Perceptions of First-year Students on Technology Majors and Careers – A Gender Analysis

Kenneth J. Sousa, PhD
Bryant University
E-mail: ksousa@bryant.edu

Abstract

The demand for information technology professionals in the United States is increasing while the number of available graduates is declining. Therefore, it is necessary to develop and refine strategies at all education levels and in business organizations to implement innovative approaches. These strategies should be designed to directly increase interest in technology majors and the recruiting/onboarding of technology personnel. This research has gathered data about technology careers relating to the attitudes and perceptions of first-year college students. The survey data was analyzed to understand perceptions through several factors compiled from past research. The seven significant factors included aptitude, attitude, interest in IT, job availability, job salary, media influence, personal image, subjective norm, and intent to major. The results of the study indicate that females believe that their perception of aptitude, attitude, subjective norm, and intent to major relating to technology careers are significantly lower than their male counterparts.

Keywords: STEM, Career choice, Student perceptions, Technology majors

Introduction

Use of Technology in Business Organizations

Business organizations continue to integrate technology as a component of their brand, strategy, and operations. Skilled professionals are needed to implement and maintain an organization's technology infrastructure. Therefore, the supply of technology-based employees remains a crucial factor in maintaining this infrastructure and the delivery of technology services. However, the gap between the supply of technology professionals and demand has formed challenges for both information technology departments and recruiters.

Impact and Trend of Technology Positions

The availability of skilled labor is a critical factor for business organizations to realize the benefits of technology integration. Based on data from the U.S. Bureau of Labor Statistics, the market for information technology jobs remains strong with technology unemployment at 1.8% in July 2023, down from 2.3% in June (Mearian, 2023). Mearian (using CompITA data) reported that technology sector employment increased by 10,400 jobs in August 2023 from the previous month to a total of 2.5M positions. However, the decreased interest in STEM-based (science, technology, engineering, and mathematics) majors has produced fewer graduates with the skills and knowledge necessary to promote technological innovation. Over the last two decades, technology-based degrees declined significantly from 2003 to 2010 (5.1% to less than 3%) while rebounding to 4.1% in 2018 (Martinez & Pearson, 2020). The statistics associated with the number of students graduating in computing from 1987 – 2012 illustrates significant gaps between gender and ethnicity (Lunn et al., 2021). When demand for personnel rises above the supply of talent, it is normal for business organizations to identify changes to their recruiting strategy. Given the strong demand for technology talent, business leaders are increasing compensation packages to expand the applicant pool (Castellanos, 2021).

Research Objective

Various research studies have explored the low representation of women in STEM-based careers. Despite the continuing under-representation of women in science, technology, engineering, and mathematics (STEM) fields, the literature requires additional exploration to identify and explain the factors that could contribute to women's interest and commitment to technology careers. However, much of the prior research focused on the technical computer science domain associated with the representation of females (Yagmur & Jaideep, 2018). However, Yagmur and Jaideep believe that there is a lack of research to investigate the newer, more business-focused IT subfields, specifically management information systems (MIS). Therefore, the purpose of this research is to identify factors associated with first-year college students' intention to select information technology (e.g., management information systems) as an undergraduate major. The empirical outcomes of an analysis to identify which influences, if any, provide the foundation to develop or refine strategies in education and industry. This research gathered information about perceptions and attitudes associated with technology careers through a survey instrument administered to first-year undergraduates to determine whether differences exist between females and males. An additional factor asked their level of interest in majoring in technology.

Literature Review

Labor Demand and Availability

The shortage of skilled technology professionals has plagued American businesses for decades. The U.S. Bureau of Labor Statistics aggregates data associated with various occupational categories compiled in BLS Table 1.7 (U.S. Bureau of Labor Statistics, 2020) has been summarized in Table 1 below. BLS reported 2022 total employment at 164 million, with the Mathematical and Computer Occupations matrix code (15-0000) employing 5.27 million people. The six matrix codes identified as Computer Operations (15-1210 – 15-1299) accounted for a total employment of 4.92 million. Through 2032, BLS projects an additional 701 thousand computer occupation positions will be available, a 14.2% increase. Therefore, a significant number of technology-based positions will be available for applicants and employment in the next decade.

Role of Gender in Technology Careers

Research relating to gender imbalance in technology-related careers (and STEM-based jobs in general) has been a continuing trend for a few decades. The Census Bureau reports that the U.S. civilian workforce of female information technology professionals trails all occupations substantially (Beckhusen, 2016). Beckhusen reported as of 2014, women comprised 47% of the entire civilian workforce versus 25% of IT workers. The U.S. Census Bureau reported that while women in the STEM workforce increased their representation from 1970 to 2019 (8% vs. 27%), the gap is still significant (Martinez & Chrisnacht, 2021). However, males comprise 52% of the total workforce but occupy 73% of all STEM positions. Despite efforts to increase the number of female students selecting STEM-based careers, minimal emphasis has been placed on supporting women in their degree completion and career transition (Blackburn, 2017; Fouad & Santana, 2017).

Table 1 – Employment Trends in Information Technology Careers (https://www.bls.gov/)

Occupational Description	**Matrix Code**	**Employment (000s) 2022**	**2032**	**Number and Pct Change, 2022-32**	
Total, all occupations	*00-0000*	*164,482.6*	*169,148.1*	*4,665.5*	*2.8%*
Computer and mathematical occupations	*15-0000*	*5,277.6*	*6,081.4*	*803.8*	*15.2%*
Computer and information analysts	15-1210	700.3	804.7	104.4	14.9%
Computer and information research scientists	15-1221	36.5	44.8	8.3	22.7%
Computer support specialists	15-1230	914.1	963.3	49.2	5.4%
Database and network administrators and architects	15-1240	669.4	696.4	27.0	4.0%
Software and web developers, programmers, and testers	15-1250	2,159.4	2,628.6	469.2	21.7%
Computer occupations, all other	15-1299	449.4	493.1	43.8	9.7%
Total – Computer Occupations	**1210 – 1299**	**4,929.1**	**5,630.9**	**701.9**	**14.2%**

While 38% of women believe that there is a lack of opportunities for women in STEM (Anonymous, 2021), the challenge extends beyond the decision to select technology as a major. According to the U.S. Department of Education, the number of degrees granted for computer and information sciences decreased by 9.3% from 2011 – 2021 (Anonymous, 2022). Using data from NCES, Blake (2022) discussed that while peaking in the 1980s, women were only 18% of the computer science bachelor's degrees. In technology-based organizations, women represent 31% of the total employees. However, only 20% of the pure technology positions (employed in a technology-based position) are held by females (Epsztajn, 2019).

The distribution of women across the various STEM-based jobs is imbalanced. A study by the Pew Research Center found that while women comprise about half of the STEM workforce (science, engineering, and math), the share of women represents only 25% of computer occupations (Kennedy et al., 2021). A research study by Accenture (2020) asserts two important statistics: 1) Half of young women who enter a technology career will withdraw by the age of 35, and 2) Women leave technology roles at a 45% higher rate than their male counterparts. Barr

(2017) reported that approximately 45% of women leave their technology career within five years, while their male counterparts have a lower 5-year departure rate (17%). The underrepresentation of women has been an ongoing issue relating to technology positions (Adam et al., 2004; Armstrong et al., 2018).

Several studies explored the attitudes and thought level of female students' interest relating to technology careers (Anderson et al., 2017; Baer & DeOrio, 2020; Frieze & Quesenberry, 2019; Harmon & Walden, 2021; Lunn et al., 2021; Merhout et al., 2022). Harmon and Walden found that technical learning self-efficacy and agentic goals have increased importance for women. Carnegie Mellon University (CMU) believes that culture and environment are more important than focusing on gender-based differences (Frieze & Quesenberry, 2019). Merhout (2022) found that the perception of the IS field significantly influenced all attitudes investigated in their study, directly influencing the intention to major. Furthermore, CMU's efforts to review and modify the computer science curriculum to be more suited toward women did not prove successful.

Influencing Factors

Epsztajn (2019) asserts that lack of confidence is one of the obstacles preventing women from fully embracing STEM-based occupations. The negative perception of females of STEM focuses on lower self-efficacy as well as intellectual and practical interest (de Vries, 2005; Endepohls-Ulpe et al., 2012). Research by Wang and Deol (2013) addressed the impact of sociocultural factors (e.g., gender and stereotypes) and psychological factors (e.g., science identity). Additionally, one of the factors that may negatively affect the low employment of women in technology positions is imposter syndrome, focusing on the self-doubt associated with technology skills affecting a career decision (Clay, 2023; Hubbert, 2023). This influence is substantiated by Yagmur and Jaideep (2018), who found that female students placed a higher emphasis on required technical skills as compared to their male counterparts. Chipidza et al. (2019) explored the difficulty of majoring in MIS using Ajzen and Driver's (1991) perceived behavioral control mode (PBC) model but found no significance associated with the intent to major. Conversely, Zhang (2007) found that students express concern about the difficulty of a major in technology.

The work environment may also provide an indicator of intent to major in a career. In the last several years, groups have been formed, such as Girls Who Code and Black Girls Who Code, to promote and encourage females to develop their coding skills with various programs and education classes. Organizations like these provide a supportive environment to build confidence and skills to succeed in a male-dominated industry (Lunn et al., 2021). Hill (2008) defined workplace flexibility as "the degree to which workers are able to make choices to arrange core aspects of their professional lives, particularly regarding where, when and for how long work is performed." However, work-life balance was not found to significantly impact attitudes toward an IS career (Joshi & Kuhn, 2011). Joshi and Kuhn further state that ignoring these results could be a mistake, as workload was found to be a significant influence on the attitude toward choosing an IS major (Kuechler et al., 2009).

Some research suggests that work policies are perceived to be less flexible in STEM-based careers. Many technology positions tend to be structured as project-based rather than transaction-based. For example, technology positions are assigned to project-based tasks (development, analysis, project management, etc.). Therefore, it would be difficult for employees (specifically women) who wish to have a family and elect for a leave of absence. Operational or transactional tasks (accounts payable, customer service, or technology help desk positions) can be reassigned more easily than a project-based position, which "loses" personnel and role in the middle of a project. Considering the current employment mindset and culture associated with family flexibility and life balance, this issue requires more attention than almost two decades ago.

A person's behavior can be guided by investigating the effect of social comparison perceptions and their effect on their sense of belonging (Baumeister & Leary, 1995; Walton et al., 2012). It is interesting to note that a similar gender gap also exists in finance-based careers. For financial services employees, 46% are women, but only 15% are employed at the executive level (Anonymous, 2018). This underrepresentation (similar to technology careers) may impair female professionals' sense of belonging (Dennehy & Dasgupta, 2017; Murphy et al., 2007; Stout et al., 2011).

Some research suggests that student experiences relating to technology and sciences at school shape their perceptions (de Vries, 2005; Osborne & Collins, 2000; Stein & McRobbie, 1997). Research by Lindahl (2007) confirms that any interest in science or technology careers are generally determined by the age of 14. Ardies et al. (2015) found that as males transitioned into the second year of their secondary education, their technology interest developed, while females regarded technology as more of a masculine subject.

Female college students believe that completing a science or business major, rather than traditional liberal arts majors, would tend to lower marriage rates and building a family, while men believe that a major has no effect on their personal life (Wiswall & Zafar, 2021). Yagmure and Jaideep (2018) surveyed students at the beginning of core MIS courses and found that females believed that the MIS profession was dominated by males, with a statistical difference in perceptions between males and females. Chipidza et al. (2019) believed that several negative images and stereotypes associated with MIS majors hinder interest and are costly to change majors.

The broad definition of a subjective norm is "the perceived social pressure to perform or not to perform the behavior" in question (Ajzen, 1991). Finlay et al. (1999) further describe a subjective norm as an individual's perception or "opinion about what important others believe the individual should do." Saleem (2014) states that students' choices can be prompted to perform behavior based on the influence of others, including parents' profession and mass media.

Valentino et.al. (2016) found that students who define family flexibility as a factor when choosing their major are less likely to select STEM majors (Valentino et al., 2016). Females may view positions that focus on short-term or transactional activities to be more favorable to a positive family life environment. Some research has focused on specific environmental factors, such as being asocial, lack of connections to the outside world, and lack of interest in human interaction (Baer & DeOrio, 2020). Chipidza et al. (2019) found that the perceived social pressures (specifically, friends and family) are a significant influence on students selecting MIS as a major, while high school teachers or college academic advisors have no impact. Kuechler (2009) found that subjective norms affected the intention to choose an IS major for both females and males.

Several research studies indicate that a child's parents have an influence over the selection of career and college major decisions. The primary influence on a child's career aspirations and selection are their parents (Miller, 2008). Miller also believes that parents act as a filter on acceptable careers. Children are restricted to certain professions through the influence of their parents, financial dependence, and socio-economic conditions (Arthur & Rosseau, 1996; Jodl et al., 2001). Turner (2002) maintains that parents can provide motivation or limitations on their children to select the career of their children's choice. Several other research studies have found that parents form a significant influence on their children's perceptions of occupation-related decisions and vocational goals (Astin, 1984; Eccles, 1994). Additionally, high parental engagement, conversations, and encouragement have been found to build an interest in STEM topics throughout their schooling, especially at a young age (Myers et al., 2011; Sheehan et al., 2018).

Research suggests a stronger influence when the parents and children are of the same gender. Adya & Kaiser (2005) found that parental involvement is pivotal in the selection of IT as a career. Furthermore, their research found that the professional status and education of mothers have a significant impact on their daughters' career choices. The recent phenomenon associated with the influence of millennial "*helicopter parents*" proves to be an important source of career information (Gomes & Deuling, 2019). Similar research suggests that a romantic partner is the most influential attachment figure in an emerging adult's decision-making process (Kvitkovicová et al., 2017). However, Kvitkovicová further states that attachment relationships between parents and best friends also remain important. Specifically, the profession of a student's parent has an influence on their child's decisions (Cohen & Hanno, 1993; Law & Yuen, 2012; Saleem et al., 2014). In addition, Kuechler et al. (2009) believed that both family and advisors affect the decision of an IS major.

Human beings are influenced by strategies such as marketing, consumer behavior, and media. Levine et al. (2021) found that media has a significant impact on Vocational Anticipatory Socialization (VAS) is defined as a multi-year, multi-step process that begins in childhood and informs young adults about possibilities for their future work-life experience. Levine further states that media appears to inspire females to pursue STEM education and careers and that repeated viewing may increase their interest. Furthermore, children who use media to learn about occupational roles and career choice is supported by social cognitive theory (Bandura, 2001).

Students are influenced by the prospects of both earning capacity and the availability of positions as they explore career and education options. Using a theory of reasoned action (TRA) model, Zhang (2007) found that students are affected by concerns of job availability. Income values, explored as work-value congruency, were found to a favorable attitude toward IS careers (Joshi & Kuhn, 2011). Walstrom (2008) studied the factors that are important to the choice of a major. Upon review of the top seven factors, five factors were related to salary/income and job availability. The beliefs associated with expected earnings report changing perceptions by major (business/science vs. humanities/arts) and gender over three age groups (22, 30, and 45). Research by Wiswall and Zafar (2021) shows small differences for business majors between females and males at 22 years old. However, at 30 and 45 years old, the expected earnings of females in business/science are significantly less than their male counterparts. This outcome may be influenced by the work-life, marriage, and family attitudinal changes associated with females.

Kuechler et al. (2009) found one behavioral belief, genuine interest in an IS field, was significant using a TRA model. These findings are consistent in that interest is an important determinant of the intention to major in an IS major (Zhang, 2007). Furthermore, Kuechler et al. found that both interest and attitude were significantly related to the intent to choose an IS major for both females and males. Kuechler et al. did not find any significant impact on aptitude toward the attitude to select an IS major directly. Baer (2020) believed that women who major in computing have lower confidence with computers as compared to their male counterparts.

Factor Listing

Based on the compilation of the literature, an analysis of research studies was completed to compile a range of factors to design a research model. This analysis resulted in twelve factors as the foundation to develop a survey instrument. A series of factors were compiled using various studies to support the research objective. The final listing of the research model's factors and the related research citations are compiled in Table 2.

Table 2 – Research Factors and Related Literature Review

Factor	**Research Citations**	**Factor Category**
Aptitude to study information technology	(Epsztajn, 2019; Joshi & Kuhn, 2011; Kuechler et al., 2009; Mims-Word, 2012; Walstrom et al., 2008)	AP
Interesting to use; complete work with technology	(Heinze & Hu, 2009; Kuechler et al., 2009; Mims-Word, 2012; Moore & Burrus, 2019; Walstrom et al., 2008)	AT
Difficulty of major; requiring significant study time	(Chipidza et al., 2019; Heinze & Hu, 2009; Prescod et al., 2018; Walstrom et al., 2008)	DM
Interest in information technology	(Chipidza et al., 2019; Joshi & Kuhn, 2011; Mims-Word, 2012; Vainionpää et al., 2022)	IN
Availability of job positions	(Chipidza et al., 2019; Heinze & Hu, 2009; Joshi & Kuhn, 2011; Kuechler et al., 2009; Walstrom et al., 2008)	JA
Gaining a high starting salary	(Beckhusen, 2016; Joshi & Kuhn, 2011; Kuechler et al., 2009; Walstrom et al., 2008; Young et al., 2018)	JS
Influence of media	(Apostol & Näsi, 2013; Bright et al., 2005; Walstrom et al., 2008)	MI
Importance of self-image; image of information technology professionals	(Adya & Kaiser, 2005; Baumeister & Leary, 1995; Bright et al., 2005; Chipidza et al., 2019; Dennehy & Dasgupta, 2017; Fox et al., 2001; Inzlicht & Ben-Zeev, 2000; Murphy et al., 2007; Sekaquaptewa & Thompson, 2002; Stout et al., 2011; Walton et al., 2012; Yagmur & Jaideep, 2018)	PI
Social image: considered a respectable career	(Baumeister & Leary, 1995; Chipidza et al., 2019; Eddy & Brownell, 2016; Joshi & Kuhn, 2011; Kuechler et al., 2009; Murphy et al., 2007; Walstrom et al., 2008; Walton et al., 2012; Wang & Degol, 2013; Yagmur & Jaideep, 2018)	SI
Influence of family, friends, professors, advisors, and peers	(Chipidza et al., 2019; Derricks & Sekaquaptewa, 2021; Heinze & Hu, 2009; Inzlicht & Ben-Zeev, 2000; Joshi & Kuhn, 2011; Kuechler et al., 2009; Miller, 2008; Moore & Burrus, 2019; S. Turner & Lapan, 2002; Vainionpää et al., 2022; Walstrom et al., 2008)	SN
Work environment	(Coser, 1974; Gill et al., 2008; Joshi & Kuhn, 2011; McIlwee & Robinson, 1992; Valentino et al., 2016)	WE
Intent to major		IM

Research Methodology

Hypotheses

The factors identified above provide the foundation to define the hypotheses for this research study. Twelve hypotheses were compiled based on the factors as well as the intention to declare information technology as a major. The hypotheses are listed in Table 3. A t-test statistical analysis will be completed to evaluate the hypotheses to determine if any significant differences are found between females and males.

Table 3 – Research Hypotheses

Hypothesis	Description
	There are no significant differences between females and males based on …
H1	… attitude to gain a career in information technology.
H2	… aptitude in information technology.
H3	… perception of the difficulty to major in information technology.
H4	… interest in information technology.
H5	… believe that there are sufficient information technology positions available.
H6	… believe that salaries for information technology positions are high.
H7	… being influenced by various media environments.
H8	… having a positive personal image of information technology professionals.
H9	… having a positive social image of information technology professionals.
H10	… being positively influenced by others relating to information technology careers.
H11	… believe that a career in information technology has a positive work environment.
H12	… believe that they will intend to declare information technology as a major.

Survey Instrument

A survey instrument was compiled using questions designed from past research studies, resulting in thirty-six survey questions. The questions were compiled either 1) directly from the appendix of a research study, if available, or 2) developed based on the foundation research of the factor. For example, the five media sources identified from research studies were integrated with the following preface: “For each of the following sources, rate the level of influence on the selection of your major.” Then, the five sources (career fairs/business presentations, newspapers/magazines, job listings, social media, and television/movies) were identified in the survey to provide a response for the influence on the student’s career decision. A complete listing of the survey questions by factor is compiled in Table 4.

Table 4 – Survey Question Listing

Category	Question Text
AP	Majoring in information technology will be a good fit for me
AP	I believe that I will perform well in an information technology career
AT	I find computers and technology interesting to use
AT	It is interesting when I use information technology to complete my work
DM	Majoring in information technology will require more study time
DM	I believe that I will be able to successfully complete a major in information technology
IM	I intend to major in information technology
IM	It is likely that I will choose to major in information technology
IN	I enjoy learning about technology software
IN	I believe that I will enjoy … working in a team
IN	I believe that I will enjoy … using computer software
IN	I believe that I will enjoy … presenting business-related problems
IN	I believe that I will enjoy … analyzing business related problems
JA	Upon graduation, the number of information technology jobs will be enough so that I can find a position.
JA	The availability of information technology jobs make me comfortable to maintain a successful career.
JS	I believe that I can secure a high paying job, upon graduating with a major in information technology.
JS	My starting salary will be satisfying if I major in information technology.
MI	For each of the following sources, rate the level of influence on the selection of your major. Career fairs, business presentations
MI	For each of the following sources, rate the level of influence on the selection of your major. Newspapers, magazines
MI	For each of the following sources, rate the level of influence on the selection of your major. Job listings
MI	For each of the following sources, rate the level of influence on the selection of your major. Social media
MI	For each of the following sources, rate the level of influence on the selection of your major. Television, movies
PI	Choosing an information technology major would make me appear to be a nerd or not cool while I am in college.
PI	As an information technology major, people would perceive me as anti-social or boring
SI	Information technology jobs are just for nerds or introverts
SI	Majoring in information technology will lead to a respectable career
SN	My family is encouraging me to choose a majoring in information technology
SN	My friends are encouraging me to choose a majoring in information technology
SN	The opinion of my peers is ...
SN	My professors believe that information technology would be a good fit for me
SN	My advisors believe that information technology would be a good fit for me

Category	Question Text
WE	I believe that information technology will be a challenging career
WE	Majoring in information technology will give me the opportunity to obtain a leadership position in business
WE	Majoring in information systems will give me the opportunity to work on a variety of positions, tasks, and activities in business
WE	I believe that working in information technology will allow me to be creative
WE	When working with information technology, I will be able to benefit people in society by what I work on

In addition, three questions were included to compile data about gender, class standing, and GPA. The question order in the final survey was arranged so that the redundant (reworded) factor questions were *not* in sequence grouped by factor order. Some of the factor questions were replicated by redesigning the question in a negative manner. For example, the two major difficulty questions (for the DM factor) were separated in the survey and re-worded as: "Majoring in information technology will require more study time" versus "I believe that I will be able to successfully complete a major in information systems."

A summary of the factors and the related number of questions are compiled in Table 5. Each of the questions was measured on a seven-point Likert scale. The scales for each question are defined as strongly disagree vs. strongly agree (SD/SA) and not important vs. extremely important (NI/EI). The item scales were defined with a value of one (1) as strongly disagree (or not important at all) and seven (7) as strongly agree (or extremely important).

Table 5 – Survey Factor Summary

Factor Category	Factor Name	Number of Questions	Question Scale
AP	Aptitude	2	SD/SA
AT	Attitude	2	SD/SA
DM	Difficulty of Major	2	SD/SA
IN	Interest in IT	5	SD/SA
JA	Job Availability	2	SD/SA
JS	Job Salary	2	SD/SA
MI	Media Influence	5	NI/EI
PI	Personal Image	2	SD/SA
SI	Social Image	2	SD/SA
SN	Subjective Norm	5	SD/SA
WE	Workload Environment	5	SD/SA
IM	Intent to Major	2	SD/SA
	Total Factor Variables	***36***	

Survey Population

Several studies have explored the uncertainty and decisions of major selection of undergraduate students. NCES (2017) found that within three years of the initial college enrollment, 30% of undergraduates changed their major at least once. A study by Businesswire (2019) found that almost two-thirds feel overwhelmed about the process while a significantly higher percentage of Gen Z and Millennial generations have changed their major during their undergraduate experience (44% and 58% respectively). A similar study confirms a lack of confidence with the process of changing majors with 62% and 67% (Gen Z and Millennial generations respectively) (Ellucian, 2019). Clearly, there is uncertainty and volatility associated with the major selection process and completion of the major. The population of this research will focus on first-year college students' perceptions as they begin their higher education experience and career exploration process.

Findings and Results

Survey Response

The survey was administered in nine semesters from 2016 – 2021 at two four-year institutions. All surveys were administered in a required course; either in a required business course or a first-semester general education course. Over the survey period, a total of 1,392 male and female students completed the survey. Several surveys were considered invalid (76) due to several reasons (total time in survey, limited responses, etc.). Therefore, the final analysis consisted of 1,316 records (35% vs. 65% female to male ratio) as shown in Table 6.

Table 6 – Survey Response Summary

Semester	Female	Male	Total
Fall 2016	53	110	163
Spring 2017	68	131	199
Fall 2017	173	306	479
Spring 2018	62	75	137
Fall 2019	22	52	74
Fall 2020	38	73	111
Spring 2021	12	36	48
Fall 2021	28	77	105
Total	***456***	***860***	***1,316***
Percent of Total	***34.7%***	***65.3%***	

Population Assumptions

Two population sample assumptions were evaluated to ensure the reliability of the calculation, evaluation, and discussion of the statistical results.

<u>Independence of Observations</u> – Each survey administration was administered to one specific course of first-year, registered students for a required course. Students completed one

survey during a class session proctored by a faculty member. Therefore, this administration model substantiates that students would complete only one survey throughout all survey administrations.

Homogeneity of Variance – The population consisted of a group of first year and transfer students. Transfer students would be prevented from registering for upper-level (major) courses until this course was completed. Therefore, the evaluated population has similar characteristics among all survey administrations.

Reliability Analysis

To ensure the reliability of the observed variables (survey questions), Cronbach's Alpha Test of Reliability test was completed to confirm the consistency of the observed variables believed to calculate the factor. The results of the reliability test are shown in Table 7.

Table 7 – Cronbach's Alpha Test of Reliability

Factor	Number of Items	Cronbach's Alpha	Removed	Number of Items	Cronbach's Alpha
Aptitude	2	0.833			
Attitude	2	0.824			
Difficulty of Major	2	0.281	*		
Interest in IT	5	0.715			
Job Availability	2	0.844			
Job Salary	2	0.828			
Media Influence	5	0.786			
Personal Image	2	0.784			
Social Image	2	0.384	*		
Subjective Norm	5	0.739	SN3	4	0.851
Workload Environment	5	0.790			
Intent to Major in IT	2	0.936			

The outcome of the reliability test resulted in ten factors calculating high alpha scores (>0.70). The subjective norm factor consisted of one item (SN3) associated resulting in a negative reliability value. The question may have created ambiguity when evaluated by the respondents. Therefore, this item was removed from the analysis. A new reliability analysis was calculated with a higher alpha value (0.851) using four items. Therefore, it is reasonable to assume that the remaining four items are dependable as assigned to the corresponding factor.

The remaining factors, difficulty of major and social image, resulted in low alpha values (0.281 and 0.384 respectively). Unfortunately, an item could not be removed since these factors were measured with only two items. Therefore, the corresponding hypotheses (H3, H9) and associated four items (DM, SI) were removed from this research.

MANOVA Pre-Testing

A MANOVA analysis was executed using the ten remaining factors to determine if any correlations existed between the factors associated with the gender. As shown in Table 8, the results of the MANOVA clearly resulted in significant differences ($p<.001$) using the four test statistics (Pillai, Wilks, Hotelling, Roy) and the null hypotheses can be rejected. Therefore, these results prove that gender has a significant effect on the ten remaining factors and the test of significance (t-tests) may be evaluated.

Table 8 – Summary of MANOVA Test Results

Test	Value	F	Sig.
Pillai's Trace	.145	21.936	.000
Wilks' Lambda	.855	21.936	.000
Hotelling's Trace	.169	21.936	.000
Roy's Largest Root	.169	21.936	.000

Statistical Results

For each survey response, a mean value was calculated for each of the individual questions associated with a factor. For example, a mean value was calculated using the five workload environment items to generate an average score for the WE factor. To avoid a mean value being underestimated due to the non-response of an individual item on the survey, the SPSS Mean function was used to ignore any missing values which normally would integrate a zero value into an average calculation. For example, the mean score of a survey response for the five work environment items (4, 3, 4, 4, 0) would result in a mean score of 4.75 instead of 3.80.

A t-test was completed by using the factor average scores as well as the gender averages using the grouping factor. The output of the t-test statistical results including the mean values as well as the t-test scores are compiled in Table 9.

Insert Table 9 approximately here

Hypotheses Evaluation

Each of the hypotheses, as outlined in Table 9, were evaluated based on the results of the t-test. For the ten hypotheses, nine of the null hypotheses were rejected with p-values less than the accepted value (.05); resulting in significant differences between the means of the groupings (female and male). Seven of the research hypotheses (aptitude, attitude, interesting in technology, job availability, personal image, subjective norm, and intent to major) were found to be highly significant ($p<.001$). Two hypotheses (job salary and media influence) calculated significant p-values ($p<.01$). One hypothesis was found to be non-significant (workload environment).

Table 9 – Summary of t-Test Results

	Means					
Factor	**Female**	**Male**	**Overall**	**t**	**Sig.**	
Avg Aptitude	3.21	4.06	3.76	9.705	0.000	***
Avg Attitude	4.74	5.39	5.17	8.554	0.000	***
Avg Interest IT	4.73	5.30	5.10	10.081	0.000	***
Avg Job Avail	4.71	5.02	4.91	4.242	0.000	***
Avg Job Salary	4.88	5.06	5.00	2.675	0.008	**
Avg Media Influence	4.45	4.22	4.30	-3.126	0.002	**
Avg Pers Image	5.75	5.52	5.60	-3.394	0.000	***
Avg Subjective Norm	2.79	3.41	3.19	8.303	0.000	***
Avg Workload Env	4.99	5.07	5.04	1.611	0.107	ns
Avg Intent Major	2.51	3.19	2.96	6.901	0.000	***

Discussion and Conclusions

Discussion

Even after decades of discussions, innovative teaching techniques, and targeted promotions of STEM-based careers/majors, the perception differences between gender relating to information technology careers remain. Most of the hypotheses (88%) resulted in significant differences between females and males. With the increasing need for technology professionals, the results of this research identify several perceptions that require strategies and tactics associated with educational pedagogies as well as the promotion of STEM/technology careers, especially among females. Barr (2017) stated that the efforts to promote and recruit women for technology careers has not succeeded in changing the climate. The results of this research clearly indicate a gender gap exists relating to technology careers and gender.

The next sections discuss the various hypotheses (factors) resulting in significant differences between females and males.

<u>Aptitude (H1)</u> – The results of the respondents indicate that females consider themselves to have lower STEM aptitude than their male peer. The difference between the gender mean values (0.85) is highly significant; with females scoring lower. The overall mean score (3.76) is the second lowest of the factors indicating that the perception of their information technology knowledge is near a benign perception (“nether agree or disagree”) with the questions’ narrative. The results suggest that female students believe that their aptitude is below males.

<u>Attitude (H2)</u> –The overall mean score associated with attitude is the second highest in the factor list (5.17). Both females and males responded higher to the attitude questions than the aptitude factor (4.74 and 5.39 for females and males respectively). However, the higher value from the aptitude factor did not change the differences between genders with females resulting in a score lower than males (0.65). On a positive note, the range of the overall and gender scores trend higher leaning toward the strongly agree (5) perception. The results suggest that while students believe that technology is more interesting to use, females’ attitude is 12% lower than

their male counterparts. Contrasting the aptitude and attitude results suggests that their attitude (interesting to use and complete their work) is higher than their fit and performance of a technology career.

Interest in IT (H4) –The questions for this factor pose several examples relating to technology including learning about software in various scenarios (working in a team, using software, presenting business related problems, and analyzing business related problems). The mean scores associated with males was higher (difference of 0.57) than females. The mean scores associated with their interest correspond closely in value to the attitude factor. Comparing the first three factors, the aptitude scores (overall and gender) are significantly lower (1.24 – 1.53) below the interest attitude and aptitude.

Job Availability (H5) & Job Salaries (H6) – While career research is an important task for high school and college students, the timing and magnitude of this information on major choice is not clear. However, job availability and salaries are usually the data points discussed by students and parents. From this research, their perceptions of job availability rate high for both females and males (4.71 and 5.02 respectively). Male students perceived the availability of IT positions higher than females; a mean score difference of 0.31. The gender and overall mean scores indicate that students "somewhat agree" that job availability is important to major in IT with the three mean scores ranked in the middle of the factor range.

Media Influence (H7) – Our society is affected by the various forms of media. The impact of the media can also vary the extent to which they are objective, anecdotal, opinion-based, and credible. However, students believed that the various sources (career fairs, newspapers/magazines, job listings, social media, and television/movies) have a considerable influence on their decisions. It is interesting to note media influence is one of two factors showing the least differences between the gender means. The overall mean for media influence is 4.30 (moderately important = 4). Females believe that media influence on IT careers is higher than males with the difference between the gender means is 0.23.

Personal Image (H8) – The personal image of information technology professionals is an important consideration based on societal and cultural perceptions. The mean scores associated with this factor (overall and gender) represent the highest factor scores in this research; with averages closer to the "agree" perception of the scale. When considering the mean scores, it is interesting that students do not consider information technology majors as nerdy (or "not cool") while in college, scoring a value in the range 5.52 – 5.75. In addition, they do not consider the major to be boring. Coincidentally, this factor resulted in a similar result as media influence except that the means associated with personal image are higher (1.30) in all means (males, female, overall).

Subjective Norms (H10) – The influence of people on the student was found to be highly significant between genders. The mean of males scored significantly higher than females (0.62). However, all means (female, male, overall) are the second lowest of all factors (2.79, 3.41, 3.19). The values calculated between "disagree" to "somewhat disagree." The scores clearly indicate limited influence by others (family, friends, peers, professors, and advisors). The results suggest that students are relying more on personal judgment and perceptions rather than the others as it relates to selecting information technology as a major.

Workload Environment (H11) – The factor probes an information technology career's ability to obtain a leadership position, assignment on a variety of projects, ability to integrate their creativity and a challenging career. No significant differences were found for the workload environment factor, with only a 0.08 difference in the gender mean values. However, the overall mean value was ranked fourth of all factor averages depicting a "somewhat agree" perception. These perceptions indicate that students consider that, when placed in a technology career, there are positive perceptions on their career environment. While there are no differences between the genders, there is an opportunity to explore their perceptions with the reality of these positions. The results from this research support the results of Valentino et al. (2016) finding that college men and women are equally likely to be deterred from STEM careers due to future family flexibility.

Intent to Major in IT (H12) – This factor is the most important single factor because it measures the overall perceptions of selecting an information technology major. Each of the mean scores (female, male, overall) rank as the lowest on the Likert scale (2.51, 3.19 and 2.96 respectively). One of the mean values (males) indicated a perception slightly above the "somewhat disagree" value. The female mean value was significantly different from their male counterparts (0.70). The mean values clearly indicate that females surveyed are less interested than males in an information technology major as an undergraduate student. It should be noted that the two highest mean differences between female and male students are the intent to major (0.68) and aptitude (0.85). It may not be coincidental that the negative perception of information technology aptitude adversely affects the intent to major decision. In addition, it is worthy to note that the subjective norm and intent to major averages (group and grand) are the lowest of all factors. In addition, the two averages (female and male) for these two factors displayed same trajectory (increase from female to male averages).

Conclusions and Implications

The results of this research validate the current environment compared to previous research studies using a different population and timeframe. Most of the factors resulted in significant differences between genders. This research suggests that continued attention *must* be allocated to attract attracting students, especially females, into information technology careers.

This study found significant differences in females in the aptitude, attitude, and workload environment of STEM careers. The underrepresentation of females in information technology could be affected by social group status. Social group status is explained by social identify theory defined as social groups which enhance the psychological attachment in other groups member creating a sense of belonging (Turner & Oakes, 1986). The research of Derricks & Sekaquaptewa (2021) suggests that the importance of the proportion of women to men in a classroom setting negatively affects the completion of a technology major. Additionally, Barr (2017) reported that "while women are heading in the front doors of companies, they are hemorrhaging out the side and back doors." Derricks (2021) discusses the implications of gender imbalance which are important when individuals view themselves in a token status situation. Derricks asserts that structures may create challenges associated with "belonging and contribute to the leaky pipeline for women in STEM." The classroom environment is viewed as a predictor of the future workplace environment.

These research studies, coupled with the results of this research, indicate that the classroom environment may depict a male-dominated STEM workforce. Therefore, the efforts to recruit women into technology positions requires a deliberate and on-going process. A variety of initiatives at both K – 12 and higher education levels need to be designed, initiated, re-engineered and expanded. Several recommendations have been compiled to develop a portfolio of strategies to change the dynamic to increase majors and interest in information technology careers.

<u>Career Role Models</u> – During daily life, young people have seen female pharmacists, doctors, and laboratory personnel. These subtle, but consistent experiences can provide a foundation to consider medical professions that were once dominated by males. Therefore, educational institutions need to provide students with various female role models (faculty, administrators). When considering business visitors, thoughtful planning should be considered to integrate based on gender, age, and experience level. A thoughtful integration of these professionals with students will create the formation of accurate perceptions of industry professionals and career details to increase interest for a career path in technology. This approach is supported by an Accenture study which found that women who have a "good image" of tech workers are 27% more likely to look for a job in technology (Accenture, 2020) as well as appropriate role models in industry (Clay, 2023; Merhout et al., 2022). Also, women tend to be more communal (Blake, 2022) which provides additional credibility for the influence of role models. Merhout (2022) found that mixed gender panels with young alumni can serve as positive and active role models to students. This initiative will focus an effort to re-balance stereotypes and stigmas while reinforcing positive tactics to increase the technology workforce for both gender and minority groups.

<u>Women as Leaders and Community</u> – Mentoring and aspiration are key components to develop people in business, education, and society. Implemented collaterally with role model initiatives, mentoring can be an effective extension of the role model initiatives discussed above. If implemented properly, this strategy can provide a "*slow drip*" of important and consistent advice, information, and encouragement to future technology professionals. As more women are being selected as corporate leaders (chief executive officers, C-level leaders, and management leaders), an "*upward spiral*" visibility would dissolve stereotypes and provide inspiration for women to aspire to hold technology positions in the future. Furthermore, Accenture (2020) supports this strategy that when "women who see a clear path from their tech program to a tech career are 25% more likely to want to pursue one" (a career in technology). This conclusion is supported by findings indicating that gender-neutral skills such as leadership and problem-solving can be leveraged and promoted to attract females into technology careers (Kvasny et al., 2011). The findings of this research (Kvasny) would not only appeal to female entrants into the technology profession, but also to their male counterparts.

<u>Advising and Mentoring</u> – It is crucial to consider that educational professionals (faculty, career services, alumni affairs) are a valuable resource to formulate and refine students' process of career and education exploration. Faculty must provide a vigorous effort to communicate a wider and assorted perspective on the various careers available in technology while diminishing inaccurate stereotypes. The misconceptions discussed in research by Kuechler et al. (2009) identified four misconceptions associated with technology: 1) Only about computers, 2) Only about programming, 3) No opportunities for growth into high-level positions and 4) Offers no opportunities for creative thought. Kuechler (2009) continues to identify the myth that technology positions are "low-level technicians." These career myths must integrate <u>*non-technical skills*</u> (project management, strategic implications and process analysis) associated with technology careers to provide a more accurate perception of technology careers (Trauth et al., 2010). Accurate

information relating to various careers *can* mitigate the misperceptions as discussed by Kuechler (2009), replacing inaccurate or stereotype-based perceptions. In addition, Hubbert (2023) reported that only 17% of women in technology receive a promotion or advancement with their current employer. Merhout et. al, (2022) found that role models can influence the perceptions of both job availability, perception of information system professionals, and their social skill set. While that percentage is too low, employers cannot effectively promote employees that they do not have. Therefore, increasing female representation among technology employees may have a positive effect on advancement.

<u>Curriculum Activities</u> – Aptitude, difficulty of major, and attitude have a significant effect on intent to major and can positively affect students' confidence. A study by Sarj et al. (2018) stated that problem-based STEM activities heighten several skills including problem solving, teamwork, and creativity while increasing interest in STEM disciplines. These activities will offset the negative stereotypes identified by Moore et al. (2019) associated with technology careers (isolation, lack of creativity, boring, etc.). In addition, generating confidence and increased self-efficacy (Akbulut-Bailey, 2012) may be strengthened by problem-based activities. These activities can be designed by educators using a "stepped" approach to build confidence showing the outcome of a problem which can be easily realized by students. Strategies including curriculum activities support the research of Levine et al. (2021) on vocational anticipatory socialization (VAS) as discussed earlier.

<u>Options for Higher Education Majors</u> – Business and education professions sometimes promote an "*all or nothing*" mentality resulting in a binary outcome; select technology as a major or not. However, Vainionpää et al. (2022) suggests that women may be great candidates for a minor in technology. Therefore, future initiatives must focus on the promotion of a technology minor (usually four courses) to complement another major or concentration. Three outcomes may naturally occur from this strategy:

- increase of total technology declarations (majors, concentrations, and minors),
- expand their selection from a minor to major as students become more comfortable, confident, and enjoy the coursework, and
- leverage the technology minor for their recruitment process with its natural synergies to other business and science majors.

The third choice has significant implications to provide an *active* platform for females to develop into "full" technology careers, complete a graduate degree as well as advance to leadership positions in technology. This strategy may leverage the "getting their feet wet" syndrome and increase a students' vision in business skills and career. Additionally, educational leadership should refrain from any curriculum or courses which are designed to lower standards or skill sets. Harmon (2021) claims that both women and men can succeed with the same curriculum rather than customizing a program specifically targeted for women. Designing a curriculum to lower the content and/or standards does not provide a positive view of technology majors and careers.

Limitations and Further Research

Limitations

This research is subject to several limitations and thoughts. While the survey population consists of a considerable number of respondents, the number of valid surveys has decreased over the five-year period for a variety of reasons. The initial plan was to integrate two universities into the study. One university participated for one semester which could distort the findings with the other university's perceptional data over the other five years. Unfortunately, the researchers could not gain additional survey administrations from the second university.

In addition, this replication analysis encompasses a considerable number of student perceptions over the five-year period. However, it is an understatement that the world has changed in many ways … socially, culturally, lifestyles, perceptions and economically. Young people have significantly changed as well; educationally, maturity, creating thinking, preparation, and resilience.

Further Research

The results of this five-year study establish some interesting questions which affect the perception of the major, career and activities of information technology majors.

The perception of careers and majors can be influenced through their depiction in the media, movies, or television. Information technology is not the only gender underrepresented career. Finance careers are also significantly male dominated. Several recent articles discuss the issues with female students in finance careers. The challenges include advancement, work-life balance, graduate business school imbalance, social group status and lack of support (Chandler, 2021; Kessler, 2021). Since there were five sources for the media factor, it may be useful to complete a review of the individual sources for any research findings.

This research has developed several questions that have emerged in various areas This research has developed more questions which could be further explored:

- Are other influences and perceptions permeating through the thoughts of young people?
- Are technology positions perceived as compartmentalized within business organizations?

The results revealed an interesting disconnect between aptitude and use of technology. While young people significantly use technology in their daily lives, their use is more transactional in nature; adopting and using technology is exciting. However, the curiosity to analyze, develop, monitor, or implement technology is not as interesting as using technology.

Future studies should investigate the differences or trends in the factor perceptions over the five-year period as well as the effect of various individual media sources associated with student perceptions and outcomes.

From the results of this study, there are clear and distinguishable differences between females and males. The endless discussion of the number of females entering technology positions (and STEM-based careers in general) remain important and requiring attention. Education leaders (from K-12 to higher education) as well as business leaders need to continue promoting, acting as role models and active advocates with young people. The increasing demand for technology by businesses and individuals reflects the need to continue all efforts to promote technology as a formidable and satisfying career. Our ability as a national economy will specifically depend on increasing the number of young people who desire a technological position.

Business organizations need to be integrated as an active partner in the exploration and promotion of technology careers. The topic must remain *front and center* with attention from both the business and education sectors. The results clearly require a concerted "*call to arms*" in our society to focus on direct opportunities to attract a balanced gender population in technology careers.

References

Accenture. (2020). *Resetting tech culture*. https://www.accenture.com/_acnmedia/PDF-134/Accenture-A4-GWC-Report-Final1.pdf#zoom=50

Adam, A., Howcroft, D., & Richardson, H. (2004). A decade of neglect: Reflecting on gender and IS. *New Technology, Work, and Employment*, *19*(3), 222–240. ABI/INFORM Global. https://doi.org/10.1111/j.1468-005X.2004.00139.x

Adya, M., & Kaiser, K. M. (2005). Early determinants of women in the IT workforce: A model of girls' career choices. *Information Technology & People*, *18*(3), 230–259. WorldCat.org. https://doi.org/10.1108/09593840510615860

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179.

Akbulut-Bailey, A. (2012). Improving IS Enrollment Choices: The Role of Social Support. *Journal of Information Systems Education*, *23*(3), 259–270. ABI/INFORM Global.

Anderson, L., Edberg, D., Reed, A., Simkin, M. G., & Stiver, D. (2017). How Can Universities Best Encourage Women to Major in Information Systems? *Communications of the Association for Information Systems*, *41*, 29. https://doi.org/10.17705/1CAIS.04129

Anonymous. (2021). *Women in Tech Survey 2021: An exploration of career progression among Women in Tech*. IPSOS. https://wearetechwomen.com/wp-content/uploads/2022/10/women-in-tech-survey-2021-ipsos.pdf

Anonymous. (2022). *Undergraduate Degree Fields* (Digest of Education Statistics 2022, Table 321.10 National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS)). U.S. Department of Education. https://nces.ed.gov/programs/coe/indicator/cta

Anonymous. (2018, June 5). 5 Things You Need To Know About Women In Finance. *Forbes*. https://www.forbes.com/sites/forbesmarketplace/2018/06/05/5-things-you-need-to-know-about-women-in-finance/?sh=595841fe4e77

Apostol, O., & Näsi, S. (2013). Firm-Employee Relationships from a Social Responsibility Perspective: Developments from Communist Thinking to Market Ideology in Romania. A Mass Media Story. *Journal of Business Ethics*, *119*(3), 301–315. WorldCat.org. https://doi.org/10.1007/s10551-013-1642-1

Ardies, J., De Maeyer, S., Gijbels, D., & van Keulen, H. (2015). Students attitudes towards technology. *International Journal of Technology and Design Education*, *25*(1), 43–65. WorldCat.org.

Armstrong, D. J., Riemenschneider, C. K., & Giddens, L. G. (2018). The advancement and persistence of women in the information technology profession: An extension of Ahuja's gendered theory of IT career stages. *Information Systems Journal*, *28*(6), 1082–1124. https://doi.org/10.1111/isj.12185

Arthur, M. B., & Rosseau, D. M. (1996). A career lexicon for the 21st century. *The Academy of Management Executive*, *10*(4), 28–39. https://doi.org/10.5465/ame.1996.3145317

Astin, H. S. (1984). The Meaning of Work in Women's Lives A Sociopsychological Model of Career Choice and Work Behavior. *The Counseling Psychologist*, *12*(4), 117–126. WorldCat.org. https://doi.org/10.1177/0011000084124002

Baer, A., & DeOrio, A. (2020). A Longitudinal View of Gender Balance in a Large Computer Science Program. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education* (pp. 23–29). Association for Computing Machinery. https://doi.org/10.1145/3328778.3366806

Bandura, A. (2001). Social Cognitive Theory of Mass Communication. *Media Psychology*, *3*(3), 265–299. https://doi.org/10.1207/S1532785XMEP0303_03

Barr, V. (2017). Gender diversity in computing: Are we making any progress? In *Communications of the ACM* (Vol. 60, Issue 4, pp. 5–5). ACM New York, NY, USA.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*. WorldCat.org.

Beckhusen, J. (2016). *Occupations in information technology* (1–1 online resource (16 pages) : color illustrations.). U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau. http://purl.fdlp.gov/GPO/gpo71526

Blackburn, H. (2017). The Status of Women in STEM in Higher Education: A Review of the Literature 2007–2017. *Science & Technology Libraries*, *36*(3), 235–273. https://doi.org/10.1080/0194262X.2017.1371658

Blake, S. (2022, April 13). The Rate Of Female Comp Sci Majors Is Still Dispiritingly Low. What Can Be Done? *Triangle Tech News*. https://grepbeat.com/2022/04/13/the-rate-of-female-comp-sci-majors-is-still-dispiritingly-low-what-can-be-done/

Bright, J. E. H., Pryor, R. G. L., Wilkenfeld, S., & Earl, J. (2005). The Role of Social Context and Serendipitous Events in Career Decision Making. *International Journal for Educational and Vocational Guidance*, *5*(1), 19–36. https://doi.org/10.1007/s10775-005-2123-6

Businesswire. (2019). *New Survey: Student Confusion Selecting Majors Increases Higher Education Cost and Time to Earn Degree*. https://www.businesswire.com/news/home/20191014005009/en/New-Survey-Student-Confusion-Selecting-Majors-Increases-Higher-Education-Cost-and-Time-to-Earn-Degree

Castellanos, S. (2021, September 21). IT Leaders Adjust Hiring Strategies With Tech Talent Even More in Demand; IT job market has added about 13,000 positions during each month of 2021 so far. *Wall Street Journal (Online)*.

Chandler, S. (2021). *Why Are So Few Women in Finance? It's Complicated*. https://www.investopedia.com/articles/investing/092315/why-are-so-few-women-finance-its-complicated.asp

Chipidza, W., Green, G., & Riemenschneider, C. (2019). Why do Students not Major in MIS? An Application of the Theory of Planned Behavior. *Journal of Information Systems Education*, *30*(2), 111–126.

Clay, L. (2023). *The Biggest Challenges for Women in Tech: Explained*. https://www.advantisglobal.com/blog/biggest-challenges-for-women-in-tech

Cohen, J., & Hanno, D. M. (1993). An Analysis of Underlying Constructs Affecting the Choice of Accounting as a Major. *Issues in Accounting Education*, *8*(2).

Coser, L. A. (1974). *Greedy institutions; patterns of undivided commitment*. Free Press.

de Vries, M. J. (2005). *Teaching about Technology: An Introduction to the Philosophy of Technology for Non-philosophers*. Springer.

Dennehy, T. C., & Dasgupta, N. (2017). Female peer mentors early in college increase women's positive academic experiences and retention in engineering. *Proceedings of the National Academy of Sciences*, *114*(23), 5964. https://doi.org/10.1073/pnas.1613117114

Derricks, V., & Sekaquaptewa, D. (2021). They're Comparing Me to Her: Social Comparison Perceptions Reduce Belonging and STEM Engagement Among Women With Token Status. *Psychology of Women Quarterly*, 1. https://doi.org/10.1177/03616843211005447

Eccles, J. S. (1994). Understanding Women's Educational And Occupational Choices: Applying the Eccles et al. Model of Achievement-Related Choices. *Psychology of Women Quarterly*, *18*(4), 585–609. https://doi.org/10.1111/j.1471-6402.1994.tb01049.x

Eddy, S. L., & Brownell, S. E. (2016). Beneath the numbers: A review of gender disparities in undergraduate education across science, technology, engineering, and math disciplines. *Physical Review Physics Education Research*, *12*(2). WorldCat.org.

Ellucian. (2019). *Helping students find and follow a path to success: A Survey of U.S. Students*. https://www.ellucian.com/assets/en/2019-student-success-survey-results.pdf

Endepohls-Ulpe, M., Ebach, J., Seiter, J., & Kaul, N. (2012). *Women's Choices in Europe* (C. Quaiser-Pohl & M. Endepohls-Ulpe, Eds.; pp. 79–93). Waxman.

Epsztajn, I. (2019). Where are all the women in tech? *Organisation for Economic Cooperation and Development. The OECD Observer*, 1–3.

Finlay, K. A., Trafimow, D., & Moroi, E. (1999). The Importance of Subjective Norms on Intentions to Perform Health Behaviors. *Journal of Applied Social Psychology*, *29*(11), 2381–2393.

Fouad, N. A., & Santana, M. C. (2017). SCCT and Underrepresented Populations in STEM Fields: Moving the Needle. *Journal of Career Assessment*, *25*(1), 24–39. WorldCat.org. https://doi.org/10.1177/1069072716658324

Fox, T. L., Hindi, N., & Remington, W. S. (2001). Students' perceptions and misconceptions of a career in is. *The Journal of Computer Information Systems*, *42*(1), 83–89.

Frieze, C., & Quesenberry, J. L. (2019). How computer science at CMU is attracting and retaining women. In *Commun. ACM* (Vol. 62, Issue 2, pp. 23–26). Association for Computing Machinery.

Gill, J., Sharp, R., Mills, J., & Franzway, S. (2008). I still wanna be an engineer! Women, education and the engineering profession. *European Journal of Engineering Education*, *33*(4), 391–402.

Gomes, S. B., & Deuling, J. K. (2019). Family influence mediates the relation between helicopter-parenting and millennial work attitudes. *Journal of Managerial Psychology*, *34*(1), 2–17. https://doi.org/10.1108/JMP-12-2017-0450

Harmon, K., & Walden, E. A. (2021). Comparing Three Theories of the Gender Gap in Information Technology Careers: The Role of Salience Differences. *Journal of the Association for Information Systems*, *22*(4), 3. ABI/INFORM Global. https://doi.org/10.17705/1jais.00690

Heinze, N., & Hu, Q. (2009). Why college undergraduates choose IT: a multi-theoretical perspective. *European Journal of Information Systems*, *18*(5), 462–475.

Hubbert, J. (2023, April 25). 70+ Women In Technology Statistics (2023). *Exploding Topics*. https://explodingtopics.com/blog/women-in-tech#women-in-tech-stats

Inzlicht, M., & Ben-Zeev, T. (2000). A threatening intellectual environment: Why females are susceptible to experiencing problem-solving deficits in the presence of males. *Psychological Science*, *11*(5), 365–371.

Jodl, K. M., Michael, A., Malanchuk, O., Eccles, J. S., & Sameroff, A. (2001). Parents' roles in shaping early adolescents' occupational aspirations. *Child Development*, *72*(4), 1247–1265. Research Library. https://doi.org/10.1111/1467-8624.00345

Jones, B. L., Scoville, D. P., Hill, E. J., Childs, G., Leishman, J. M., & Nally, K. S. (2008). Perceived versus used workplace flexibility in Singapore: Predicting work-family fit. *Journal of Family Psychology*, *22*(5), 774.

Joshi, K. D., & Kuhn, K. (2011). What Determines Interest in an IS Career? An Application of the Theory of Reasoned Action. *Communications of the Association for Information Systems*, *29*, 1.

Kennedy, B., Fry, R., & Funk, C. (2021). *6 facts about America's STEM workforce and those training for it*. https://www.pewresearch.org/fact-tank/2021/04/14/6-facts-about-americas-stem-workforce-and-those-training-for-it/

Kessler, S. (2021). *'Mediocre' men get ahead in finance more easily, say women in the industry.* https://www.nytimes.com/2021/06/17/business/gender-equality-finance-industry.html

Kuechler, W. L., McLeod, A., & Simkin, M. G. (2009). Why Don't More Students Major in IS? *Decision Sciences Journal of Innovative Education*, *7*(2), 463–488.

Kvasny, L., Joshi, K. D., & Trauth, E. (2011). The influence of self-efficacy, gender stereotypes and the importance of it skills on college students' intentions to pursue IT careers. In *Proceedings of the 2011 iConference* (pp. 508–513).

Kvitkovicová, L., Umemura, T., & Macek, P. (2017). Roles of attachment relationships in emerging adults' career decision-making process: A two-year longitudinal research design. *Journal of Vocational Behavior*, *101*, 119.

Law, P., & Yuen, D. (2012). A multilevel study of students' motivations of studying accounting. *Education & Training*, *54*(1), 50–64. ABI/INFORM Global. https://doi.org/10.1108/00400911211198896

Levine, K. J., Miller, V. D., Quilliam, E. T., McAlister, A. R., & Aley, M. R. (2021). Socialization to science: Using media to help young people in the United States consider a career in a STEM-related field. *Communication Studies*, *72*(4), 547–562.

Lindahl, B. (2007). *A longitudinal study of students' attitudes towards science and choice of career*. NARST Annual Conference, 2007, New Orleans. DiVA.

Lunn, S., Zahedi, L., Ross, M., & Ohland, M. (2021). Exploration of Intersectionality and Computer Science Demographics: Understanding the Historical Context of Shifts in Participation. In *ACM Trans. Comput. Educ.* (Vol. 21, Issue 2, p. Article 10). Association for Computing Machinery.

Martinez, A., & Chrisnacht, C. (2021, January 26). Women Are Nearly Half of U.S. Workforce but Only 27% of STEM Workers. *America Counts: Stories*. https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html

Martinez, C., & Pearson, E. (2020, March 4). The Decline of Computer Science: Two Decades of Trends Reshape the Industry. *Steppingblocks*. https://blog.steppingblocks.com/the-decline-of-computer-science

McIlwee, J. S., & Robinson, J. G. (1992). *Women in engineering: Gender, power, and workplace culture* (1–1 online resource (xiii, 248 pages).). State University of New York Press.

EBSCOhost http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=8013

Mearian, L. (2023, September 5). How many jobs are available in technology in the US? *Computerworld*. https://www.computerworld.com/article/3542681/how-many-jobs-are-available-in-technology.html

Merhout, J. W., Benamati, J. 'Skip,' & Rajkumar, T. M. (2022). The influence of career panels on student perceptions, attitudes, and intentions toward the information systems profession. *Decision Sciences Journal of Innovative Education*, *20*(2), 61–75. https://doi.org/10.1111/dsji.12257

Miller, V. D. (2008). Organizational Assimilation. In *The International Encyclopedia of Communication*. https://doi.org/10.1002/9781405186407.wbieco016

Mims-Word, M. (2012). The Importance Of Technology Usage In The Classroom, Does Gender Gaps Exist. *Contemporary Issues in Education Research (Online)*, *5*(4), 271.

Moore, R., & Burrus, J. (2019). Predicting STEM Major and Career Intentions With the Theory of Planned Behavior. *The Career Development Quarterly*, *67*(2), 139–155. ABI/INFORM Global. https://doi.org/10.1002/cdq.12177

Murphy, M. C., Steele, C. M., & Gross, J. J. (2007). Signaling Threat: How Situational Cues Affect Women in Math, Science, and Engineering Settings. *Psychological Science*, *18*(10), 879–885. WorldCat.org.

Myers, K. K., Jahn, J. L. S., Gailliard, B. M., & Stoltzfus, K. (2011). Vocational Anticipatory Socialization (VAS): A Communicative Model of Adolescents' Interests in STEM. *Management Communication Quarterly*, *25*(1), 87–120. https://doi.org/10.1177/0893318910377068

Osborne, J., & Collins, S. (2000). *Pupils' and Parents' Views of the School Science Curriculum* (1–82). https://www.kcl.ac.uk/sspp/departments/education/web-files2/news-files/ppt.pdf

Prescod, D. J., Daire, A. P., Young, C., Dagley, M., & Georgiopoulos, M. (2018). Exploring Negative Career Thoughts Between STEM-Declared and STEM-Interested Students. *Journal of Employment Counseling*, *55*(4), 166–175. https://doi.org/10.1002/joec.12096

Saleem, N., Hanan, M. A., & Shamshad, R. M. (2014). Career Selection: Role of Parent's Profession Mass Media and Personal Choice. *Bulletin of Education and Research*, *36*(2). Research Library. http://bryant.idm.oclc.org/login?url=https://www.proquest.com/scholarly-journals/career-selection-role-parents-profession-mass/docview/1662043250/se-2?accountid=36823

Sarı, U., Alıcı, M., & Şen, Ö. F. (2018). The effect of STEM instruction on attitude, career perception and career interest in a problem-based learning environment and student opinions. *The Electronic Journal for Research in Science & Mathematics Education*, *22*(1).

Sekaquaptewa, D., & Thompson, M. (2002). The differential effects of solo status on members of high- and low-status groups. *Personality and Social Psychology Bulletin*, *28*(5), 694–707. WorldCat.org. https://doi.org/10.1177/0146167202288013

Sheehan, K. J., Hightower, B., Lauricella, A. R., & Wartella, E. (2018). STEM Media in the Family Context: The Effect of STEM Career and Media Use on Preschoolers' Science and Math Skills. *European Journal of STEM Education*, *3*(3), 17.

Stein, S. J., & McRobbie, C. J. A. P. (1997). Students' conceptions of science across the years of schooling. *Research in Science Education*, *27*(4), 611–628. WorldCat.org.

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the Tide: Using Ingroup Experts to Inoculate Women's Self-Concept in Science, Technology, Engineering, and Mathematics (STEM). *Journal of Personality and Social Psychology*, *100*(2), 255.

Trauth, E. M., Joshi, K. D., Kvasny, L., Chong, J., Kulturel, S., & Mahar, J. (2010). *Millennials and masculinity: A shifting tide of gender typing of ICT?*

Turner, J. C., & Oakes, P. J. (1986). The significance of the social identity concept for social psychology with reference to individualism, interactionism and social influence. *British Journal of Social Psychology*, *25*(3), 237–252.

Turner, S., & Lapan, R. T. (2002). Career self-efficacy and perceptions of parent support in adolescent career development. *The Career Development Quarterly*, *51*(1), 44–55.

U.S. Bureau of Labor Statistics. (2020). *BLS Occupational projections and worker characteristics (Table 1.7)*. https://www.bls.gov/emp/tables/occupational-projections-and-characteristics.htm

Vainionpää, F., Molin-Juustila, T., & Arhippainen, L. (2022). Understanding Interest in Studying IT – "Desire for Change" Among Adult Women. *Journal of Information Systems Education*, *33*(1), 32–40. ABI/INFORM Global.

Valentino, L., Moller, S., Stearns, E., & Mickelson, R. (2016). Perceptions of Future Career Family Flexibility as a Deterrent from Majoring in STEM. *Social Currents*, *3*(3), 273–292.

Walstrom, K. A., Schambach, T. P., Jones, K. T., & Crampton, W. J. (2008). Why Are Students Not Majoring in Information Systems? *Journal of Information Systems Education*, *19*(1), 43–54.

Walton, G. M., Cohen, G. L., Cwir, D., & Spencer, S. J. (2012). Mere belonging: The power of social connections. *Journal of Personality and Social Psychology*, *102*(3), 513. WorldCat.org. https://doi.org/10.1037/a0025731

Wang, M.-T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review*, *33*(4), 304–340.

Wiswall, M. J., & Zafar, B. (2021, June). New Approaches to Understanding Choice of Major. *NBER*. https://www.nber.org/reporter/2021number2/new-approaches-understanding-choice-major

Yagmur, A. A., & Jaideep, M. (2018). Gender based Investigation of Stereotypical Barriers in Management Information Systems Profession. *Advances in Management*, *11*(4), 1–8.

Young, D. K., Carpenter, D., & Maasberg, M. (2018). An Examination of Factors That Influence Students' IT Career Decisions. *The Journal of Computer Information Systems*, *58*(3), 253–263. https://doi.org/10.1080/08874417.2016.1235473

Zhang, W. (2007). Why IS: Understanding Undergraduate Students' Intentions to Choose an Information Systems Major. *Journal of Information Systems Education*, *18*(4), 447–458.