general framework for future research on gender gaps in interdisciplinary technology programs, especially in *computer* and *engineering* fields – two of the STEM programs that have significant underrepresentation of female students in undergraduate level (National Science Foundation, 2014).
- Be available for replication of study on similar issues by researchers in other disciplines.

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