Identifying Factors that Influence Undergraduate Women to Leave (or Remain in) Computer Science Majors

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ABSTRACT

The share of women in computing careers is significantly lower than the share of women in the United States workforce. This study seeks to examine the social, structural, and individual factors that influence the decision-making of undergraduates who identify as women to leave or remain in computer science-related disciplines. This research explores the broader computer science discipline including related disciplines such as cybersecurity, management information systems, business analytics, and information technology (IT) innovation. There have been studies targeting specific majors, but the categorization of computer science majors is not always reflective of all computing majors. It is imperative that research is performed to determine factors that could provide a more inclusive academic environment in these majors in hopes that higher education institutions can retain more students who identify as female.

Keywords

Computer science, IT, Information Technology, Women, Undergraduate, Attrition, Retention, Bachelor's degrees, cybersecurity, management information systems, business analytics, information technology innovation.

INTRODUCTION

Computer occupations make up 51% of the total occupations in all science, technology, engineering, and math (STEM) professions (Martinez & Christnacht, 2021). Computer science careers offer exceptional growth and pay among professions in the United States. According to the U.S. Bureau of Labor Statistics (BLS), computer and information technology (IT) employment will increase by 13% from 2020 to 2030 (U.S. Bureau of Labor Statistics 2021). Additionally, the BLS identifies that computer and IT jobs pay $49,300 more than the median annual wage for all jobs. (U.S. Bureau of Labor Statistics 2021). Women make up 47% the workforce in the United States overall (U.S. Bureau of Labor Statistics 2022). However, they only make up 27% of STEM employees, and 26.2% of employees in computer science (U.S. Bureau of Labor Statistics 2022).

The field of computer science requires specialized knowledge, most often obtained through the completion of a bachelor's degree in computer science (U.S. Bureau of Labor Statistics 2021). IT careers offer opportunity for everyone; yet, despite years of efforts to attract and retain women in the profession, the share of women receiving undergraduate degrees in computer sciences as a share of the percentage in the degree field has decreased overall (National Center for Science and Engineering Statistics, 2021). In STEM degrees, women represented about 50% for bachelor's degrees, about 45% for master's degrees, and about 41% of all doctorates (National Center for Science and Engineering Statistics, 2021). In psychology and biology, women make up most degrees at the bachelor's, master's, and doctoral levels (National Center for Science and Engineering Statistics, 2021). The share of women pursuing STEM degrees are lowest in computer science and engineering (National Center for Science and Engineering Statistics, 2021), which represent 80% of STEM jobs (Martinez & Christnacht, 2021). According to the National Center for Science and Engineering Statistics, the share of women earning master's and doctorates in Computer Science from 1998 to 2018 increased, while the share of women receiving bachelor's degrees in computer science decreased by 7.1% (National Center for Science and Engineering Statistics, 2021). These statistics help emphasize some of the key areas of concern surrounding the lack of women pursuing undergraduate degrees in computer science disciplines. This research seeks to learn more about factors contributing to women's retention or attrition in computer science degree programs.

LITERATURE REVIEW

While the research surrounding retention and attrition among undergraduate women in computer science is well-developed, the inclusion of multiple sub-disciplines such as cybersecurity, management information systems, IT innovation, and bioinformatics has not been studied extensively in an all-encompassing form. For example, Woszczynski & Shade (2010) discuss the challenges that women face as majors in cybersecurity and the need for retention and recruiting strategies. Annabi & Tari (2018) discuss the need for research and retention methods that are theoretically grounded, particularly for marginalized groups.

While several studies surrounding gender and information systems research have previously been explored, there are still many unanswered questions in this research domain. Ahuja used a phased, "life-cycle stage" model to analyze women's start and progression in IT, including career choice, persistence, and advancement (Ahuja, 2002). Undergraduates would fall into the "career choice" phase, when they are choosing to enter the field of IT or not (Ahuja, 2002). As can be seen in Figure 1, during the career choice life-cycle phase, women are most susceptible to the social barriers of social expectations and work-family conflict, and the structural barriers of occupational culture and lack of role models (Ahuja, 2002).
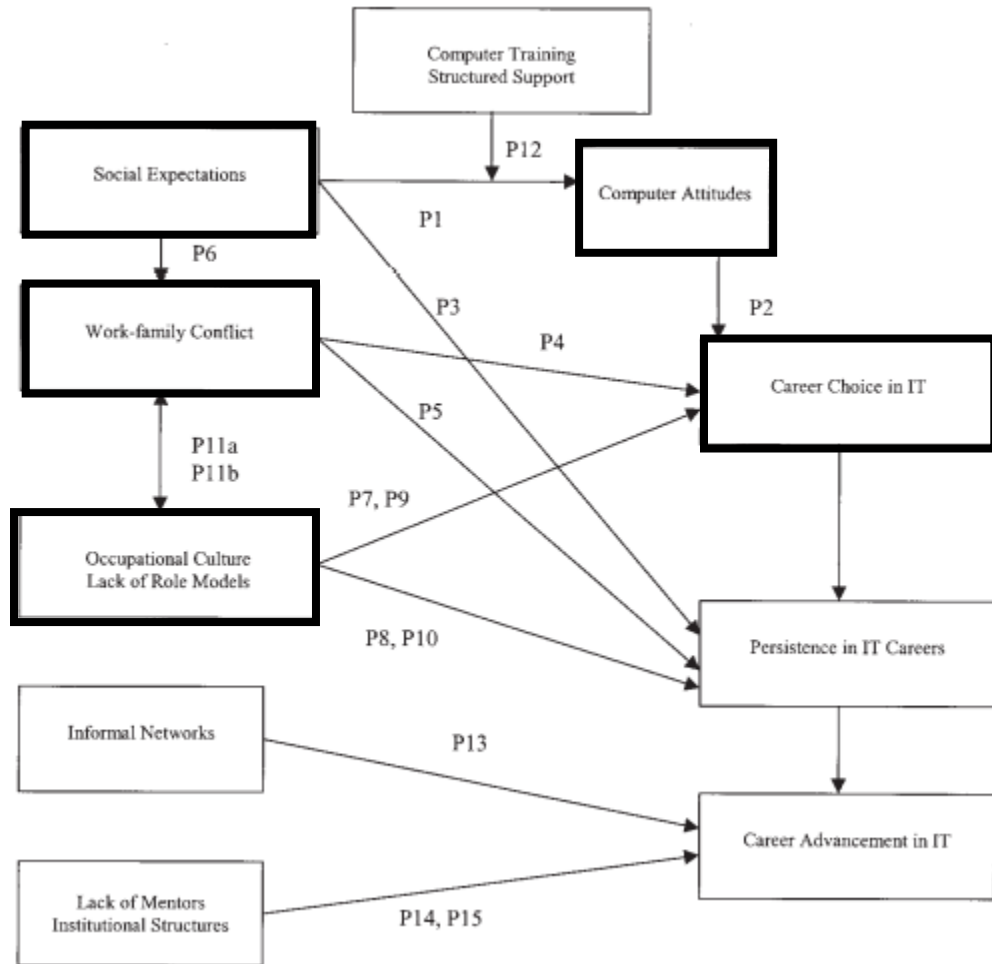

Figure 1. Ahuja's model of social and structural determinants of women's career choice, persistence, and advancement in IT (Ahuja, 2002), with added emphasis for the career choice life-cycle phase.

Most theorists, including Ahuja, use their frameworks to group women into a similar IT experience (Trauth et al, 2009). Truath et al, while acknowledging Ahuja's barriers, interviewed only women and compared their experiences for a more granular view of effective and ineffective factors in the retention of women in IT workplaces (Trauth et al, 2009). Trauth et al. (2009) explored individual identity, "to examine work-life balance" (p.483), individual influence to focus on mentors, and the influences of the organizational environment on the individual (Trauth et al., 2009).

Why, with so much opportunity for greater pay, growth, and number of jobs, are the share of women pursuing computer science bachelor's degrees declining overall? The purpose of this study is to examine the social, structural, and individual factors that influence the decision-making process of undergraduate women in computer science who leave the major vs. remain in the major.

Research Question 1 – Which demographic characteristics influence women to remain in a technology-related major?

Research Question 2 – Which demographic characteristics compel women to leave a technology-related major?

Research Question 3 – What social, individual, and structural factors influence undergraduate women in computer science to leave and remain in the major?

Research Question 4 – What gender-specific interventions did undergraduate women who left computer science majors use or not use prior to leaving and what are their perceptions of the interventions?

While examining the factors that influence the attrition of women from undergraduate computer science degrees and the interventions that did not prevent them from leaving, consideration will be given to the intersections of gender and gender identity, race, nationality, and ethnicity in the attrition of women from undergraduate computer science majors.

METHODOLOGY

The study will gather data from an urban, public university in the Midwest that has majors which are under the umbrella of the computer science discipline. These majors include computer science, management information systems, IT innovation, bioinformatics, and cybersecurity. The targeted demographic of participants for this research are undergraduates who identify as female.

The study will begin with analyzing several years of demographic and anonymized data collected from the university. This data will include completion or non-completion of the undergraduate degree in the major, time to completion, enrollment dates, age group, gender, country of origin, full- or part-time enrollment status, race/ethnic origin, and enrollment in successive programs. This data will inform us of any potential relationships between attrition and the data demographics. Identified relationships may inform the specific questions we ask in our next step, when we collect quantitative data through a survey utilizing Qualtrics.

The survey will be sent out to current and former undergraduate students in computer-science related majors. This survey will ask specifically about potential factors for retention in computer science related majors or attrition from those majors. We plan to use MK Ahuja's framework for social and structural factors combined with Trauth, Quesenberry, and Huang's individual differences theory of gender and IT (Ahuja 2002; Trauth et al 2009). We plan to use Ahuja's factors to shape our questions, while questioning women to reveal how differences between women's experiences affect their retention or attrition. We plan to analyze the factor-associated data to inform the next phase, the interview phase of the research.

Additional data will be collected utilizing semi-structured interview questions from current and past computer science majors. The interviews will drill down to even more specificity related to why the women left or stayed. We will organize the interview findings into themes – seeking to see if they inform our understanding of the factors that are related to women leaving or staying in computer science related majors.

CONTRIBUTIONS TO RESEARCH AND PRACTICE

Research surrounding the representation of women in computer science often focuses on increasing the number of young women entering the profession. Retaining the women who choose the profession is equally important. Not only do the computer science fields offer significant opportunities for income and influence for women, but computer science also suffers when women do not contribute their diversity of thought (Annabi 2018) to the field's body of work.

This research will provide perspectives in a unique context surrounding women in technology majors that leave or remain. While the computer science discipline has an extensive research domain in this area of research, there is a gap for technology majors outside of the specific domain of computer science in an urban setting. The researchers hope to discover strategies that have worked to retain women undergraduate students and utilize these strategies to improve retention capabilities in the field. We hope the research findings will help university programs with similar populations identify factors that influence undergraduate women's retention in computer science related majors.

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