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Student Perceptions of Challenges and Role of Mentorship in Cybersecurity Careers: Addressing the Gender Gap

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Abstract

The cybersecurity industry is facing a significant shortage of professionals to fill open positions, with a projected staffing shortage of 1.8 million jobs worldwide by 2022. Part of this shortage can be attributed to the underrepresentation of women in the field. This research addresses the gender gap in cybersecurity by exploring the perceptions of students in cybersecurity programs about the differences between men and women in terms of the challenges they will face in pursuing a career in this field and the role of mentorship in attracting and retaining professionals in the field. Researchers conducted a set of focus groups with a total of 25 students to explore these issues. A key finding indicates that while stereotypes of a male-dominated field and gender-related challenges still exist, no gender difference or bias was reported or observed by students in their classes or workplace internships. Another key finding notes that students found peer mentorship to be one of the most valuable aspects of their cybersecurity programs and aspiring careers in the field. A set of recommendations is presented to aid in addressing all challenges identified and to suggest solutions for improving mentorship opportunities.

Keywords: cybersecurity, gender gap, mentorship, peer mentoring, qualitative, focus group

1. INTRODUCTION

Cybercrime and other cyberattacks continue to increase in number, complexity, and sophistication. Addressing this issue is one of the most critical needs within the information technology (IT) field. However, the

cybersecurity industry is facing a significant employment gap, with unfilled positions across all areas of the cybersecurity field. There are over 313,000 cybersecurity-related job openings in the United States in 2019 ("Cybersecurity supply/demand heat map", n.d.) and Forrester projects a staffing shortage in cybersecurity of

1.8 million jobs worldwide by 2022 (Balaouras, 2018). Another serious concern is the underrepresentation of women in the field (Richter, 2019; Morgan, 2019; Higgins, 2018; Peacock & Irons, 2017; LeClair, Shih, & Abraham, 2014; Bagchi-Sen, Rao, Upadhyaya & Chai, 2010). The most prominent report that is often cited in the media asserts that women make up only 11% of the cybersecurity workforce (Frost & Sullivan, 2013), even though women represent approximately 50% of the overall workforce (Richter, 2019; LeClair, Shih, & Abraham, 2014). However, more recent reports place the number of women in cybersecurity at 20% of the workforce, which shows a definite improvement, but is still too low (Morgan, 2019; Higgins, 2018). In the past eight years, there has been a steady rise in the number of STEM-related degrees earned by female students. There was a 48% increase for females from 2008 to 2016, while males earning STEM-related degrees saw a 38% increase in the same time period (Feldman, 2019). This is encouraging and indicates further movement toward closing the cyber gender gap, though the gap still persists.

There is a strong need to explore the full range of factors that may influence women in their decision to consider or maintain a career in cybersecurity (Schumba et al., 2013). Research has shown that addressing the needs, concerns, and motivations of women potentially interested in the field of cybersecurity while they are at university is crucial to their successful entry and future success in the field (Bagchi-Sen et al., 2010). Other studies show that connecting women with cybersecurity early on, such as through the Girl Scouts' cybersecurity badge or free online classes, can be beneficial in engaging them with the field (Higgins, 2018). Further research has also been called for to understand the importance of mentors or role models on the retention of females in the cybersecurity industry in particular (Higgins, 2018; Willis-Ford, 2018).

A critical review of the research literature in the domain of women in the cybersecurity field reveals an urgent need to address the employment and gender gap in the field. It is necessary to understand the challenges for female students pursuing cybersecurity careers and how they might differ from male students. It is also important to explore the perceptions of female and male students about the role of mentorship in regard to the field, as this may be a useful way to engage and retain female students in particular (Balaouras, 2018; Higgins,

2018). This study explores the challenges encountered by college women and men pursuing careers in cybersecurity programs and their views on the role of mentorship. To this end, three research questions were developed:

RQ1: What challenges do students face when pursuing a career in cybersecurity?

RQ2: What are students' perceptions about the role of mentorship when pursuing a career in cybersecurity?

RQ3: What differences exist between men and women regarding the role of mentorship and challenges faced when pursuing a career in cybersecurity?

2. LITERATURE REVIEW

Challenges for Women

Women face challenges when seeking cybersecurity positions. According to a study conducted by D'Hondt (2016), barriers for women pursuing a career in cybersecurity consist of militaristic/male-gendered culture and stereotypes, recruitment practices from companies, bias in the hiring process, and branding. When explaining the militaristic/male-gendered culture stereotypes, D'Hondt (2016) discusses the dominance of men that appear in movies or television shows about cybersecurity or hacking. Women are rarely included in these roles in shows but when they are, their characters are often portrayed as "goth" or something out of the everyday norm for a work environment. In the education environment, women are often ignored in group projects or are marginalized.

In order to overcome the recruitment barrier for women that want to enter the cyber field, it might be beneficial to have women recruiters. When it comes to bias in the workplace, since the majority of technology positions are held by men, men often hire others that are very similar to them. Having both women and men recruiters could help solve this bias issue. Lastly, organizations need to brand their marketing material to be gender inclusive. How job announcements are worded can make a difference in who actually applies for the position (D'Hondt, 2016).

A Kaspersky study (2017) surveyed 4,001 young people between the ages of 16 and 21 in regard to why women are not choosing careers in cybersecurity. The study revealed that 57% of women believe they lack coding experience,

52% do not have an interest in the career, and 45% did not know enough about cybersecurity careers. Of those surveyed, only 16% of women even knew what a cybersecurity expert does in their job, as compared to 20% of men. The issue comes down to awareness. Women do not have to be coders to be able to succeed in a cybersecurity career. One solution that Kaspersky lists is that women need to be highlighted more as technical role models in imagery and in the media. One in six women believes that the field of cybersecurity would be dull.

Role of Mentorship

Interviews conducted by D'Hondt (2016) revealed that mentorship is a key part of retention for both women and men in the cybersecurity field. Mentorship programs contribute to employees staying in the field longer. Companies should encourage both formal and informal mentoring programs. Starting with a small group of employees willing to participate and mentor new hires would be a great start. It helps, but is not necessary, to pair a woman with a woman mentor to advocate on their behalf. A study conducted by Frost and Sullivan (2017) revealed that 28% of women in cybersecurity feel that their opinions are not valued. Women who felt that their opinions were valued, 61%, indicated that their organizations provided adequate training, leadership development, and mentorship.

A study conducted by Glass (2013) shows that a lack of mentors is an important factor in few girls studying cybersecurity in middle school, high school, and at the collegiate level. If the mentor projected a stereotypical image of a "geek or nerd", girls were less likely to believe in their success in the field. The success of role models for young women is needed to help girls succeed in cybersecurity.

Willis-Ford (2018) conducted a quantitative study to gain an understanding of why women have a lower retention rate than men in the cybersecurity industry. As part of the study the author analyzed the impact of mentorship or lack thereof. The lack of mentors for women in cybersecurity is an important factor contributing to low retention rates of women in STEM. LeClair, Shih, and Abraham (2014) indicate that while equal pay and advancement opportunities are important for the retention of women in cybersecurity, having mentors is more important. The mentor does not need to be female but needs to have an interest in the mentee's success.

Cheryan et al. (2011) found there to be no difference between male or female recruiters in the STEM field but found that women mentors are more effective for keeping women in the field.

Research is split as to whether gender matters when mentoring women entering the field of cybersecurity. A factor that must be noted is that female mentors are more difficult to find due to the gender gap in the field of cybersecurity.

3. METHODOLOGY

A focus group is a small-group discussion guided by a facilitator. It is used to learn about opinions on a designated topic, and to guide future action (DeVault, 2018; Krueger & Casey, 2000). Focus groups are a common qualitative data collection method where the data is collected through a semi-structured group interview process. The focus group is a gathering of deliberately selected people who participate in a planned discussion intended to elicit perceptions about a particular topic or area of interest in an environment that is nonthreatening and receptive (DeVault, 2018; Krueger & Casey, 2000). It asks participants for open-ended responses conveying thoughts or feelings. The focus of our research is exploratory in nature, exploring the perceptions of current students in cybersecurity programs; therefore, we believe this method is appropriate.

After approval of the research by the university Institutional Review Board, we conducted three separate focus groups with a total of 25 participants. Students enrolled in a cybersecurity program at the researchers' university (approximately 189 students) were invited to participate in one of three focus groups in February 2019. The first focus group had four students (2 males, 2 females) participate. The second focus group had 10 students (8 males, 2 females) participate, and the third focus group had 11 students (9 males, 2 females) participate. The same semi-structured protocol was used for all three focus groups and we audio-recorded each of the sessions. Each focus group was led by at least one facilitator and included at least one note-taker. Each session was about 45 minutes long.

Audio recordings were transcribed and reviewed for accuracy. Thematic analysis of the data was done manually first by each member of the team. Next, teams of two developed the various themes. Then, the themes were verified by all four members of the team.

4. RESULTS

Challenges in Pursuing a Career in Cybersecurity

The first research question was (RQ1) What challenges do students face when pursuing a career in cybersecurity? This question was proposed to the participants without any leading comments or introduction suggesting that there may be a gender gap within the field. Data analysis for RQ1 suggests three themes: Need to keep learning to adapt with quickly changing technology, Male-dominated profession, and Challenging field with much responsibility (see Table 1).

Themes for RQ1	M	F	Total
Need to keep learning to adapt with quickly changing technology	8	10	18
Male-dominated profession	9	4	13
Challenging field with much responsibility	2	3	5

Table 1: Code frequencies for themes relating to perception of challenges in cybersecurity careers by gender

Participants noted that cybersecurity is a quickly changing field and constant learning of new technological solutions is required. A few participant quotes to illustrate this theme were:

"You constantly have to learn new ways, because there are people out there that are finding new ways to do things."

"It's constantly reforming itself and you constantly have to keep learning and learning and that alone is gonna be a challenge for not just me but for every other person going into the cyber world as a career."

Related to this concept was the theme that cybersecurity is a challenging field with much responsibility. The participants acknowledged that the field can be intimidating for many students and that there is added pressure on professionals in this field because it comes with a great sense of responsibility for protecting organizations, individuals, and data. Some responses included:

"You just gotta set your mind to it. But it was daunting at first."

"It's a huge responsibility."

Cybersecurity is a male-dominated field is another theme in this study. The participants in the focus groups agreed that there are fewer women in cybersecurity than men. They expressed the viewpoint that this may have to do with pre-existing stereotypes that the field is more suited to males, even though they see this issue changing. Participants said:

"So it's always a stereotype thing and you never see it as a female role because it's almost always masculine, if that makes sense."

"And it's not so ... I feel like companies definitely want to start bringing in women so that they can get out of that direction, but um, I feel like companies felt that men are better in this career than women are."

Role of Mentorship

The second research question (RQ2) was: What are students' perceptions about the role of mentorship when pursuing a career in cybersecurity? This question addressed perceptions of the role of mentorship as participants prepare for a career in cybersecurity, and secondarily explored perceptions related to gender of mentors. Participants did not mention any gender roles for mentorship (e.g. whether gender of a mentor would impact the quality of the mentoring relationship) until they were expressly asked by the researchers. This was telling in that it was not something that occurred to the participants as an issue or consideration when thinking about the role of mentorship.

Mentorship resonated with the focus group participants and various facets of mentorships were identified in the data analysis. The main emergent themes are: Peer influence, College professor/school teacher influence, Cybersecurity-focused student club influence and Family or friend influence (see Table 2).

Themes for RQ2	M	F	Total
Peer influence	5	5	10
College professor/school teacher influence	3	7	10
IT-focused student club influence	4	5	9
Family or friend influence	2	1	3

Table 2: Code frequencies for themes relating to perception of the role of mentorship for careers in cybersecurity by gender

Our results suggest that the most important type of mentoring is the one that these students are getting from their peers. This is evidenced by the combined results in the "peer influence" and "IT-focused student club influence" categories, which both address types of influences from other students.

Peer influence is a great way of learning and teaching fellow classmates about technology in an informal and relaxed environment. Participants said:

"I think a lot of my mentors have been previous students, as well as people who are my peers right now."

"I don't know if it's more direct or indirect. I would say it's more indirect in just seeing what other people have accomplished so far and being able to talk to them and just getting some information."

"... and when you do trial and error with a partner and you finally figure it out. Just the feeling is... like, you know what you're doing now."

Mentorship from professors or school teachers also emerged as an important factor in helping students develop a grasp of professional roles and its expectations in real world settings. Students benefitted from learning from professors and seeking advice from them. Many of them were influenced by school teachers to develop an interest in cybersecurity in the first place. Participants illustrated this theme by saying the following:

"Two of my biggest mentors here at [university]... and those two have guided me and like taken me under their wing so to the point that I'm like, I feel prepared..."

"Not only does she care about her students in the classroom, but she also cares about her students outside of the classroom."

"...even with that, she gives you so many opportunities for internships, she'll setup tours, I mean like, she's just phenomenal if you're like, trying to do something with this major. Hands down."

"...um, I talk to him a lot about like getting into the FBI and what to expect."

Participating in a cybersecurity-focused club played an important role in developing confidence for these aspiring cybersecurity professionals. An opportunity to engage with experts in the industry or participate in competitions provide a unique perspective to students about the careers they are hoping to achieve. Participants noted:

"If you are not in [club name] yet and you think it's a sham, you're wrong."

"The connections that everybody has and I think after going and touring a couple of these places and touring with [club name], you learn that the field is more connected than any other field."

"... what you're not getting in the classes. It opens more for you."

Family and friends also play an informal but crucial role in shaping the perceptions and expectations of students from themselves and from the industry. A participant stated:

"One person told me that where the future is headed is IT security and that's the reason why I got into it."

It is clear that while many professors, teachers, family members, and friends were counted among the mentors identified by the participants, peer mentorship was key for them. A cybersecurity-focused student club was pivotal for many of the participants in achieving this high level of community and mentorship amongst their peers.

Differences between Men and Women

The third research question (RQ3) stated: What differences exist between men and women regarding the role of mentorship and challenges faced when pursuing a career in cybersecurity? This research question was analyzed by looking at themes for any underlying differences in male and female perceptions in terms of challenges and mentorship in cybersecurity careers. The focus was to understand if the participants see any difference in challenges for males vs. females or if they had preconceived ideas about male mentorship vs. female mentorship. Three themes emerged in this context: Gender not an issue for job tasks, More pressure on women to show confidence, and Gender unimportant for mentorship (see Table 3).

Themes for RQ3	M	F	Total
Gender not an issue for job tasks	3	6	9
More pressure on women to show confidence	3	2	5
Gender unimportant for mentorship	1	2	3

Table 3: Code frequencies for themes relating to gender differences in perceptions of challenges and the role of mentorship in cybersecurity by gender

When asked if gender differences were perceived in terms of job tasks in the workplace, participants, both males and females, agreed that there were no differences. These views were expressed by participants:

"My entire team, I am one of 3 males on a team of 18. Um, my manager is a woman, my manager's manager is a woman. Our security operations manager is a woman... I don't see any difference between males and females in the workplace at all." (Male participant)

"No, I've never been treated differently than a male would. Especially my internship or classes, nothing." (Female participant)

"...I don't think there's a gender, um, problem there. Again, women can be just as successful in this field as men can." (Male participant)

"I didn't see any difference between males and females in the workplace at all. Every single person's treated equally, completely, and we all get pretty much the exact same amount of work." (Male participant)

These results suggest that our participants' perception is that if there are women on the team, they are treated just like males on the team and given similar opportunities to take responsibilities. Even though these participants are primarily students that are yet to enter the workforce officially, most of them work as interns in the cybersecurity field and have observed and experienced a corporate environment closely. The women in the group did not feel discriminated based on their gender, in their limited experience in industry work culture. This is a healthy sign and shows promise for young generations feeling less burdened by gender stereotypes and more into direct competition with their peers irrespective of gender.

Despite this view, both male and female participants agreed that in similar roles in organizations, women feel more pressure to perform and deliver and be more confident in their day-to-day interactions than their male counterparts. Participant statements that illustrated this point included:

"I can only for myself, but you have to have that level of confidence and not even a sense of arrogance, but like a real sense of confidence within yourself saying I can do just as much as you if not more." (Female participant)

"...and the managers would always watch her closely and so she always felt like she had something to prove, which would always make her work harder." (Male participant)

"...but it's almost like they watch them more. Like they just watch the women more... to see if they are really better. Which, I don't think it should be like that, but that's just how it is." (Male participant)

It is interesting that even though these participants feel that all workers are treated equally irrespective of gender, they agree that the weight of expectations to succeed is far greater on a female worker than a male worker.

Results further suggest that males and females both feel that mentorship is important for their success, and that the gender of a mentor is unimportant. Many male participants shared their stories about being mentored by females at the workplace and in college. Similarly, female participants felt that as long as there is a mentor to guide them, it does not matter if it is a male or a female. Participants stated:

"I don't see a problem with it at all." (Female participant)

"I have no quarrels with gender." (Male participant)

The participants all experienced some level of mentorship at different stages from both male and female mentors.

5. DISCUSSION

Women make up only 20% of the cybersecurity workforce, which is up from 11% in 2013, (Richter, 2019) but still needs to be better in terms of involving more women in the field. There is lot of demand in the cybersecurity field

and the lack of women in IT overall and cybersecurity in particular, has created a gap in diversity that fails to capture women's perspectives. Lack of female participation in cybersecurity programs and careers is a broad-spectrum systemic problem that needs to be addressed.

The results of this study identify perceptions of cybersecurity students about challenges and the role of mentorship for cybersecurity careers. It is important to note that the results from this qualitative study are limited by the small population of participants and that the goal of this research is not to provide a generalized set of results for all cybersecurity students, but rather to gain a clearer understanding of the experiences and opinions of this group of participants in order to contribute to the overall understanding of the underlying issues. The themes suggest an awareness of women facing different expectations in general and are conscious about the differences. However, these results also show a generation of young students not much worried about typical stereotypes but expecting competency and skills as the main drivers of success.

A broader and inclusive approach may be required to address this gender gap. Frieze and Quesenberry (2019) in a case study about representation of women in computer science majors, concluded that cultural factors are more important than gender differences as an approach in understanding and fixing this problem. Creating a culture in an academic institution where women feel they have opportunities to pursue things that interest them in an amicable environment requires institutional support at many levels. A cultural approach considers the existing stereotypes and provides funding, opportunities, and guidance for women. There are strong women in the cybersecurity space already who need to be positioned in a way that their voices are heard. A female working as a cybersecurity leader can intentionally act as role model for a younger generation of girls (Gonzalez, 2015).

Recommendations

Based on the data and research literature in the field, the following recommendations are presented. These are prescriptive strategies that are grounded in the data-driven themes and provide guidance to practitioners and academic audiences for solutions to this problem.

Challenges were identified as a constant need to learn to keep up with the challenges of a rapidly

changing field, the challenging nature of the field that holds a high level of responsibility, and the perception that the field is male-dominated. Recommendations to address these challenges include:

- Provide constant learning opportunities for employees; e.g., training, conferences, seminars, formal education
- Consider job rotation for exposure to new methods and tools
- Promote teamwork and collaboration in order to alleviate some of the pressure in responsibility for individual cybersecurity professionals
- Highlight women in cybersecurity leadership positions inside and outside the organization
- Challenge stereotypes about cybersecurity jobs through reach-out programs for women and girls in the K-12 system

Perceptions about the role of mentorship were identified as the influence of peers, professors and teachers, family and friends, and cybersecurity-focused student clubs. Recommendations to address these perceptions and reinforce the mentorship roles seen as valuable by participants include:

- Create a positive environment for students to reach out and collaborate; Peers have a significant role in mentoring and promoting co-workers
- Provide opportunities for professors to become formal or informal mentors for students in cybersecurity
- Promote cybersecurity-focused organizations that allow students to interact with industry experts to provide context for learning
- Recognize that family and friends play an important role in influencing educational and career choices; Educate and interact with families of potential students

Mentors are important to both men and women who are starting out in the cybersecurity field. Mentors offer invaluable guidance on job decisions, degrees, and other specializations in the industry ("Mentorship", 2018). The relationship between mentor and mentee is one of mutual benefits. Mentors can learn from their mentees in terms of new applications and tools in the rapidly changing cybersecurity industry. There is also shortage of mentors to provide training and mentorship to young women, something that is essential for women to be attracted to the field (Gonzalez, 2015). It is crucial that the government continues to support STEM education through funds that are used to

train and develop mentorship programs. It is important to get young girls excited about cybersecurity in high school (Dampier, Kelly, & Carr, 2012) and for students to be mentored not only by faculty members but also by peers. The researcher's university has successfully created a Leadership and Mentorship program for women that provides great opportunities for mentorship by professors, industry experts, and peers. It also provides opportunities for the women in the program to mentor the freshmen cohort, as soon as they are juniors in their programs. It could be beneficial for programs like these to be focused specifically on the cybersecurity field.

Finally, differences between men and women regarding challenges for cybersecurity careers and the role of mentorship were explored. The findings indicate that gender is not an issue for job tasks, though there is more pressure on women to show confidence in the workplace. Findings also indicate that gender is unimportant for mentorship. Recommendations to address these findings include:

- Recognize that female employees have greater pressure to perform well and succeed in the workplace; Discuss gender expectations in the work environment openly for constructive dialogue
- Recognize that mentorship is a symbiotic process with mutual give and take, but gender of the mentor does not matter
- Refrain from special treatment for women to encourage participation, but rather promote a culture of equal opportunities; This will go a long way in correcting gender imbalance

6. CONCLUSION

There are many contributions of this study. It is a unique study about the perceptions of cybersecurity students regarding challenges in pursuing a career in their field and the role of mentorship in success in this field. The results contribute to the body of knowledge by providing insight into gender differences in the cybersecurity field as this is a relatively less explored area in research. These results can fuel several studies in this area.

Two results stood out to the researchers about the findings of this study. The first is that although there is a clearly identified gender gap in the field of cybersecurity, the participants in this study displayed an interesting mix of perceptions on this issue. They indicated that a challenge exists for women in that the field of

cybersecurity is perceived as a male-dominated field, and noted that their experiences also show that women need to show a higher level of confidence than their male counterparts in their day-to-day activities in order to be successful. These findings were consistent with previous research (Richter, 2019; Morgan, 2019; Higgins, 2018; Willis-Ford, 2018; D'Hondt, 2016). However, the participants, citing their own experiences via internships in the workplace, were also very clear that males and females were not treated differently in terms of job tasks, and that gender was not an issue in terms of team or management roles. There were no differing viewpoints on this issue between male and female participants in the study. This potentially speaks to a promising future as this new cohort of students completes college and moves into the workplace carrying less gender stereotypes and expectations of bias and more confidence that their own competency and skills will be the primary drivers of their success in the profession.

The second finding is in regard to the role of mentorship. Participants found mentorship to be valuable, which is consistent with the literature ("Mentorship", 2018; Frost & Sullivan, 2017; D'Hondt, 2016). However, they surprisingly cited peer mentorship as one of the driving forces in their success within their cybersecurity programs. This was recognized through informal peer relationships during classes at the university combined with the influence of a cybersecurity-focused student club that exposed students to a variety of industry experts, sites, and areas of research.

The main limitation of the study is that all participants are from the same university. More studies are needed that incorporate participants from multiple schools and other populations. Despite this limitation, this study contributes to practitioners in industry as well as academic administrators by recommending strategies to overcome the challenges identified and formalize mentorship initiatives.

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