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ITLS 6510 Synthesis of Articles

**Women in Computer Science**

We have seen in the past couple of decades that women are gaining ground compared to men in many different areas. Heilbronner (2013) summarized from the National Science Foundation from 2010 that women earn more doctoral degrees in some science fields than men. Women are earning 57% of all bachelor’s degrees from every field. However, women are being underrepresented in many science, technology, engineering, mathematic (STEM) fields. Seeing many women in other fields is inspiring, but the lack of women in STEM brings a lot of concern to me. Heilbronner (2013) elaborated more from the National Science Foundation that only 20 percent of the engineering degrees were earned by women with this number decreasing. Likewise, Beyer (2014) mentioned from the National Science Foundation from 2013 that women earned only 22.3% of all Computer Science degrees with only 0.4% of first-year female students intending on pursuing Computer Science.

Computer science (CS) is a blooming field and there are plenty of opportunities for careers in CS. Women would benefit immensely from pursuing these careers. The typical woman makes less than the typical man. Jobs in CS typically pay well. Holding a job in CS could boost what income women get. Beyer (2014) mentioned the smaller pay gap in CS careers (p. 154). Beyer (2014) described that women can enhance the quality of workers, especially with so few in the workplace (p.154). The low numbers hurt these businesses because they may not have the best person for the job. Women bring a unique perspective that can benefit any company and give that company an edge. Beyer (2014) included that women have creative and innovative ideas that are outside-of-the-box because women impact the diversity of the employees. Including women in CS would bring many solutions to some of our current problems. This paper analyzes other articles that mention different factors that affect women going into STEM and CS and retention of these women.

**STEM and CS in High School**

Heilbronner (2013) reported her findings of why women go into STEM and factors that detract them from going into STEM. Heilbronner (2013) did a study where she surveyed some of the participants in the Science Talent Search (STS) competition. She surveyed the semifinalists from two cohorts, one cohort consisted of semifinalists and finalists from 1987 through 1989, and the second cohort consisted of semifinalists and finalists from 1997 through 1999. Heilbronner (2013) mentioned that these years were chosen because there was an increased number of undergraduate degrees earned by women in STEM fields.

After Heilbronner (2013) got results from the survey, she noted that these women had less self-efficacy in STEM fields. These women scored lower than men, which means they didn’t believe as much as men that they could be successful in STEM. There could be many reasons that contribute to women having less self-efficacy, including male dominance in STEM fields (Beyer 2014 p. 156) or family responsibilities outweigh STEM fields (Heilbronner, 2013 p. 49).

Something interesting from the data the Heilbronner (2013) obtained from the STS competition is how many of the semifinalists and finalists were males and how many were females. Heilbronner (2013) reported between the two cohorts a total of 901 male semifinalists versus 659 female semifinalists (p. 43). Also reported was 146 male finalists compared to 94 female finalists (Heilbronner, 2013 p. 43). From this, we see that females consisted of 42% semifinalists and 39% of finalists. Thus, females are for the most part successful in STEM and compete with males. It would be interesting if the number of participants were the same, how many of them would become semifinalists as well as finalists. Therefore, we can see females are successful and could better be a part of STEM fields.

Something to note about the study from Heilbronner (2013) is that the competition is called “Science Talent Search”, which means the competition is geared more towards science. Heilbronner (2013) mentioned that 59.7% of biology degrees 72% of premedical degrees in 2009 were awarded to women (p.40). She also reported in 2009 that women earned 54.5% of all doctoral degrees in biology, 29.5% of all doctoral degrees in physical sciences, and 21.3% of all doctoral degrees in engineering (p.40). We can see from this trend that women represent science fields better than engineering fields.

**CS for Freshmen in College**

 Another perspective on women in CS can be seen at the college level. In order to get higher numbers of women in CS careers, women need to get a degree in CS. Because CS careers require a lot of technical training to be successful, many employers require a minimum of a bachelor’s degree in CS. In order to get a CS degree, a student must go through college. Selecting a degree can be challenging. Many students will choose their major within the first year or two. Enrollment numbers for majors depends on how students view each program. Beyer (2014) researched what freshman think about general information in CS.

 Beyer (2014) surveyed 1319 first-year students asking information about “demographic information, stereotypes about CS, values, computer self-efficacy and experience, personality variables, and experience in CS courses.” Beyer (2014) further analyzed each item. The participants:

* were mostly lower middle-class or working class (p. 164).
* were white and first-generation college students (p. 164).
* thought CS majors as nerdy and like to play games (p. 167).
* thought CS was a demanding career (p. 167).

Women varied a bit in their thoughts than men from the survey by:

* considering societal impacts more (p. 167).
* considering balance of career and family more (p. 167).
* avoiding science and technology careers more (p. 172).
* having significantly less self-efficacy scores (p. 168).
* scoring higher in the Big 5 personality test (p. 169).

Beyer (2014) suggested different cultural influences that deter women from CS majors. Males were more likely to have experience with computers and to have taken a CS class before college. Students were reported to have interest in CS if they were less interested in families, less concerned about their awareness of others, and less opened to different experiences (Beyer, 2014 p. 178). The typical woman doesn’t fit that description as much as the typical male.

**Retention in CS**

 The next big concern for CS is retention. Once students get into the program, it is imperative that you keep the students in. Beyer (2014) proposed that when students had excellent educators for CS that used complete and developed curriculum, these students were more likely to take a class in CS in the future.

White (2016) contributed to the understanding of why women leave STEM majors. He mentioned different strategies that keep students in STEM fields. When a student’s previous experience is similar to their new experience, he/she notes the similarities and is more likely to continue in the class (White, 2016 p.4). Students are more likely to persist if they have a positive attitude towards their area of interest, they are able to absorb the material in their area of interest well, they feel the right amount of rigor in their assignments, and they are able to see that they are making progress in their area of interest (White, 2016 p.4).

Based on White’s (2016) list women can have different problems with some of these areas. It appears they can see the progress they are making with the content and they can realize they are absorbing the material well. Everyone might think the rigor to STEM fields is too much and leave for that reason. Women may have problems with having a positive attitude, particularly when it is dominated by men that may discourage women from entering the field. Like mentioned from Beyer (2014), people with interest in CS are in general more close-minded to new experiences, and less involved in family and societal issues. Beyer (2014) reported that if a subject is considered more appropriate for males, the worse self-efficacy for females. If men are dominating CS and generally speaking don’t want change, they might discourage women from creating that change. Therefore, women might have a harder time having a positive attitude in STEM fields.

**Similar Findings between Articles**

 One common finding between the articles is the fact that women are less interested in STEM and CS because these fields are less about family and social life and making change to the world, and more about work and computer knowledge. Beyer (2014), Heilbronner (2013), and White (2016) all mentioned a couple of these ideas.

 Another common finding between the articles is that women have less self-efficacy than men and do not believe that they can be effective in STEM and CS. This problem could have ties to these STEM and CS fields being male dominated with very few female role models (White, 2016). It can be hard for women to believe in themselves when few women have shown impactful success.

 The last common finding I will mention from the articles is that retention is most likely to occur with excellent instructors that use effective pedagogy to teach students (Beyer, 2014). Students that didn’t have a positive experience are likely to not continue learning CS. A positive experience with an experienced instructor gives students a reason to persist in their CS studies.

**Discussion**

White (2016) elaborated that many students drop out, but that they could have made it and have the skills necessary to have succeeded in the field. Women can succeed as shown by Heilbronner (2013) and the participate statistics from the STS for semifinalists and finalists. Women were able to be well represented and competed with men. Beyer (2014) said that the CS underrepresentation of females is not due to their ability and that they perform similar to males in CS courses. The task would be to instill in women better self-efficacy so they would stay in CS because they have the skills to succeed.

Women tend to avoid STEM careers because the stereotypes they hold towards CS contradicts some of their values for family and society (Beyer, 2014). Women are more attracted to fields that work more directly with people (Beyer, 2014). Having such stereotypes for CS and STEM, they avoid CS and STEM. Beyer (2014) mentioned that CS can be very people-oriented and if women understood this better, they might be more likely to pursue CS.

Instructors are a major reason for students leaving CS and other majors. With excellent instructors that are able to teach well, students are likely to continue taking CS classes (Beyer, 2014). However, the opposite happens with an ineffective instructor. Heilbronner (2013) reported that women left STEM fields for many reasons, including poor teaching in college with little support given by the college. Women like better student-faculty interaction (Beyer, 1014), whereas CS and STEM typically have lower interactions. Heilbronner (2013) confirmed that social isolation was one of the most influential factors that influenced the decision to drop STEM.

For these changes to take place there needs to be a greater change in our culture. To take the next step, White (2016) proposes asking questions on involvement and experiences that affect women’s’ choices to stay or leave STEM. From Beyer (2014) topics like social psychological variables can be added. She also mentioned the importance of quality instructors and their influence on retention for students. Heilbronner (2013) suggested looking into increasing self-efficacy in women and their ability to be in CS. She also suggested analyzing more fully why women leave for family responsibilities and how that impacts retention in STEM.

**References**

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