



Computing Specializations: Perceptions of AI and Cybersecurity Among CS Students



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Problem Statement



High demand for AI & cybersecurity

- More positions require AI and cybersecurity skills than there are individuals to fill them [Cyberseek 2022, LinkedIn Talent Solutions 2022]
- There is a gap in our understanding of how students choose to specialize in these fields

Need for broadening participation

- Patterns of underrepresentation exist in the AI and cybersecurity workforce, leading to a loss of potential contributions
- Student perceptions of AI and cybersecurity may deter them from pursuing these fields



Research Question



How do undergraduate computing students perceive AI and cybersecurity?

Methods



- **Participants:** 17 undergraduate CS majors/minors (given pseudonyms)
- **Protocol:** Interview questions such as whether they are interested in AI/cybersecurity classes, what people do in those jobs, and whether the field can help society
- **Analysis:** Qualitative coding of interview transcripts to identify themes and variation

1: Students have preconceived notions about **who can do** AI & cybersecurity



- Even students who haven't taken courses in AI or cybersecurity seemed to believe...
 - Only very smart people can work in these fields
 - Cybersecurity is largely for men

1: Students have preconceived notions about **who can do** AI & cybersecurity



Interviewer: “What type of person do you think would be encouraged to pursue AI?”

Idris: “Um, in my experience, it’s definitely been like... it’s usually people who have, who already have the resources and, you know, they've been coding for ages and like, they know all the software things.”

1: Students have preconceived notions about **who can do** AI & cybersecurity



Interviewer: “What stereotypes have you heard about the people who work in security?”

Gail: “Security? I heard it’s very male-dominated... I guess, which is also the reason why I’m like, not really want to go into it [*sic*].”

1: Students have preconceived notions about **who can do AI & cybersecurity**



- This matters because these ideas could **deter students from pursuing AI and cybersecurity**. Previous research has shown that...
 - Beliefs in “innate brilliance” negatively correlate with the number of women PhDs [Leslie et al. 2015]
 - “Masculine culture” contributes to the gender gap in STEM fields [Cheryan et al. 2017]

1: Students have preconceived notions about **who can do** AI & cybersecurity



- What would you do in your classrooms to mitigate the impact of these preconceived notions?
 - Please put some ideas in the chat!

2: Students' notions about AI & cybersecurity work are **not always accurate or complete**



- Student beliefs are narrow and do not represent the breadth of these fields. Our participants suggested that...
 - AI work is “training models”, but students are vague about what this means
 - Cybersecurity work entails low-level, systems programming

2: Students' notions about AI & cybersecurity work are **not always accurate or complete**



Interviewer: “What do you think the day-to-day work of someone who does AI looks like?”

Parth: “At the company [internship] I worked for... the whole thing is about like machine learning... One of the engineers there told me... they’re developing some model or something or the other with machine learning... and then they train it and then they try to vary the parameters of that model to best fit it. And then they call it a day.”

2: Students' notions about AI & cybersecurity work are **not** **always accurate or complete**



Interviewer: “Do you have any stereotypes in mind of the kind of people who work in security?”

Nora: “I would say your work is maybe really tedious. That's just what I think. ‘Cause I think system programming are always really time consuming and tedious.”

2: Students' notions about AI & cybersecurity work are **not always accurate or complete**



- This matters because students make decisions on what to pursue based on these **incomplete notions**
 - Students may not be aware of the breadth of cybersecurity roles which exist, such as “Cyber Legal Advisor” [NICE Framework]
 - Students from historically underrepresented groups were less interested in an AI course because of their perception of its content [Barretto et al. 2021]

2: Students' notions about AI & cybersecurity work are **not** **always accurate or complete**



- What would you do in your classrooms to mitigate the impact of these inaccurate or incomplete notions?
 - Please put some ideas in the chat!

3: Beliefs about the **impacts** of AI & cybersecurity may **deter students** from pursuing these fields



- Students seemed to think critically about the potential societal impacts of AI and cybersecurity:
 - AI can be used for societal impact, but not always in a positive way
 - Cybersecurity was often associated with adversarial “hacking”, but was also considered useful in modern society

3: Beliefs about the **impacts** of AI & cybersecurity may **deter students** from pursuing these fields



Interviewer: “Do you think there are any stereotypes about AI people that you've heard?”

Henry: “I don't know if it's really a stereotype, but there's a lot of negative effects that AI can have, whether it's like reinforcing prejudice on Google and stuff or like Tesla self-driving cars running into people, but yeah, there's a lot of moral gray areas when it comes to AI.”

3: Beliefs about the **impacts** of AI & cybersecurity may **deter students** from pursuing these fields



Interviewer: “Are there any stereotypes that you've heard about people who work in cybersecurity?”

Lillian: “I guess one thing was maybe they work for the government or something or some kind of scary organization.”

3: Beliefs about the **impacts** of AI & cybersecurity may **deter students** from pursuing these fields



- This matters because prior work suggests that **these beliefs do deter students** from computing
 - Students tend to pursue careers and fields if they align with their goals, such as benefiting society [Diekman et al. 2010]
 - The goal of benefiting society is more often endorsed by students from historically underrepresented groups [Isenegger et al. 2023]

3: Beliefs about the **impacts** of AI & cybersecurity may **deter students** from pursuing these fields



- What would you do in your classrooms to mitigate the impact of these beliefs regarding societal impacts?
 - Please put some ideas in the chat!

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Broadening participation in AI and cybersecurity requires us, as practitioners, to work to dismantle prevalent stereotypes about computing.

Thank you for your attention!

Comments and questions are welcome at vojha3@illinois.edu

Spoiler: Takeaways



- Students have preconceived notions about **who can do** AI & cybersecurity
- Student preconceptions about AI and cybersecurity work are **not always accurate or complete**
- Student beliefs about the societal impacts of AI and cybersecurity may **deter them from pursuing these fields**

Prior Research



Students choose specializations largely based on their experiences in courses

[Hewner 2014]

Students may not have clear conceptions of AI and cybersecurity before taking a course

[CloudPassage 2016, Kreinsen & Schulz 2021, Ottenbreit-Leftwich et al. 2021]

CS stereotypes include the need for innate brilliance, the inability to have a positive impact on society, and a masculine culture

[Diekman et al. 2010, Lewis et al. 2011, Cheryan et al. 2017]

Methods: Coding (Saldaña 2021)



Descriptive coding

- Word or phrase identifying the literal topic of the excerpt
- E.g. a participant sharing that they've "*felt a sense of intimidation*" in cybersecurity was coded as "*perceptions of cybersecurity / intimidating*"

Concept coding

- Word or phrase identifying the bigger picture behind the excerpt
- E.g. a participant discussing their perception that "*AI is kind of a buzzword*" was coded as "*perceptions of AI / cool/popular*"

Implications & Future Work



- Our work suggests that interventions are needed **outside of classrooms**
 - because not all students will elect to take an AI or cybersecurity course
- Interventions could...
 - Expose students to a breadth of career options
 - Challenge existing stereotypes