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Gender Disparity in Students' Choices of Information Technology Majors

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Abstract

Background: The gender disparity in the Information Technology (IT) field has persisted over the years. In 2018, only 27.2% of IT workers were women. Once hired, women face more challenges, and they are leaving the field twice as fast as men are. The misconception that women are weak in tech is one of the root causes of gender disparity issues in IT. **Objectives:** We examine the gender disparity in students' choices of IT majors, as well as the decision process of Computer Information Systems (CIS) graduates. **Methods/Approach:** We use the United States public universities' student data from 2010 to 2018. Both the Pooled and the Satterthwaite t-test are used to investigate the gender disparity issue among the students. **Results:** Our results support our hypothesis that female students are statistically less likely to choose CIS than their male peers are. An additional analysis of students' grades in CIS courses shows that female students perform equally well as male students do. We did not find any evidence that it takes longer for female students to get the CIS degree; however, female students did change their majors more often. **Conclusions:** Female students tend to avoid IT majors; they often think they may not do well in the courses; however, such an assumption is not true. Our findings provide strategies for university and high school administration to be more proactive in developing recruiting strategies to attract and retain female CIS students.

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Introduction

The gender disparity in the Information Technology (IT) field has persisted over the years. In fact, it is getting worse. According to the U.S. Bureau of Labor Statistics, in 2018, based on over 3.3 million employed in IT-related fields, only 27.2% were women (United States Department of Labor, 2019). Women are leaving the field twice as fast as men (Mundy, 2017).

Once hired, women face more challenges. The key reasons for women leaving the field have nothing to do with the nature of the job. Women enjoy tech jobs. The main reasons include "workplace conditions, a lack of access to key creative roles, a sense of feeling stalled in one's career", and "Undermining behavior from managers" (Mundy, 2017). In general, women have not been nurtured in their career path in the technology field.

While women have outnumbered men in college nowadays, the percent of women in technology peaked at 37% in 1984 (Mundy, 2017). The issue is complicated. From an early age, we associate tech toys with boys rather than girls. Observing local area grade school robotics club photos posted on social media, the majority of the members are boys. Most women became involved in technology post-high school; therefore, they feel excluded in the hiring process when the interviewers and recruiters made male-centric references (Schoenberger, 2018). A male Google employee stated, "I'm simply stating that the distribution of preferences and abilities of men and women differ in part due to biological causes and that these differences may explain why we don't see equal representation of women in tech and leadership" (Clifford, 2017). Such misconceptions persist in our society and are one of the root causes of the gender disparity issues in IT.

Since 2014, some tech giants released data on women and minorities employed and have been implementing strategies to improve the representation of women and minorities. However, the changes are slow. To solve the issue of gender disparity, companies have been using a variety of methods such as unconscious bias training, objective skill assessment and standard questionnaires in hiring practices, and set explicit hiring goals (e.g., Intel set a goal of 45% of new hires to be women and minorities) (Mundy, 2017).

Prior research of the gender disparity in the IT field mainly used survey methods and mostly examined the differences in computer attitudes (e.g., Young, 2000; Fedorowicz et al., 2010; Carter, 2006; Hunsinger et al., 2009; Beyer, 2008). Although those studies have found the attitudinal root causes of the gender disparity issue, they are subjective and perception-based.

There is a very limited number of studies on the gender disparity issue in students' actual choice of IT-related majors using objective assessments. To fill the gap, we examined the gender differences in choosing the Computer Information System (CIS) majors or minors and the gender difference in course performances using a U.S. public university's archival data from 2010 to 2018.

Our analysis studied graduation statistics – out of 10,254 graduates, 1.68% earned their degree in CIS, 0.66% of those students being women. To get a closer insight into the enrolment issue, the major decision process of CIS graduates in terms of the number of times they took to decide on the CIS major is examined. The university tracked each declared major during each graduate's college career. We also analyzed those who declared CIS as their major but later changed. Overall, 24% of the CIS graduates from this university were female.

Moreover, we used a t-test to check if the percentages of female and male students choosing CIS as a major or a minor are significantly different. Our results support the hypothesis that female students are statistically less likely to choose CIS

than their male peers. Additional analysis of students' grades on CIS courses shows that female students perform just as well as male students. We didn't find any evidence that it takes longer for female students to get the CIS degree. However, female students did change their majors more often.

Although the technology industry is rapidly growing, needing more people with IT backgrounds, the number of students enrolled in this field has not significantly increased over the years. It is now not only a problem where women are underrepresented – It is a problem where more IT talents are needed. Female students tend to avoid IT majors or think they may not do well in the courses. The findings of this research will provide strategies for university and high school administrations to be proactive in developing recruiting and development strategies to attract and retain female students in the IT field. The results will also inspire more students, women especially, to consider information technology as a career option.

This paper contributes to the literature on gender disparity in the IT field in the following ways.

First, this study adds to the existing gender disparity in IT literature. Gender disparities are an often-cited concern of the IT workforce (DiSabatino, 2000; Patel and Parmentier, 2005; Trauth et al., 2008; Langer et al., 2020). It has been documented that working women face severe challenges in the IT workforce. For example, there is a pay gap in hourly compensation of 22% in favor of men. Moreover, women are most underrepresented in the IT occupations (DiSabatino, 2000). Women's participation is still based on a continuation of traditional gender roles, which places women on the periphery of an IT organization (Patel and Parmentier, 2005). Cultural attitudes about maternity, childcare, parental care, and working outside the home seriously affect a woman's choice of an IT career (Trauth et al., 2008). Women realize less benefit from performance gains than men and less benefit from tenure within IT firms (Langer et al., 2020).

Our paper differs from the studies mentioned above in that it shows challenges for women are not only in the workplace but also in education. We find that there're significantly fewer female students choosing CIS as their majors, and female CIS students seem to change their majors more frequently.

Second, the paper also contributes to the existing gender disparity in education literature. Gender disparity has attracted considerable attention in today's educational research and practice. However, very few studies examine the gender differences in students' choices of CIS majors in higher education.

Early studies have revealed that gender discrimination in schools exists in the areas of science and mathematics. Girls are not receiving the same quality or even quantity of education as their male classmates (Emfinger, 2002; Tindall and Hamil, 2004). In terms of IT, topics mainly focus on attitudes toward the usage of IT-related tools and applications among students (Wong and Hanafi, 2007) or computer-related competence (Basavaraja and Kumar, 2017). Studies find that not only female students but also female instructors had lower confidence and less experience in the use of computers (Zhou and Xu, 2007). Instead of testing attitudes or competence, we investigate how students choose the CIS major and their performance in the major.

Third, previous research has found that developing countries have a monopoly on gender inequality. It is particularly true in the area of IT (Akubue, 2001; Patel and Parmentier, 2005; Geldof, 2011; Bhattacharyya and Ghosh, 2012).

In Indian, women's participation failed to occur at the same speed as IT expansion (Patel and Parmentier, 2005; Bhattacharyya and Ghosh, 2012). In Ethiopia and Malawi, existing gender norms in terms of domestic responsibilities gave women less time to interact with IT and restricted their mobility. Due to this limited time and

mobility, they had less exposure to IT beyond the vicinity of their homes (Geldof, 2011). The power of the socialization process in inhibiting women's education in science, engineering, mathematics, and technology education is often underestimated and has not received the attention it deserves in Third World (Akubue, 2001).

However, relatively few studies examine the gender disparity in IT in developed countries. This study tries to fill this research gap by examining a case in a typical developed country, the United States. We show that even in a developed country, gender disparity still exists and should not be neglected.

Finally, unlike most of the prior research on the gender disparity, which uses a survey as the primary method of investigation (Wong and Hanafi, 2007; Zhou and Xu, 2007; Johnson et al., 2008), this paper used archival data of a U.S. public university. The data are more objective. To the best of our knowledge, it is the first paper to do such an analysis.

The remainder of the paper proceeds as follows. The next section provides literature review and develops our hypotheses. Section three presents the research methods. Section four describes the results. Section five discusses the findings and concludes.

Literature review and hypotheses development

Prior research documents that gender differences regarding IT can be found as early as in middle schools and high schools, and the effects of such differences is long-lasting throughout college and career advancement (e.g., Young, 2000; Fedorowicz et al., 2010; Carter, 2006; Hunsinger et al., 2009; Malgwi et al.,2005; Beyer, 2008).

At an early age, girls in general have less confidence with technology and perceive the field as male dominant. Young (2000) used 462 middle and high school students as subjects to investigate gender differences in computer attitudes. Five aspects have been examined: confidence, perception of computers as male domain, positive teacher attitudes, negative teacher attitudes, and perceived usefulness of computers. Survey results show that the main gender differences are greater confidence among boys, and the perception of computers as a male domain is prevalent among boys.

One of the causes of negative perceptions of the technology field could be the amount of exposure and access to technology. Fedorowicz et al. (2010) surveyed teenagers in middle and high schools. They found that there were differences in the amount of time boys and girls spend using technology. Boys owned more technology and had more access to technology in their homes. However, these differences did not become pronounced until high school.

The girls' lack of exposure to technology manifests even further in college. Several studies investigated the factors that affect college students' choices of their majors. Carter (2006) reported on a study in which 836 high school calculus and pre-calculus students were surveyed to try to determine why students did not pursue a major in Computer Science. They found that female students have more reasons to reject a Computer Science major because they have an incorrect or no perception of what the field is. This was echoed in Hunsinger et al. (2009), where they interviewed and surveyed female college students to better understand why they choose to major (or not major) in CIS. They found that female students lacked knowledge about the CIS major and believed that it was a challenging major.

Malgwi et al. (2005) found that besides interest, female students were more likely influenced by the aptitude in the subject. However, male students were significantly more influenced by the major's potential for career advancement and job opportunities and the level of compensation in the field.

Beyer (2008) distributed surveys to 159 Business majors enrolled in Management Information Systems (MIS) classes at the University of Wisconsin-Parkside. She found that female high school computer teachers and role models are very important for female students to choose MIS as their majors.

Another reason that prevents female students from choosing IT-related majors is the lack of confidence in their abilities, which is documented by Shashaani (1997), Beyer et al. (2003), Lee (2003), and Lee and Huang (2014).

The gender disparity is apparent in choosing the IT major and career in young women. Unfortunately, such difference has translated into job insecurity and other work attitudes for women in IT fields. Truman et al. (1994) examined the extent to which gender discrimination was a force affecting the senior managerial ranks of the information systems (IS) occupation. They analyzed data gathered by the Society for Information Management (SIM) and found that women received lower salaries than men even when job level, age, education, and work experience are controlled. Using the data from 159 African Americans and 98 Anglo Americans, Johnson et al. (2008) found the ethnic and gender differences in IT fields. Specifically, Anglo American women reported lower levels of IT self-efficacy than did members of all other groups.

Based on the discussion above, we see that the prior literature has depicted a clear picture of the attitudinal root causes of the gender disparity issue in the IT field. The perception of the field of being male dominant has prevented female students from choosing to study and work in this field. The lack of exposure to technology by girls from a young age has resulted in an erroneous understanding of the field and, in general, less confidence in their ability in technology. The prior gender disparity literature, however, is mainly subjective and perception-based. There is a very limited number of studies on the gender disparity issue in students' actual choice of IT-related majors using objective assessments. Therefore, we advance our first hypothesis:

H1: There are significantly fewer female graduates than male graduates in the CIS major.

Students take minors that appeal to their personal interests and motivate them the most (STOCK, P., and STOCK, E., 2018). As we discussed previously, women are less confident in their abilities to use computers. Moreover, parents tend to emphasize the importance of math, physics, and computer science for their sons and literature and reading for their daughters (Shashaani and Khalili, 2001). To provide further evidence on the gender disparity in students' choices of CIS, we hypothesize that:

H2: There are significantly fewer female graduates than male graduates in the CIS minor.

Gender has been documented as a factor that affects students' academic performance (Kruck and Lending, 2003; Nyikahadzoi et al., 2013; John et al., 2018). In the study of Nyikahadzoi et al. (2013), Male students seem to have a better chance of achieving higher grades. However, data provided by John et al. (2018) do not show that females underperform relative to their male counterparts. Since prior research provided mixed results, we make the following hypothesis:

H3: There's no significant difference between male and female CIS students' academic performance.

Most students do not receive enough assistance or advice in their decision of an academic major. This might explain why the majority of college students change their major at least once during their college years (STOCK, P., and STOCK, E., 2018). Allen, H. (1973) Found that the major reasons given by the seniors for changing their majors are as follows: (1) had a change of interest, (2) had greater success in another field, (3) discovered he had unrealistic goals in terms of ability, and (4) felt he had received

inadequate counseling. There's no evidence showing that CIS particularly affect students to change their majors. Therefore, we have the following hypothesis:

H4: There's no significant difference in the frequency of changing majors between CIS and other major graduates.

Changing an academic major can add one or more semesters to the student's total time in college. Besides additional time in college and delayed graduation, a change of major incurs additional cost for tuition and fees. No studies have found any gender differences in the frequency of changing majors. We hypothesize that:

H5: There's no significant difference between male and female CIS students in terms of the frequency of changing majors.

College students who select an academic major matching their interests are more likely to finish their degree plans on time. However, most students are not choosing academic majors that match their interests or skills (Sheehy, 2013). These arguments lead to the following hypothesis:

H6: There's no significant difference in the length of time to complete a degree between CIS and other majors.

Sheridan and Pyke (1994) used a multiple regression procedure to predict the time taken to complete a degree. Selected demographic (e.g., sex, age, marital status, registration status, citizenship), academic (e.g., GPA, discipline, type of program), and financial support were used as independent variables. Results indicate that full-time registration, increased financial support, and a higher GPA significantly decrease time to completion. In their study, sex is not a significant factor that affects the time to complete a degree. Thus our last hypothesis is as follows:

H7: There's no significant difference in the length of time to complete the degree between male and female CIS students.

Methodology

For this study, we utilized two research methods.

First, we analyzed student and course data ranged from 2010 to 2018 from a public university in the United States. This university is located in the South, with over 6,000 students enrolled. For our analyses, we requested gender, age, enrollment date, graduation date, graduating major, past majors, minors, department, GPA, and ACT scores from the university.

We used the T-test to examine if there are any significant differences between the male and female student groups for all the hypotheses. Both Pooled and Satterthwaite methods were used to address the issue of equality of variance in standard deviation and unequal sample sizes for the t-test.

As our second study method, a combination of CIS graduates in the workforce and current students were interviewed about their opinions and experiences with the gender disparity issue in IT. This method was primarily used to shed light on some possible solutions towards the gender disparity issue. The interviews also revealed attitudes toward this issue from both genders.

Results

Table 1 reports the summary statistics of our data. During the sample period of 2010 – 2018, 10,254 students graduated. The average age of graduates is 25.70. The average length to complete a degree is 5.4 years, while the median is 4 years. CIS major is coded to be a binary variable with a value of 1 if the student is a CIS major and 0 otherwise. The data shows that out of 10,254 graduates, 1.68% of students graduated with a CIS degree. Gender is also a binary variable, which is coded as 1 for female

and 0 for male. About 62% of the graduates are female and only 38% are male. On average, the graduates changed their majors 1.73 times before they got their degrees. The average college GPA, high school GPA and ACT score for all the graduates are 2.97, 3.32, and 21.72, respectively.

Table 1
Descriptive Statistics

Variable	N	Mean	Median	Std Dev	Lower Quartile	Upper Quartile
Age	10254	25.70	23.00	6.22	22.00	26.00
Years to complete a degree	10254	5.40	4.00	4.61	3.00	5.00
CIS major	10254	0.02	0.00	0.13	0.00	0.00
Gender	10254	0.62	1.00	0.48	0	1.00
Frequency of changing majors	10254	1.73	1.00	1.53	1.00	2.00
College GPA	10254	2.97	2.98	0.51	2.60	3.35
High school GPA	7560	3.32	3.37	1.53	2.98	3.69
ACT score	8277	21.72	21.00	3.46	20.00	24.00

Note: Age is calculated as graduation year minus birth year. Years to complete a degree is calculated as graduation year minus first year.

Figures 1 and 2 depict the number of female and male graduates/ CIS graduates per year from 2010-2018. We can see that over the years, there were more female graduates than male graduates. However, the situation is just the opposite for the CIS major, in which there have been more male graduates than females. Female CIS graduates are always less than 10 for the years under investigation.

Figure 1
Number of Female and Male Graduates Per Year

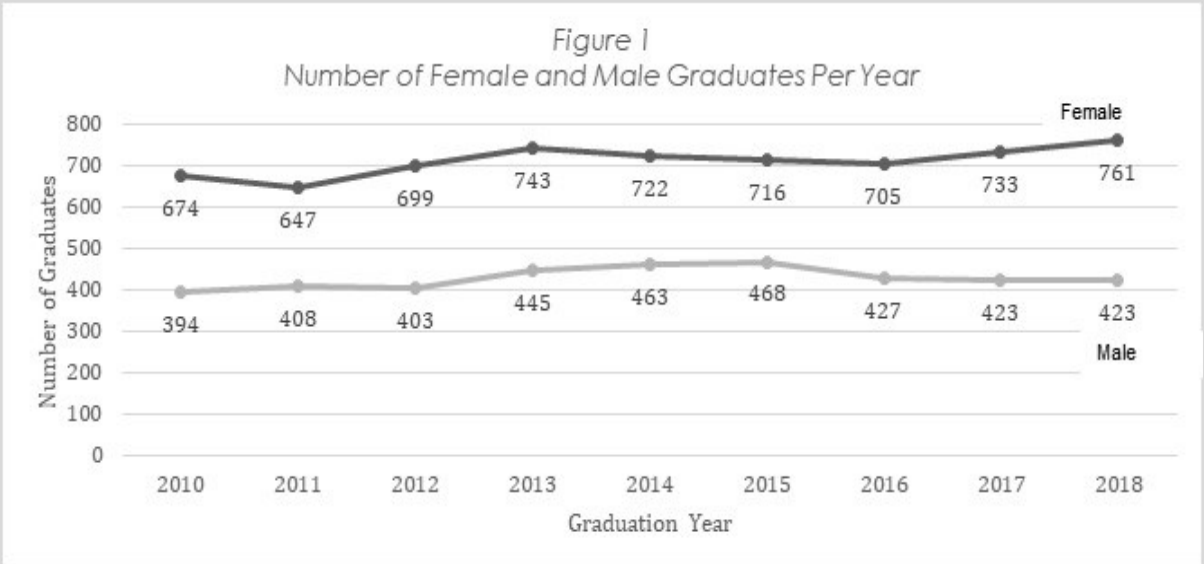

Figure 2
Number of Female and Male CIS Graduates Per Year

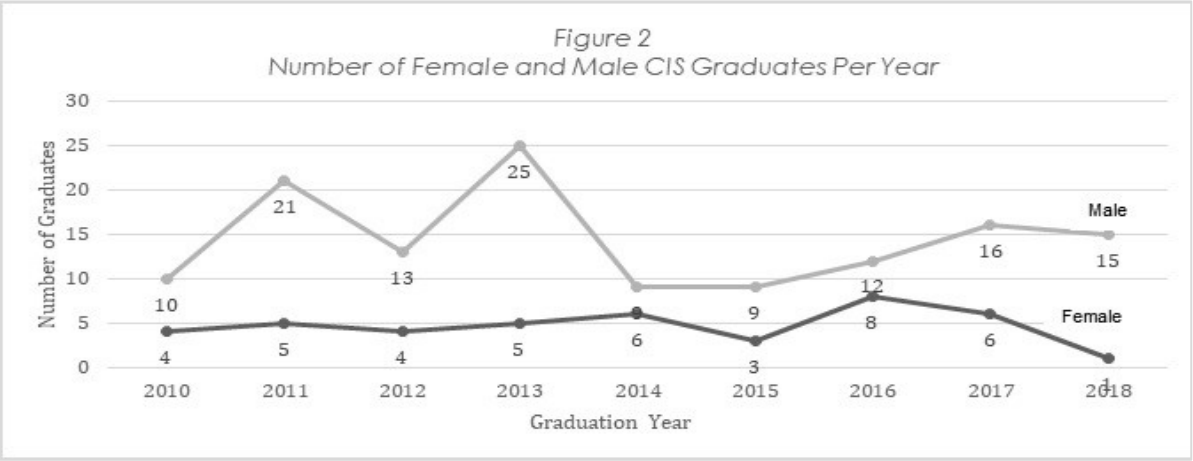

Table 2 shows the results of our H1 test. From 2010 to 2018, the university had 6,400 female graduates and 3,854 male graduates. Among those, only 0.0066 or 0.66% of the female students chose CIS as their majors, while 0.0337 or 3.37 % of the male students are CIS majors. The difference is -0.0271 or -2.71%. Female students are 2.71% less likely to choose CIS as their majors compared to their male peers. Both the Pooled and Satterthwaite methods of the t-test show that this difference is statistically different at the 1% level (P <.0001). Therefore, our H1 is supported by the results.

Table 2
The t-test of Students Choosing the CIS Major

Variable: CIS major				
Gender	**N**	**Mean**	**Std Dev**	**Std Err**
Female	6400	0.0066	0.0807	0.00101
Male	3854	0.0337	0.1806	0.00291
Diff (Female - Male)		-0.0271	0.1278	0.0026
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	10252	-10.43	<.0001***
Satterthwaite	Unequal	4795.1	-8.82	<.0001***

Note: CIS major is a binary variable with a value of 1 if the student is a CIS major and 0 otherwise.

Table 3 presents the results of the H2 test. The means show that there are 0.16% of the female students chose CIS as their minors, while 0.21% of the male students did so. We can see that the male students are still more likely than the female students to choose the CIS minor with a 0.05% higher rate. However, this difference is not statistically significant. Both Pooled and Satterthwaite methods of the t-test don't show a significant P-value. This might be due to the fact that the sample size is very small for the CIS minor data. Only 18 observations were pulled up from the university's databases.

Table 3
The t-test of Students Choosing the CIS Minor

Variable: CIS Minor				
Gender	**N**	**Mean**	**Std Dev**	**Std Err**
Female	6400	0.0016	0.0395	0.000494
Male	3854	0.0021	0.0455	0.000733
Diff (Female - Male)		-0.0005	0.0419	0.000854
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	10252	-0.6	0.5476
Satterthwaite	Unequal	7243	-0.58	0.5615

Note: CIS minor is a binary variable with a value of 1 if the student is a CIS minor and 0 otherwise.

There seems to be a misconception that female students don't do well in IT-related courses compared to their male counterparts. Table 4 shows the results of Hypothesis 3. We collected the course grades for all the CIS courses up to the year 2018. There are 5,219 course grade observations for female students and 7,593 course grade observations for male students. The average CIS grade is 2.78 and 2.81 for females and males, respectively. The grade is 0.03 lower for female students; however, this difference is not statistically significant based on the Pooled and Satterthwaite methods' P-Values. Both P-Values exceed 0.1. In addition, we tested the final GPA of the CIS graduates and found no difference between male (2.92) and female (2.98) students. The results are shown in Table 5. Thus, H3 is supported.

Table 4
The t-test of CIS Course Grades

Variable: Grade				
Gender	**N**	**Mean**	**Std Dev**	**Std Err**
Female	5219	2.78	1.053	0.015
Male	7593	2.81	1.043	0.012
Diff (Female - Male)		-0.03	1.047	0.019
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	12810	-1.61	0.1064
Satterthwaite	Unequal	11145	-1.61	0.107

Note: Grade is a numerical variable. It is coded as 4 for A; 3 for B; 2 for C; 1 for D and 0 for F.

Table 5
The t-test of College GPA between Male and Female CIS Graduates

Variable: College GPA				
Gender	**N**	**Mean**	**Std Dev**	**Std Err**
Female	42	2.98	0.5536	0.0854
Male	130	2.92	0.5008	0.0439
Diff (Female - Male)		0.06	0.5140	0.0912
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	170	0.57	0.5690
Satterthwaite	Unequal	64.121	0.54	0.5897

To investigate the patterns of how students choose majors, we counted the number of times they switched majors before they finally completed the degrees. We first compared the switching patterns between CIS and other major graduates. The results are shown in Table 6. There are 172 CIS graduates and 10,082 other graduates during our sample period. On average, CIS graduates switched their majors 1.1221 times while other graduates switched 1.7395 times before they completed their degrees.

The difference shows that CIS graduates are 0.6174 times less likely to change their majors, compared to other graduates. Both Pooled and Satterthwaite methods show that this difference is statistically significant at 1% level (P-Value<.0001). The results do not support H4 that there's no difference between CIS and other major graduates in terms of how they make their choices. There is a significant difference. CIS graduates are much less likely to change their majors once they made their decisions.

Table 6
The t-test of Changing Majors between CIS and Other Major Graduates

Variable: frequency of changing majors				
Majors	**N**	**Mean**	**Std Dev**	**Std Err**
Other majors	10082	1.7395	1.5301	0.0152
CIS	172	1.1221	1.0663	0.0813
Diff (Other majors -CIS)		0.6174	1.5235	0.1172
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	10252	5.27	<.0001
Satterthwaite	Unequal	183.22	7.46	<.0001

We then compared male and female CIS graduates' switching patterns. The results are tabulated in Table 7. As we discussed previously, overall, 62% of the graduates are female and 38% are male. It is just the opposite for the CIS major. Out of 172 students that graduated with a CIS degree, 24% were female, and 76% were male. Over the eight years, only 42 females graduated with a CIS degree.

In Table 7, the mean of the frequency of changing majors for females is 1.381, which means female CIS graduates changed their majors 1.381 times before they graduated. Male CIS graduates only changed 1.0385 times on average. The difference is 0.3425, which is marginally significant at the 10% level (P-value <0.1). Although it seems that female CIS graduates are more likely to change their majors than their male counterparts, if we compare the number with other majors' in table 6, female CIS graduates are still 0.3585 (1.7395-1.381) times less.

Overall, CIS students are more stable in their major decision, but the female CIS students may still have some problems in determining their majors. Interestingly, we noticed that for non-CIS majors, the male graduates changed their majors more frequently than females.

Table 7
The t-test of Changing Majors between Male and Female CIS Graduates

Variable: frequency of changing majors				
Gender	**N**	**Mean**	**Std Dev**	**Std Err**
Female	42	1.381	1.1884	0.1834
Male	130	1.0385	1.0147	0.089
Diff (Female - Male)		0.3425	1.0592	0.188
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	170	1.82	0.0702
Satterthwaite	Unequal	61.502	1.68	0.098

We also investigated how long it takes the graduates to complete their degrees. Same as the frequency of changing major tests, we first compared the CIS and other major graduates and then compared the male and female students within the CIS major. Results are demonstrated in tables 8 and 9. It takes CIS graduates 5.1977 years while other majors require, on average, 5.4044 years. The difference is 0.2067 years, which is not statistically significant. The results support our H6 that CIS students spend

as much time completing their degrees as others. Table 9 shows the results of a further comparison between male and female CIS students. The females completed the degree 0.3875 years faster than males. However, the difference is not statistically significant (P-value > 0.1). Thus, H7 holds.

Table 8
The t-test of Length of Time to Complete A Degree between CIS and Other Major Graduates

Variable: length of time to complete a degree				
Majors	**N**	**Mean**	**Std Dev**	**Std Err**
Other majors	10082	5.4044	4.6236	0.046
CIS	172	5.1977	4.0604	0.3096
Diff (Other majors -CIS)		0.2067	4.6148	0.3549
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	10252	0.58	0.5602
Satterthwaite	Unequal	178.65	0.66	0.5099

Table 9
The t-test of Length of Time to Complete A Degree between Male and Female CIS Graduates

Variable: length of time to complete a degree				
Gender	**N**	**Mean**	**Std Dev**	**Std Err**
Female	42	4.9048	4.4051	0.6797
Male	130	5.2923	3.956	0.347
Diff (Female - Male)		-0.3875	4.0689	0.7222
Method	**Variances**	**df**	**t-value**	**Pr > |t|**
Pooled	Equal	170	-0.54	0.5922
Satterthwaite	Unequal	63.773	-0.51	0.6133

We also interviewed both CIS graduates in the workforce and current students about their opinions and experiences with the gender disparity issue in IT. The responses are listed in Appendix B. The interviews revealed attitudes and some possible solutions towards the gender disparity issue. The female students who are not enrolled in CIS but are within the College of Business stated that they enjoyed the CIS courses that they have taken, but that they are not confident that they could succeed in this field. Interviewed students expressed that they have noticed the gender disparity issue within the CIS department. When asked if they have experienced any sexism or disrespect, 3 out of 5 female students said that they had experienced this within the CIS department. A CIS graduate that is now in the workforce admitted that she had experienced sexism and disrespect within the workplace. She also mentioned that a big reason why women aren't in IT is likely due to cultural norms and societal expectations. The most common reasons that prevent females from choosing CIS mentioned by the interviewees are self and societal expectations. Women tend to think they can't handle the subject, and their credibility is questioned.

Discussion and conclusion

This paper examines the gender disparity in students' choices of information technology majors. We used a U.S. public university's archival data from 2010 to 2018 to test our hypotheses. Our findings show that there are significantly fewer female graduates than male graduates in the CIS major. However, we failed to find similar

results in the minor test. Contrary to popular belief, our results revealed that female students are not weak in IT-related courses. Even though the female students did as well as the male students, we found that females may still have some problems in determining their majors. Specifically, female CIS students changed their majors more frequently than males. In terms of years to complete the CIS degree, we didn't find any significant differences between male and female students.

This study makes the following contributions. First, it adds to the prior literature that examines the gender disparity issue in IT. Specifically, we conduct an inter-temporal analysis to determine whether female students are less likely to choose CIS majors or minors. The analysis provides direct evidence to show the gender disparity. Second, our study also contributes to the CIS education literature by giving another example. Third, the gender difference in IT has been studied in-depth in developing countries. However, relatively few studies examine the issue in developed countries. This study fills the gap. Finally, we didn't use survey methods, which have been extensively used in this type of research. Instead, we used archival data. The data are more objective.

Although the gender disparity issue is being recognized at the national level, little attention is being paid to the issue at the university level. Many students are uncomfortable discussing the issue. University administrations seem to have not looked into this, as there are few programs to encourage gender inclusion. Our research shows that female and male CIS students are equal in their ability and performance, even though many people believe that men in this field are more capable than women. Female students tend to avoid IT majors or think they may not do well in the courses - there is a general lack of confidence in their technical ability.

A Women in Tech club or a scholarship for female CIS majors would be a good starting point. Setting an enrollment goal for female students would be another game-changer. Many students don't think of CIS as an option due to the lack of promotion for the CIS department at the university level. This issue could be addressed by simply promoting the CIS department in the same way that other departments in the College of Business are promoted. The University of Washington produces double the national average of graduates in technology. This is not an accident - this university holds programs like Women's Research Day to promote their department and get more students involved. Overall, the solution has to be systemic starting early on in life - raising awareness to local K-12 schools. Starting programs and mentorships to encourage and include young girls in technology-oriented activities would allow girls to be educated about the tech industry. By getting girls involved at a young age and systematically improving female entry and retention in IT, we may see a future where gender disparity in IT is simply in the past.

The limitation of our paper is that the study is based on one university only. Our sample is relatively small and may not be a perfect representative of the population. Future studies can include more universities. In addition, we didn't identify other factors, such as age, marital status, citizenship and financial support, that may affect students' choices and performance. Multiple regression/correlation analyses to include other factors should be examined in future research. However, the results still shed light on the fact that female students are under-represented in IT-related majors. The education authorities need to find proactive ways of attracting and retaining female students in technology.

References

1. Akubue, A. I. (2001), "Gender Disparity in Third World Technological, Social, and Economic Development". The Journal of Technology Studies, Vol. 27 No. 2, pp.1-10.
2. Emfinger, K. (2002). "Gender equity and education" in Aldridge, J., Goldman (Ed.), Current issues and trends in education, Boston, Pearson, pp. 163-170.
3. Allen, H. (1973), "A comparison study of why college students make changes in their majors", University of the Pacific Theses and Dissertations. Available at: https://scholarlycommons.pacific.edu/uop_etds/3030 / (20 October 2016).
4. Basavaraja, M. T., Kumar, B. S. (2017), "Gender disparities in the use of ICT: a survey of students in urban schools", Journal of Information Science Theory and Practice, Vol. 5 No. 4, pp. 39-48.
5. Beyer, S. (2008), "Gender Differences and Intra-Gender Differences amongst Management Information Systems Students", Journal of Information Systems Education, Vol. 19 No. 3, pp. 301-310.
6. Beyer, S., Rynes, K., Perrault, J., Hay, K., Haller, S. (2003), "Gender differences in computer science students", ACM SIGCSE Bulletin, Vol. 35 No. 1, pp. 49-53.
7. Bhattacharyya, A., Ghosh, B. N. (2012), "Women in Indian information technology (IT) sector: A sociological analysis", IOSR Journal of Humanities and Social Science, Vol. 3 No. 6, pp. 45-52.
8. Carson, E. (2016), "In US, Getting Women into Tech Is Everyone's Business -- Study." Available at www.cnet.com/news/women-in-tech-girls-who-code-report-cracking-the-gender-code-computer-science-majors/ (20 October 2016).
9. Carter, L. (2006), "Why students with an apparent aptitude for computer science don't choose to major in computer science", ACM SIGCSE Bulletin, Vol. 38 No. 1, pp. 27-31.
10. Cheng, R. (2015), "Women in Tech: The Numbers Don't Add Up." CNET, CNET, 6 May 2015, Available at www.cnet.com/news/women-in-tech-the-numbers-dont-add-up/ (6 May 2015).
11. Clifford, C. (2017), "12 Highlights from the Viral Anti-Diversity Google Manifesto." Available at www.cnbc.com/2017/08/07/shocking-quotes-from-the-viral-google-manifesto.html (9 August 2017).
12. DiSabatino, J. (2000), "Glass Ceiling for Women in IT Persists", Computerworld, Vol. 34 No. 20, pp. 12.
13. Fedorowicz, J., Vilvovsky, S.G., Golibersuch, A.J. (2010), "Gender Differences in Teenagers' Elective Use of Computer Technology", CAIS, Vol. 27 No. 1, pp. 3.
14. Geldof, M. (2011), "Earphones are not for women: Gendered ICT use among youths in Ethiopia and Malawi", Information Technologies & International Development, Vol. 7 No. 4, pp. 69-80.
15. Hempel, J. (2018), "Melinda Gates Has a New Mission: Women in Tech" available at www.wired.com/2016/09/melinda-gates-has-a-new-mission-women-in-tech/ (10 January 2018).
16. Hunsinger, D.S., Holt, A.E., Knight, M.B. (2009), "Factors Influencing Females Whether to Become Computer Information Systems Majors", Information Systems Education Journal, Vol. 7 No. 1. Available at https://www.isedj.org/7/1/ISEDJ.7(1).Hunsinger.pdf / (10 January 2018).
17. John, T. M., Badejo, J. A., Popoola, S. I., Omole, D. O., Odukoya, J. A., Ajayi, P. O., Atayero, A. A. (2018), "The role of gender on academic performance in STEM-related disciplines: Data from a tertiary institution", Data in brief, Vol. 18, pp. 360-374.
18. Johnson, R.D., Stone, D.L., Phillips, T.N. (2008), "Relations among ethnicity, gender, beliefs, attitudes, and intention to pursue a career in information technology", Journal of Applied Social Psychology, Vol. 38 No. 4, pp. 999-1022.
19. Kruck, S. K. S., Lending, D. L. D. (2003), "Predicting Academic Performance in an Introductory College Introductory College-Level IS Course Level IS Course", Information Technology, Learning, and Performance Journal, Vol. 21 No. 2, pp. 9-15.
20. Langer, N., Gopal, R. D., Bapna, R. (2020), "Onward and Upward? An Empirical Investigation of Gender and Promotions in Information Technology Services", Information Systems Research, Vol. 31 No. 2., pp. 1-16.

21. Lee, A.C.K. (2003), "Undergraduate students' gender differences in IT skills and attitudes", Journal of computer assisted learning, Vol. 19 No. 4, pp. 488-500.

22. Lee, C.L., Huang, M.K. (2014), "The influence of computer literacy and computer anxiety on computer self-efficacy: the moderating effect of gender", Cyberpsychology, Behavior, and Social Networking, Vol. 17 No. 3, pp. 172-180.
23. Malgwi, C.A., Howe, M.A., Burnaby, P.A. (2005), "Influences on students' choice of college major", Journal of Education for Business, Vol. 80 No. 5, pp. 275-282.
24. McKinsey & Company (2016), "Women in the Workplace 2016", Available at www.mckinsey.com/business-functions/organization/our-insights/women-in-the-workplace-2016 / (September. 2016).
25. Mundy, L. (2017), "Why Is Silicon Valley So Awful to Women?" Available at www.theatlantic.com/magazine/archive/2017/04/why-is-silicon-valley-so-awful-to-women/517788/ (6 December 2017).
26. Nyikahadzoi, L., Matamande, W., Taderera, E., Mandimika, E. (2013), "Determinants of Students' Academic Performance in Four Selected Accounting Courses at University of Zimbabwe", Research in Higher Education Journal, Vol. 21, pp.1-9.
27. Patel, R., Parmentier, M. J. C. (2005), "The persistence of traditional gender roles in the information technology sector: A study of female engineers in India', Information Technologies & International Development, Vol. 2 No. 3, pp. 29-46.
28. Shashaani, L. (1997), "Gender differences in computer attitudes and use among college students", Journal of Educational Computing Research, Vol. 16 No. 1, pp. 37-51.
29. Shashaani, L., Khalili, A.(2001), "Gender and Computers: Similarities and Differences in Iranian College Students' Attitudes toward Computers", Computers and Educations, Vol. 37 No. 3-4, pp. 363-375.
30. Sheehy, K. (2013). "Study: High school grads choosing wrong college majors", US News & World Report, pp. 281-99.
31. Sheridan, P. M., Pyke, S. W. (1994), "Predictors of time to completion of graduate degrees", Canadian Journal of Higher Education, Vol. 24 No. 2, pp. 68-88.
32. Stock, P., Stock, E. (2018), "Factors that Influence a College Student's Choice of an Academic Major and Minor", Vol. 9 No.1, pp. 56-78.
33. Tindall, T., Hamil, B. (2004), "Gender Disparity in Science Education: The Causes, Consequences, and Solutions", Education, Vol. 125 No. 2, pp. 282-295.
34. Trauth, E. M., Quesenberry, J. L., Huang, H. (2008), "A multicultural analysis of factors influencing career choice for women in the information technology workforce", Journal of Global Information Management, Vol. 16 No. 4, pp. 1-23.
35. Truman, G.E., Baroudi, J.J. (1994), "Gender differences in the information systems managerial ranks: An assessment of potential discriminatory practices", MIS quarterly, Vol. 18 No. 2, pp.129-142.
36. United States Department of Labor (2019), "Employed Persons by Detailed Industry, Sex, Race, and Hispanic or Latino Ethnicity", Available at www.bls.gov/cps/cpsaat18.htm / Accessed (18 January 2019).
37. Wong, S. L., Anafi, A. (2007), "Gender differences in attitudes towards information technology among Malaysian student teachers: A case study at University Putra Malaysia", Journal of Educational Technology & Society, Vol. 10 No. 2, pp. 158-169.
38. Young, B.J. (2000), "Gender differences in student attitudes toward computers", Journal of research on computing in education, Vol. 33 No. 2, pp. 204-216.
39. Zhou, G., Xu, J. (2007), "Adoption of Educational Technology: How Does Gender Matter?", International Journal of Teaching and learning in higher education, Vol. 19 No. 2, pp. 140-153.

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Appendix A - 2019 University Enrolment Data

- Out of 5103 students currently enrolled, 64% are female and 36% are male.
- 3% of students are CIS majors
- Out of 153 CIS majors, 15% are female and 85% are male.
- An average ACT composite score, as well as an average GPA, was calculated for female and male current CIS students – no significant difference was found.
- Average female ACT score: 22.31
- Average male ACT score: 22.29
- Average female GPA: 2.92
- Average male GPA: 2.9

Appendix B - Interviews with students and employees

Female students that are not enrolled in CIS, but are within the College of Business stated that they enjoyed the CIS courses that they have taken, but that they are not confident that they could succeed in this field.

- "I like thinking I could be in IT, but in reality, I don't think I could handle the deeper understanding of what goes into the background of IT."

Female Business major

- "I took an intro CIS course as a prerequisite to another course. I liked it a lot so I changed my major from general business to CIS."

Female CIS major

Interviewed students expressed that they have noticed the gender disparity issue in the CIS department. When asked if they have experienced any sexism or disrespect, 3 out of 5 female students said that they had experienced this within our department. A former IBM employee admitted that she has experienced sexism and disrespect within the workplace. A lot of men don't trust women's expertise.

- "It's kind of like a question of credibility against women."

Former IBM employee

The former IBM employee also mentioned that a big reason why women aren't in IT is likely due to cultural norms and societal expectations – it is typically expected, from a young age, that females become nurses, teachers, etc.

- "We need to make people aware of how much IT matters. Doctors, lawyers, etc. cannot do what they do without the applications that we program to allow them to do their job. We are an internal part…If we can show people how important IT is and how big of an impact IT is, I think more people would want to make a difference… if people can understand that we can do that in IT, they might be more inclined to pursue it."

Former IBM employee