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## Factors and experiences that prepare students for a cyber career: a gender-based study

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### Abstract

There are more than 700,000 unfilled cybersecurity positions across the U.S. According to various studies and reports; women comprise a small percentage of the cybersecurity workforce. As academia works to prepare qualified professionals to fill these positions, it is important to examine what kind of preparations are effective in helping students succeed and to examine any possible gender difference in these activities and the drivers in selecting this field of study. This paper investigates the factors associated with choosing this field and the preparatory activities the students found helpful, with gender being a significant focus in the evaluation strategy. Two focus groups were conducted for data collection at two different universities, and participants were asked to discuss their experiences in preparing for the Cyber Security field. An interpretive thematic analysis technique was used to analyze the data. Our results suggest various themes for selecting the field, and three themes emerged when looking at gender differences.

**Keywords:** cyber security, major, career, gender, focus group, women in cybersecurity, qualitative

### Introduction

The increasing number of security breaches and network attacks is fueling the growth of cyber security jobs. There are more than 700,000 unfilled cybersecurity positions across the U.S., and unless this labor shortage is systematically addressed, businesses and nations might keep incurring more losses (Rende, 2023).

According to various studies and reports, women comprise a small percentage of the cybersecurity workforce, typically less than 25% in most countries (Rende, 2023). There are many reasons for this gap: lack of awareness (women might not be aware of career opportunities), biases (women's perception of their abilities in technical fields discourage women from pursuing a career in this field), work culture (could be perceived as complex), and lack of role models. Women are generally considered better in soft skills, and cyber security requires adaptability with a mix of soft and technical skills (Polmera, 2023). There are a variety of domains in cyber security that require strong communications skills, attention to detail, and reaching out to stakeholders for decision-making. Women typically perceive themselves as more assertive in softer skills and consider men fitter for technical jobs in cyber security (Hughes, 2022). Women experience gender bias in this industry resulting in unequal pay and a lack of support systems to maintain a work-life balance (Hughes, 2022). The shared cultural tendency that people working in IT or cyber security are "nerds" or cybersecurity careers for women is not worthy of pursued as there is a lack of

opportunities for them to grow (Hoteit, 2022) and act as barriers for women who want to enter this occupation.

The lack of an adequately trained workforce to meet increasing cybersecurity demand creates challenges for organizations unable to fill security positions. There are tremendous opportunities in the cyber security domain for women to add value to the field by bringing diverse experiences and perspectives. However, women in the workforce do not consider this field a potential career growth area. Similarly, there needs to be more women in cyber security programs at universities. It is essential to address this gender gap in cybersecurity programs by investigating how women perceive these programs.

This paper aims to understand how men and women perceive cybersecurity programs and prepare to be successful in such programs. The general perception of cyber security being a male-dominated profession needs rebranding. To accomplish this, we need to clearly understand what motivates men and women to choose such programs in college and pursue a career along these lines.

The research questions posed in this study are:

**RQ1:** *What factors influence the selection of cyber security as a major/career field?*

**RQ2:** *What are the differences between men and women in selecting a cybersecurity major?*

**RQ3:** *What experiences are most valued by students in preparing them for the cyber field?*

The rest of the paper is organized as follows. A critical review of the extant literature is presented, followed by a description of the methodology section entailing data collection and analysis techniques. The results and discussions about the results follow the methodology section. Implications are drawn, and limitations are noted. The conclusion section presents the paper's objective and how it was accomplished in this study.

### Literature Review

Nearly all fields have conducted studies on gender differences. From leadership (analyzing leadership qualities (Alan, 2020) to psychiatry (studying the effects of anxiety (Yang et al., 2021) to real estate (studying transaction negotiations (Andersen, 2021)) to occupational studies (researching gender segregation and its generational roots (van der Vlieten et al., 2018), many researchers use gender as a demographic variable of interest.

Gender issues within STEM fields, specifically regarding women in STEM, are frequently studied (Elliott et al., 2020; Collins & Steffen-Fluhr, 2019; Bird & Rhoton, 2021; Sendze, 2022). While various studies analyze whether the number of female students in a classroom environment versus the number of male students affect the female students' interest in the course (Casad et al., 2019; Cheryan et al., 2009; Ramsey et al., 2013) other studies generically focus on gender representation within the STEM field (Stout et al., 2011). The stereotype of being a nerd could negatively affect this representation, and females' STEM identity as a whole (Starr, 2018). Even in cases where female students outperform males, some studies have found that the females' qualifications are still trivialized (Bloodhart et al., 2020).

Not only has STEM as a whole been studied but also various sub-fields. Hodges & Corley (2017) found that the factors that lead women to select majors, such as Information Systems (IS), change over time. But earlier than the college decision-making period, Snyder & Slauson (2016) reported that females aren't introduced to STEM fields. This leads to the need for more guidance and mentoring to ensure they select

a major that is right for them (Mishra et al., 2014). Furthering this point, a 14-year-old, seventh grade female opined:

I've seen the software industry's efforts to recruit more women in college, and sometimes high school. Let me tell you, that's way too late. We're making up our minds now—in seventh grade or even sixth. My teachers have (too often) expounded that during our middle school years we grow more than any other time of our lives outside of infancy. It is the perfect time to present software as a career, at the moment when we are most malleable (Platt, 2014).

The benefits of exposing females to computing curricula earlier in their lives, however, is an area of disagreement for some (Jung et al., 2017). There are differences among various universities regarding whether the cyber security program is a standalone major (Robert Morris University, n.d.; Saint Francis University, n.d.) or within another major, such as Computer Science or IS (Indiana University of Pennsylvania, n.d.). Despite these differences, little research has been conducted around the aforementioned issues specifically focused on the cyber security major. This is increasingly a problem because only 11% of the cyber security workforce globally are women (Poster, 2018). As a student, however, many women found after shadowing and internships that the cyber industry, perceived initially as male-dominated, is an even playing field (Pinchot et al., 2020) as long as they have an investigative mindset and enjoy analytical/critical thinking (Mishra et al., 2019). Reynolds et al. (2017) found another possible factor: CS-minded students are typically introverts, and IS-minded students are extroverts. With cyber spanning both fields, this can cause a struggle. This speculation merely leads one to conclude that the true reasons for gender differences are primarily unknown, warranting further research.

## Methodology

Due to the unstructured topic of this exploratory research, we chose focus groups as the study method. We expected that a focus group discussion would result in many discussion topics instead of an individual interview, where the respondent would forget to bring up some of these topics. The data was collected in a series of focus group discussions with the groups of students enrolled in cyber security courses in several colleges. We chose three separate focus groups of 15-20 students, with most majoring in cyber security, forensics, or similar areas. The discussion included three questions; each matched a research question and was followed by a list of five to nine talking points. The purpose of the talking points was to encourage the students to share more detailed comments; if a talking point was brought up in a discussion by the students' initiatives, we did not mention it later. In the opposite case, we asked a question according to that point. An example of a lead question and the matching talking points is given in Table 1.

**Table 1. Sample lead question with talking points**

<i>What experiences are most valued by students in preparing them for the cyber field?</i>
Did you prepare for your degree program before entering college?
What activities/events prepared you for this program?
What activities/events did you undertake that ultimately were not helpful in preparing you for your program?
What would you recommend a high schooler, who wants to be in this major, do to be better prepared?
What would you recommend they do not do?
How much math do you think is needed to become a Cyber security major?
How much, if any, programming experience is needed to become a Cyber security major?

Each focus group discussion was recorded by two researchers to reduce the risk of poor quality of sound or equipment malfunctioning; notes were also taken in each of the three discussions. After merging and transcribing the discussions, we identified the emergent themes. We then mapped the responses to the themes that we identified, specifically comparing the statements made by male and female students.

**Table 2. Panel Groups – Demographic Data**

Year in School	Count	Gender	Count	Major	Count
1	8	Female	13	Cyber Security	39
2	4	Male	36	Cyber Security & Digital Forensics	7
3	15	No Response	4	Computer and Information Systems	5
4	19			Computer Science	1
5 - graduate	1			Cyber (security) and Criminal Justice	1
No response	6			MIS & Cyber Security Administration	1

The number of subjects in the study was 53. Their average reported age was 23.84. The youngest subject was 19, and the oldest subject was 39. The number of Full-Time students was 46. The remainder did not respond to that question. Regarding residency, 23 reported living on campus, with 28 reporting that they lived off campus. The counts for Years in school, Gender, and Major can be found in Table 2.

## Findings

### Factors that influenced selecting cyber security as a field

There were four emergent themes in the part of the discussion related to Research Question 1 (factors influencing the field selection): (1) preference in courses and curriculum (2) demand and specifics of jobs (3) exposure to the area, and (4) timing of decision (Table 3).

**Table 3. Themes in field selection**

Theme	Statements
<b>Theme 1: preference in courses and curriculum</b>	<ul style="list-style-type: none"> <li>• No programming (m/f)</li> <li>• Less math (f)</li> <li>• Less writing (m)</li> <li>• Work with technology (f)</li> <li>• More hands on than other majors (m)</li> <li>• Interested in computers, but don't want to do coding (m)</li> </ul>
<b>Theme 2: demand and specifics of jobs</b>	<ul style="list-style-type: none"> <li>• Great salaries (m)</li> <li>• Demand of jobs (m/f)</li> <li>• Big chance of working remotely (m)</li> <li>• Not a lot of travel (m/f)</li> <li>• Job Security (m/f)</li> <li>• Lots of people were pulled to Computer Science which led to Cyber Security (m/f)</li> </ul>

Theme	Statements
<p><b>Theme 3: exposure to the area</b></p>	<ul style="list-style-type: none"> <li>● Military experience (m)</li> <li>● A friend got hacked (m)</li> <li>● College digital forensics 1 class (f)</li> <li>● Tech classes in Vo-tech (f)</li> <li>● Studied cyber sec in school and knew that's something I would like to do all my life (?)</li> <li>● High School experiences or jobs (m/f)</li> <li>● In-house Career &amp; Technical Center (f)</li> <li>● There is a lot of entertaining cyber security online, YouTube, forums and stuff keep my interest growing (?)</li> <li>● Worked in law, Pandemic led to lots more publicity of cybercrime (f)</li> </ul>
<p><b>Theme 4: timing of decision</b></p>	<ul style="list-style-type: none"> <li>● Elementary school (m)</li> <li>● During high school (m/f) – the majority of respondents</li> <li>● On a college tour (m)</li> <li>● During the pandemic (m/f)</li> <li>● College (m/f) – second largest group</li> </ul>

Many respondents pointed out that they considered various other career opportunities prior to enrolling in cyber security. For female students, the possible choices included psychology, engineering, business, biology, game design, CIS, and chemical engineering. For male students the areas of interest included art, medicine, and carpentry. Computer science was admitted to be a career option by both genders. The majority of the students admitted that the future curricula played a crucial role in their choice of major. As such, both male and female students admitted that they enrolled because they expected cybersecurity fields to include “no programming”. For female students, the assumption was also less math, and for male students – less writing. At the same time, both genders chose the field because it promised more hands-on experience.

Demand for cyber jobs and job specifics were frequently brought up in the discussion. Interestingly, while it is often suggested in media that such factors as remote work, flexible time, and less travel are more attractive to female employees, only male students mentioned a chance to work remotely as a reason to choose their major. Both male and female groups pointed out little travel, high job demand, and job security as the reasons for their choice.

There were various ways the students were exposed to the area of cyber security and to IT in general, from a set of courses taken in high school to an anecdotal exposure when someone they knew was hacked or a major cybercrime that they learned about from the news. The majority of the students came to college after having had some training in IT/cyber. A substantial part of the students received this training in high school (male and female) or through vocational training and in-house career centers (female only).

Surprisingly, most students admitted that they made the decision about their major in high school (most popular response) or after starting college (second most popular response). According to Platt (2014), many female students choose their career path in middle school, so these responses suggest that the lack of female students in cyber programs may be due to their lack of earlier exposure to the field.

### Gender-based differences in perception of the field

The discussion about gender-based differences in perception of cyber security careers resulted in three emergent themes, detailed in Table 4: (1) gender-specific professional characteristics, (2) being susceptible to others’ influence, and (3) is cyber-fitted to a specific gender?

Both male and female participants commented on some professional qualities that they attributed to each gender. Women were perceived as having less confidence, but at the same time being more reassuring, with soft skills and the ability to search for details and “digging into a point”. Confidence issue was mentioned multiple times, in statements like this:

“It’s a confidence thing. For example, in our software dev office we have two girls out of 14 people. Everybody is talking, men are talking, girls are talking, but no offense there is lack of confidence in girls compared to guys. The guys are always marketed towards you know what’s right. But marketing towards women side is not right, but reality.”

Many participants, including female and male, agreed that women are more susceptible to the opinions of other people who they look up to, such as their (female) relatives, teachers and mentors. One student (female) mentioned that many times if a girl announces that she would like to pursue a career in IT, her intention is met with polite interest and enthusiasm, and after that she is being discouraged from her decision. Another student (also female) suggested that for girls it was crucial to have a female role model:

“Lots of females look after their female relatives, so I was wondering if maybe market cyber security more among the professional women, help them to advance their career etc.”

The majority of the students did not agree that cyber security or similar fields were a better fit for any specific gender. At the same time, two male participants mentioned that this field attracted for unknown reasons more males than females, although things started to gradually shift towards a better balance. A female student from Saudi Arabia pointed out the lack of female representation in cyber may be culture-specific, and that in her country both groups were represented equally.

**Table 4. Themes in gender differences**

Theme	Statements
<b>Theme 1: gender specific characteristics</b>	<ul style="list-style-type: none"> <li>● Women are more into searching into a point, they are very specific digging into it, finding what’s going on (f)</li> <li>● It’s a confidence thing, female employees have less confidence (m).</li> <li>● Women need time to make a decision, and they cannot take a decision in a real time (m)</li> <li>● EQ skills are more found in women (m)</li> <li>● For example, women are better in customer service, they are more assuring (m)</li> </ul>
<b>Theme 2: influenced by others</b>	<ul style="list-style-type: none"> <li>● If a girl wants an IT career - fake enthusiasm, then advised to change their major (f)</li> <li>● Lots of females look after their female relatives (m)</li> <li>● AP Computer Science teacher guided me (f)</li> </ul>
<b>Theme 3: is cyber fitted to a specific gender?</b>	<ul style="list-style-type: none"> <li>● No specific fit (m/f) – the most popular opinion</li> <li>● Moral aspects of the field are better done by women (m)</li> <li>● It’s a male dominant career, not sure why (m)</li> <li>● It’s shifting a little, but it was male dominant from beginning (m)</li> <li>● Demand in cyber security, I am talking in Saudi Arabia, is not different between women and men (f)</li> <li>● No matter where you go in cyber, there is always something that attracts anyone (f)</li> </ul>

## Most valuable experiences

We identified three emergent themes in the discussion related to the most valuable experiences helping the students in their cyber programs: (1) IT, (2) math, and (3) criminal justice (Table 5). These discussions were gender-neutral, so we did not bring gender as a factor.

Interestingly, in the beginning of the panels, multiple students mentioned that they chose cyber as an IT field with the least amount of programming. However, approximately 1/3 of the students admitted that one needs technical knowledge to succeed in the program, including Programming 1 & 2, other CS classes, data structures, SQL, and finally networking, which was an expected choice.

In addition to technology courses, math was brought up in the discussion as an important knowledge; mainly, discrete math, along with some basic knowledge of algebra and geometry. Many students emphasized analytical thinking in general, and some admitted that calculus was not at all helpful.

A statement was made in two of the three discussions: “To catch a criminal, one must think like a criminal”. Multiple students emphasized the importance of criminal psychology in cyber programs, as well as the knowledge of forensics and not particularly cyber forensics.

**Table 5. Themes in valuable experiences**

Theme	Statements
<b>Theme 1: IT</b>	<ul style="list-style-type: none"> <li>● AP or other Computer Science classes</li> <li>● General tech classes</li> <li>● Criminal justice minor</li> <li>● Coding, programming 1 &amp; 2, SQL</li> <li>● Networking</li> <li>● Data structures</li> </ul>
<b>Theme 2: math</b>	<ul style="list-style-type: none"> <li>● Pre-calc or calculus was NOT helpful</li> <li>● Discrete math</li> <li>● Analytical thinking in general</li> <li>● Algebra, high school algebra (unanimous conclusion)</li> <li>● Geometry</li> </ul>
<b>Theme 3: criminal justice</b>	<ul style="list-style-type: none"> <li>● To catch a criminal, you have to think like a criminal. Criminal psychology should be a skill set</li> <li>● Forensics</li> </ul>

## Limitations

One interesting anecdotal finding was the difference in verbal participation in the focus group sessions between women and men but also between the genders at both institutions. While the women at one institution participated equally in the focus group, the women at the other institution did not participate the same amount as the men, sometimes even remaining silent despite their facial expressions implying that they wanted to provide input. This is not a new problem in the STEM fields.

Multiple studies have observed that women tend to participate less than men in the classroom for various reasons (Eddy et al., 2014; Aguillon et al., 2020; Bailey et al., 2020; York et al., 2021). Ballen et al. (2019) found that smaller class sizes tended to increase the participation level of women students; however, contradictory to this finding, the focus groups in this research were no larger than 18 students each. Despite these studies, other researchers have found that women tend to participate more than men (Howard & Henney, 1998; Fritschner, 2000; Howard et al., 2006) while others yet recorded no statistical differences

(Cornelius et al., 1990; Pearson & West, 1991; Brady & Eisler, 1999). In any case, the uneven participation between the genders had the potential to skew the results of this study.

## Conclusion

In determining what influences the students' decision to pursue a career in cyber security, we looked at the following three domains: (1) factors that influence selecting cyber as career field, (2) gender-based differences in perception of the field, and (3) most valuable experiences that lead the students to choose cyber as their career. We found that while the students were exposed to cyber security in a variety of ways prior to going to college, early IT training was a key aspect in directing their career choice. Another interesting finding was the time of their career decision: most students admitted that this decision was made in college, as opposed to high school.

The findings in the second domain revealed that women faced more discouragement in pursuing a cyber career; at the same time having a same-gender role model was particularly important to female students. Finally, the list of the most valuable experiences in career decision was not gender specific and included mostly prior academic exposure to IT, math and criminal justice.

This analysis of gender and the preparation for cyber careers uncovered key aspects that may affect females' decision-making on entering cybersecurity-related education and careers. Many factors that apply to both genders, however, were also uncovered. Future research should be conducted with interventions based on these factors giving special attention to the even demographic distribution of the research population.

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