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INFORMATION SYSTEMS EDUCATION JOURNAL

Editors

Invited Paper

What's in a name? Student preferences for cybersecurity-related major titles

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Abstract

There is a significant skill gap, with millions of cybersecurity jobs still needing to be fulfilled due to a lack of a trained workforce. Various academic programs are available that teach students in different aspects of cybersecurity. This paper investigates if the title of an IT program has any impact on the desirability of a program and if this impact differs based on gender, with a focus on cybersecurity majors. Two focus groups were conducted for data collection at two different universities, and participants were asked to rank order a variety of titles for cybersecurity programs. An interpretive thematic analysis technique was used to analyze the data. Our results suggest that cybersecurity is a preferred title for both men and women. Recommendations are provided, and implications are drawn.

Keywords: cybersecurity, workforce, skill gap, women in cybersecurity, focus group, thematic analysis

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What's in a name? Student preferences for cybersecurity-related major titles

Peter Draus, Sushma Mishra, Kevin Slonka and Natalya Bromall

1. INTRODUCTION

Cybersecurity job opportunities have grown over the last several years due to increased demand, a not-so-ready workforce, and a lack of students majoring in security-related degrees ((ISC)², 2021). The global cybersecurity workforce needs to grow by 65% to effectively defend organizations' critical assets ((ISC)², 2021). There is a need for more than 3.4 million security professionals worldwide, an increase of over 26% from 2021's numbers. Why do we have a shortage of skilled workforce when there are so many well-paying cybersecurity jobs available? The problem adding to the security gap remains the same: a disturbing increase in threat exposure to businesses, governments, and individuals worldwide from ever-evolving new threat vectors has fueled the growth of job opportunities in this field. The available potential workforce is not trained in cybersecurity skills to enter the job market.

Organizations are looking to academia to develop a strategy to recruit, train, and develop a pipeline of skilled cybersecurity professionals to address the significant talent gap. There are multiple cybersecurity programs at different institutions with the intent to educate young professionals in this domain. However, there needs to be more students in these programs to meet this unprecedented demand. Men and women should seek cybersecurity degrees to address the demand-supply gap in the near future. There are many reasons for the lack of interest in pursuing computer science and cybersecurity degrees. Many students need more math and science skills, making them unqualified for advanced programs in technology (Poremba, 2023). Cybersecurity requires high adaptability with this mix of technical and soft skills (Polmera, 2023). Academics need to address this unique combination of soft and technical skills. Another area that adds to this serious skill gap is a growing shortage of university professors willing and able to teach cybersecurity to students.

Women in cybersecurity have even lower representation than in other information technology fields. Microsoft's survey, conducted in 2021, suggests that men are more likely than women (21% vs. 10%) to feel qualified to apply for a cybersecurity job. In contrast, more women than men (27% vs. 21%) believe men are seen as a better fit for technology fields (Owen, 2022). The majority of women in this survey feel that there is gender bias in the industry that results in unequal pay and support (Owbe, 2022). Overall, women think they need more preparation to deal with a technical field like cybersecurity. Women who are unaware of the nuances of the cybersecurity domain typically regard those who work in the area as "nerds" or "hackers." On the other hand, those who have more awareness have a positive perception of such workers. These are consistent with broader perceptions of the file (Hoteit, 2022). These perceptions about cybersecurity are reflected in the choice of majors by men and women of college-going age. Therefore, it is essential to understand the perceptions of college-going men and women of cybersecurity programs available in academia.

This paper aims to understand how the title of a program in the cybersecurity field influences the desirability of a program and if there is any difference, based on gender, in the impact. The research questions posed by this study are:

RQ1: With a focus on Cybersecurity Majors, what impact does the title of a major have on the desirability of a program?

RQ2: With a focus on cybersecurity majors, are there differences, based on gender, in the way the title of a program impacts potential students?

The rest of the paper is organized as follows. A critical review of the research literature in the field follows this section. A description of the methodology section entails data collection and analysis description. A discussion section follows the methodology section. Implications of the study are drawn, and limitations are listed. The paper ends with a conclusion section.

2. LITERATURE REVIEW

The number of women earning college degrees is on the rise; however, in many IT professions,

women are significantly outnumbered by men. According to the research, cybersecurity is one of the fields where women are catastrophically underrepresented, with only 11% of female professionals worldwide and 14% in North America (D'Hondt, 2016). Cybersecurity professionals admit that the field needs to hire more women, who are not only a high-skilled resource, but also bring in a unique perspective of cybercrime targets (Poster, 2018).

The study of gender differences exists in nearly all fields. Whether one is practicing psychiatry and studying the effects of anxiety (Yang et al., 2021), analyzing real estate transaction negotiations (Andersen, 2021), studying leadership qualities (Alan, 2020), or uncovering intergenerational transmission of gender segregation (van der Vieuten et al., 2018), gender is a common demographic variable used in research.

When focusing specifically on STEM fields, women in STEM have been widely studied (Elliott et al., 2020; Collins & Steffen-Fluhr, 2019; Bird & Rhoton, 2021; Sendze, 2022). Some studies focus on gender representation in STEM fields (Stout et al., 2011), while others focus on the classroom environment and whether the composition of students affects females' interest in courses (Casad et al., 2019; Cheryan et al., 2009; Ramsey et al., 2013). Starr (2018) found that being stereotyped as a nerd or other labels affected the STEM identity of undergraduate female students. Even when women outperform male students, they are still looked upon as lesser than their counterparts (Bloodhart et al., 2020).

Research into specific areas of STEM has also been conducted. Understanding why the students choose a certain major and what the differences are between male and female students' perspective is extremely important for many reasons. For example, certain majors are traditionally considered male- or female-dominated, which impacts the students' decision to enroll in these majors. In an attempt to understand the roots of such gender preferences of various majors, researchers attempted to survey girls in middle and high schools and determine the factors that facilitate their decision to pursue a career in cybersecurity. For example, Jethwani et al (2017) demonstrate the importance of same-sex creative and collaborative settings with a dedicated female mentor in their study of adolescent girls in a STEM program. Similarly, many studies emphasize the importance of female mentors and role models (Horne, 2018).

Regarding the Information Systems (IS) major, the factors leading women to choose such a major have been shown to change over time (Hodges & Corley, 2017). Although females are introduced to STEM earlier in their education, they are not introduced to computing majors until much later (Snyder & Slauson, 2016) and require more mentoring and guidance to select a major that is the best fit (Mishra et al., 2014). A 14-year-old seventh grader adds the following to this discussion:

> 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).

Some studies, though, disagree on the benefits of earlier exposure to computing curriculum (e.g., Jung et al., 2017).

Although at some universities cybersecurity is found within the IS or Computer Science (CS) majors (Indiana University of Pennsylvania, n.d.), many have it as a standalone program (Robert Morris University, n.d.; Saint Francis University, n.d.). Despite this, there has not been much scholarly research into the previously identified issues focused on the cybersecurity major even though only 11% of the global cybersecurity workforce as of 2018 is women (Poster, 2018). Some students noticed that even though they perceived the field as being male-dominated, internships and shadowing showed that the playing field was even (Pinchot et al., 2020) as long as one enjoyed critical/analytical thinking and had an investigative mindset (Mishra et al., 2019). One additional factor could be that, with cybersecurity spanning both the IS and CS domains, a struggle between the extroversion of IS-minded students and the introversion of CS-minded students is at play (Reynolds et al., 2017). In any case, the reasons remain widely unknown and warrant additional research to fill this gap.

3. METHODS

Data Collection and Analysis

We chose focus groups as the data collection method in this exploratory study. This type of

study fits very well with the unstructured topic of study like the one in this research. In addition, focus groups typically result in various discussion topics brought up by the focus group participants. For our focus groups, we recruited students enrolled in similar cybersecurity courses at two universities: three focus groups. Each group had 15-20 students, mostly majoring in cybersecurity, cyber forensics, and similar areas. Both Graduate and Undergraduate students participated.

The first research question, specific to cybersecurity and related majors, "What impact does the title of a major have on the desirability of a program?" was represented as a main discussion question followed by a group of talking points. If someone mentioned a talking point during the panel discussion, we did not bring it up at a later point. If a talking point was not mentioned, we brought it up. For example, the lead question is followed by six talking points in the following group of questions.

Discussion question: What impact does the title of a major have on the desirability of the program?
- Do you think the program's title influenced your choice of a program?
- Please rank the following major titles in order of desirability (list provided)
- What made you rank the titles in the way that you did?
- Do you feel that the title of the program in which you are enrolled accurately represents the content of that program? If not, what do you feel was misrepresented?
- Do those misrepresentations affect your perception of the overall desirability of the degree program?

The second research question (Are there differences, based on gender, in the way the title of a program impacts potential students?) was answered by analyzing the respondents' demographics.

Each panel discussion was conducted and recorded by at least two researchers to avoid incorrect recording and sound issues. The Multiple researchers then transcribed the recordings the transcribed documents were put together in a master document. Each discussion segment was first used to identify the emerging themes, and then to map the subjects' statements to the themes.

As part of the discussion, the students were given a list of IT majors and asked to rank each major in terms of its desirability (1=most desirable, 12=least desirable). The names of the majors were obtained by analyzing the college major names and the IT job titles. As the result of this analysis, we came up with twelve majors that accurately reflect the list of the most common IT majors offered by the academic institutions.

4. RESULTS

Demographics

Data was collected from 53 individuals; the average reported age was 23.84, with the youngest being 19 and the oldest being 39. 86% of the subjects reported being full-time students. The rest did not respond. 43% of the subjects lived on campus, and 52% responded that they resided off campus. Further information, including the subjects, Year in school, Gender, and Current Major are listed in Tables 1, 2, and 3.

Year in School	Percentage
1	15%
2	8%
3	28%
4	36%
5 - Graduate	2%
No Response	11%

Table 1: Breakdown by Percent of Subjects by Year in School

Gender	Percentage
Female	25%
Male	68%
No Response	8%

Table 2: Breakdown by Percent of Subjects by Gender

Major	%
Cyber Security	72%
Cyber Security & Digital Forensics	13%
Computer and Information Systems	9%
Computer Science	2%
Cyber (security) and Criminal Justice	2%
MIS & Cyber Security Administration	2%

Table 3: Breakdown by Percent of Subjects by Major

Desirability of the program by the major titles

The data we collected suggested three emerging themes: (1) Cyber vs. CS, (2) Hands-on Experience, and (3) Accuracy of Representation (Table 4).

Emergent themes	
Theme 1: Cyber vs. CS	• The job market is too difficult for CS majors, there are too many of them and too much competition • Computer forensics should be more than just computers • Biased toward forensics as compared to other programs • Adding a forensics major impacted my major choice
Theme 2: Hands-on experience	• All IT classes need to be hands-on • There has to be a class/lab that gives students hands-on experience
Theme 3: Accuracy of representation	• The name of my major does not accurately represent what it actually is • Some majors have different names, but the course work is actually the same • It would help more to see the list of jobs applicable to each degree

Table 4: Major Title and Desirability of the Program

Surprisingly, the students did not mention any gender-related reasons in their decision-making, and gender factors did not show in any of the three themes. In fact, female students included a substantial group of international students who admitted that they did not have any discrepancy between male and female representation in IT jobs. The first theme reflects the deliberations between CS and other majors that the students perceive as more technical, and Cyber and similar fields are perceived as less technical (which is not always the case). Many panel participants (equally male and female) admitted that they had a particular interest in forensics, impacting their major choice. At the same time, several students emphasized that the forensics major should have just as much hands-on training as other IT majors and should be broadened to include not only the IT component but also legal, regulatory, and other components.

Discussion of hands-on training in computer forensics shifted to hands-on experience in all IT fields and led to Theme 2. Female students were not active in this discussion, but the male group considered it vital having more dedicated labs and providing more hands-on experience. The group of working students was especially vocal in this discussion.

Theme 3 emerged as the majority of respondents of both genders admitted that the major representation was either inaccurate in the title, or they had different expectations about the major, which changed after they enrolled. In such rapidly evolving fields as cybersecurity and computer forensics, the major titles change constantly to reflect the field. For example, in one of the participating institutions, the title of the major changed twice in the past five years. Being a slow process, curriculum development does not always catch up with these changes.

Major Rankings

Subjects were asked to rank possible names for their program/major. They were given a list of 12 options and were to rank them, with 1 being the highest. Results show a clear preference for the name "Cyber Security" with a mean ranking of 3.00, this also had the highest number of #1 rankings with 19. The closest mean to that was 5.16 for "Cyber Security and Forensics" which had the 2nd highest #1 rankings with 14.

Looking at the counts of the titles, shown in table 5, we find only two titles with the count of #1 ranking in double digits. The title "Cyber Security" had the second highest count for #1 with 14. The counts of the rankings for all of the proposed program names can be seen in Table 5, Appendix A. Just as "Cyber Security" and Cyber & Forensics" are obvious #1 choices, "Governance & Risk" and "Computer Engineering/Computer Security" had the highest number of the lowest rankings.

The mean rankings show a similar result with clear preferences for "Cyber Security" and "Cyber & Forensics", as shown in Table 6, Appendix A. This table shows the mean ranking for each proposed degree title and then the percentage of subjects who selected that title as their number 1 rank. The final column shows the percentage of subjects who chose that major title as their number 1, number 2, or number 3 ranking. Looking at the percentage of subjects who selected each title as their first choice and then the percentage who selected each title as their first, second, or third choice, we still get the same preferences. However, the difference between the top two is less when we include the top 3 choices.

Comparing the distribution of the counts for these top two choices, we see a difference in that "Cyber Security" has a high number of high rankings, while "Cyber & Forensics" has a flatter distribution and a cluster of lower rankings,

indicating a somewhat negative view of this name for the major (Figure 1 & Figure 2).

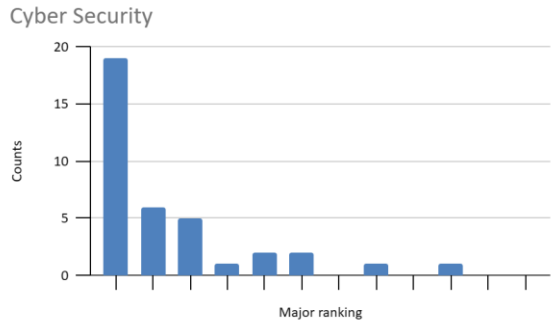

Figure 1: Cyber Security Rankings

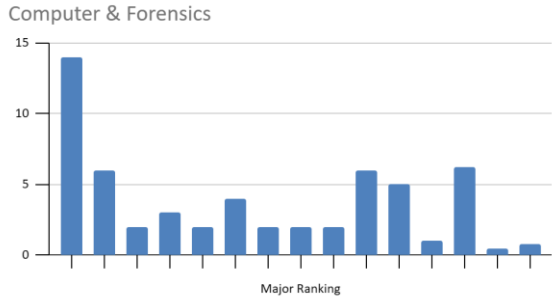

Figure 2: Cyber & Forensics Rankings

Not all subjects were currently enrolled in a Cybersecurity-related major; some subjects (N=6) who participated in the focus groups and ranking were in more generic Computer-related fields, such as CIS, Computer Science, or Software Engineering. A review of the data with only the Cybersecurity-related majors showed similar results. Table 7, Appendix A shows a reduced and consolidated set of data. The numbers were exactly the same as the overall numbers.

Looking at the subjects' current major title in comparison to their top rankings the results showed that of the 6 subjects not in a Cyber-related major, only 2 (33%) selected "Cyber Security" as their top pick. Of the remaining 46 students, 20 (43%) selected "Cyber Security" as their top pick. Of the 20 Cyber area subjects who selected the title "Cyber Security, most of them, 16 (80%) selected the same title, "Cyber Security" as their top pick. The majority of subjects who selected "Cyber Security" as their top pick (N=38) were not in a major with that title. (N=22/58%)

While only 13 subjects self-reported as women, 11 of those students were in a Cyber-related major. Table 8, Appendix A compares the rankings organized by Gender.

Mostly, the results are very similar across genders with one minor difference. The "Information Systems Security" title has the second lowest mean for women and, in fact, is very close to the mean ranking for the "Cyber Security" mean ranking, while zero men selected this as their top pick. Interestingly, none of the subjects had "Information Systems Security" as their current major title. Table 9, Appendix A shows the ranking of each title by the respective overall mean ranking score for all subjects and broken out by gender.

While the number 1 ranking is still the same across genders, the second and third-ranked titles are flipped by gender.

Looking at the distribution of the rankings for the "Cyber Security" and "Cyber and Forensics" titles (Figure 3 & Figure 4) by Gender we find clear differences in the distribution, even in the overall mean rankings were similar.

Figure 3: Cyber Security Ranking by Gender

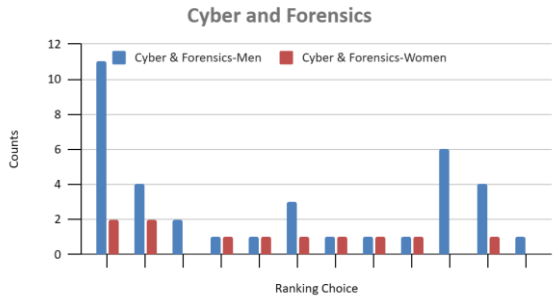

Figure 4: Cyber & Forensics Title by Gender

The biggest difference is the large higher (negative) rating of the "Cyber and Forensics" title by the men and a much less pronounced low (positive) ranking of "Cyber Security" by the women.

5. DISCUSSION

Students across two universities clearly preferred "Cyber Security" as a title for a major that covers this topic area. Out of 12 different titles, the mean ranking for "Cyber Security" was 3.0. Their second choice was "Cyber and Forensics" with a mean rank of 5.16. The third choice, "Information Systems Security" had a mean rank of 5.21. "Cyber Security" was the clear favorite. A look at the distribution of the rankings showed that "Cyber Security" had many high rankings, including 19 #1 rankings, and no low rankings, while "Cyber and Forensics" had almost as many high rankings (14) but had more low rankings. "Information Systems Security" had rankings clustered in the middle, with only 1 #1 ranking and no low rankings.

Most of the students were already in majors in this field. Most of the students, except those with the title "Cyber Security" selected a different major title than their own. The strength of this title goes beyond that of familiarity and brand identity for the students.

The word "Forensics" was in three of the majors listed. All three of those had some higher rankings, but also some much lower rankings. It appears that the word Forensics is a polarized word in the title. Interestingly enough, the title "Forensics" appeared to have much lower negative connotation with women than men. This resulted in a slightly higher (lower mean score) ranking of "Cyber and Forensics" for women than for men. "Information Systems Security" had a much higher ranking for women than men, resulting in it being ranked in second place for women instead of third place for me. While the overall ranking only changed one place, the overall means were different for this title by gender, with women ranking it at 3.09 and men at 5.40.

6. CONCLUSIONS

A survey across two universities of undergraduate and graduate students in Information and Security-related majors resulted in ranking data on 12 different major titles. "Cyber Security" was the clear preferred choice, even if it was a different title than the major they were currently enrolled in. A negative connotation for the word "Forensics" was evidenced with a stronger bias in men. While the program title is obviously not the only indicator of the desirability of the program, it does predict the program desirability. The marketing of such majors might be improved by focusing on this title.

Three themes emerged from an analysis of multiple focus group sessions; 1) Theme 1: Cyber vs. CS; 2) Hands-on experience; 3) accuracy of representation.

In our rapidly changing field, it is imperative that the titles of Majors keep pace with the changing vocabulary and connotations associated with old titles. The students are aware of the job market and the current requirements, as well as the titles of the most demanded job. They map these titles to the titles of the majors. For example, Cybersecurity was the favorite field, mainly due to the presence of the catchy word "cyber" in the title. At the same time, Information Systems Security popularity rankings were substantially lower. While there were slight differences in the rankings of some major titles by gender, overall there appears to be little gender bias in the titles of academic majors in this area.

Future research might look at hiring agents in the industry to see if similar bias and rankings exist.

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APPENDIX A

	Counts of the Ranking for each value											
Name	1	2	3	4	5	6	7	8	9	10	11	12
Cyber Security	19	9	7	3	2	3	2	2	1	1	0	0
Cyber Admin	1	3	8	7	1	5	5	5	5	3	2	3
Cyber Management	2	7	1	6	9	3	4	7	4	3	2	2
Cyber & Forensics	14	6	2	3	2	4	2	2	2	6	5	1
Digital Forensics	3	4	3	6	5	3	3	3	4	8	4	2
Computer Forensics	0	3	10	6	3	4	3	2	5	0	5	6
Information Security	1	3	7	6	6	7	7	4	3	3	1	0
Information Systems Security	1	5	5	6	8	9	8	2	1	2	0	0
Information Assurance	1	4	1	4	3	3	4	4	8	6	6	5
Govern, Risk	1	3	2	2	4	4	2	2	5	5	7	12
CS/CS	3	3	5	2	3	2	4	4	5	4	8	4
CE/CS	4	4	3	0	3	0	1	9	3	4	5	10

Table 5: Counts of ranking choices by Major title

	Name	Average	% #1	% #1-3
1	Cyber Security	3.00	38%	22%
2	Cyber Admin	6.29	2%	8%
3	Cyber Management	6.04	4%	6%
4	Cyber & Forensics	5.16	28%	14%
5	Digital Forensics	6.58	6%	6%
6	Computer Forensics	6.55	0%	8%
7	Information Security	5.69	2%	7%
8	Information Systems Security	5.21	2%	7%
9	Information Assurance	7.73	2%	4%
10	Govern, Risk	8.39	2%	4%
11	CS/CS	7.23	6%	7%
12	CE/CS	7.76	8%	7%

Table 6: Average rank and % of choices for #1 and #1 through #3 for Major

Name	Count of #1 picks	Mean	% #1	% #1-3
Cyber Security	19	3.0	38%	22%
Cyber & Forensics	14	5.16	28%	14%
Information Systems Security	1	5.21	2%	7%

Table 7: Comparison of Cyber Security, Cyber & Forensics and Information Systems Security rankings

Proposed Program	Average		%#1		% #1-#3	
Title	Male	Female	Male	Female	Male	Female
CE/CS	7.77	7.11	8%	9%	6%	10%
Computer Forensics	6.54	6.60	0%	0%	9%	8%
CS/CS	7.11	6.80	6%	9%	7%	8%
Cyber & Forensics	5.33	5.09	31%	18%	16%	10%
Cyber Admin	6.40	6.55	3%	0%	7%	5%
Cyber Management	6.31	6.09	3%	9%	6%	3%
Cyber Security	2.69	3.80	39%	36%	25%	15%
Digital Forensics	6.75	5.90	8%	0%	6%	8%
Govern, Risk	8.83	7.55	0%	0%	3%	5%
Information Assurance	8.17	7.00	0%	9%	2%	8%
Information Security	5.77	5.36	3%	0%	6%	10%
Information Systems Security	5.40	3.90	0%	9%	6%	13%

Table 8: Mean Major Title Rankings and % selected as top and top 3 by Gender

Proposed Program	Mean			Rank		
Title	All	Male	Female	All	Male	Female
Cyber Security	3.00	2.69	3.80	1	1	1
Cyber & Forensics	5.16	5.33	5.09	2	2	3
Information Systems Security	5.21	5.40	3.90	3	3	2
Information Security	5.69	5.77	5.36	4	4	4
Cyber Management	6.04	6.31	6.09	5	5	6
Cyber Admin	6.29	6.40	6.55	6	6	7
Computer Forensics	6.55	6.54	6.60	7	7	8
Digital Forensics	6.58	6.75	5.90	8	8	5
CS/CS	7.23	7.11	6.80	9	9	9
Information Assurance	7.73	8.17	7.00	10	11	10
CE/CS	7.76	7.77	7.11	11	10	11
Govern, Risk	8.39	8.83	7.55	12	12	12

Table 9: Mean Rankings by Gender and Overall Rankings by Gender