Students' Complex Perspectives on Diversity—A Mixed Methods Pilot Study

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ABSTRACT
Cybersecurity is a growing area of need in the technical workforce. But while the field of cybersecurity is expanding, only certain populations are entering the field. Research indicates that, like most technical fields, the inclusion and diversity of various underrepresented populations in cybersecurity is beneficial. Sometimes, however, the call for diversity in computing can be complicated, as diversity is a complex concept. While most of the research on diversity in computing focuses on gender and race/ethnicity, some interpret diversity in other ways. Undergraduate students are stakeholders in the assessment of cybersecurity as a diverse and inclusive subfield of computing--as they may or may not consider these concepts as they make curricular and career decisions. A goal of the study is to enrich our understanding of diversity perspectives in the field, and so we sought complexity of interpretation over a narrowing or codifying of viewpoints. Data for this piece come from three sources: Q-sort rankings, group interview transcripts, and individual interview transcripts. Q-sort rankings from 16 high-achieving scholarship students at 2 Hispanic Serving Institutions (HSI) are analyzed with a focus on diversity statement patterns. Student Q-sort responses were matched with qualitative data in the form of group and individual interviews. Results indicate that the concept of diversity in cybersecurity is complex, that students in the field prioritize diversity (or do not prioritize it) in myriad ways, and that conceptions of “diversity, equity, and inclusion” are opaque.

KEYWORDS
Diversity Equity, & Inclusion, Gender Diversity, Learning Environment, Mixed Methods, Student Perceptions, Cybersecurity

Introduction

The demand for cybersecurity professionals is rapidly growing as computing companies continue to develop and evolve. But while the field of cybersecurity is expanding, only certain populations are entering the field. As illustrated in Table 1 [1], only 9% of Blacks and 4% of Hispanics hold cybersecurity jobs, even though they comprise 13% and 19% of the population, respectively. Furthermore, while women make up half the population, only one-fourth are employed in the cybersecurity field.

Table 1. Race/Ethnicity and Gender of Population and Cybersecurity Workforce

Race/Ethnicity and Gender of Employees	**Percentage of Population**	**Percentage of Cybersecurity Workforce**
Asian	6	8
Black	13	9
Hispanic	19	4

American Indian, Alaska Native or Native Hawaiian	2	1
Women	51	24

Research indicates that the inclusion and diversity of various underrepresented populations in cybersecurity is beneficial. For example, companies with diversity in gender are financially successful, productive, and have strong team dynamics [2]. More specifically, cybersecurity organizations need diversity in their workforces to develop innovative and inclusive ideas, tackle issues in different ways, and address global cyber threats [3].

Sometimes, however, the call for diversity in computing can be complicated, as diversity is a complex concept. While most of the research on diversity in computing focuses on gender and race/ethnicity, some interpret diversity in other ways. For example, several scholars argue that it is important to expand the definition of diversity to include other demographic factors such as disability, age, parental status, and religion [4, 5]. In addition, others discuss other aspects to diversity such as viewpoints and perspectives [6], and "embodied diversity" that emphasizes the importance of body and emotion in affective responses [7].

Furthermore, research indicates that many discuss diversity issues using "colorblind discourse," which disregards race and racism [8]. In particular, a study by Goode et al. [9] that focused on computer science teachers revealed that when talking about race, some avoided the conversation or dismissed racism impacts. While the colorblind ideology centers on treating individuals equally, they are not considering the importance of multiculturalism, which emphasizes and celebrates diversity and cultural differences.

Regardless of these challenges, there has been some progress for diversity of underrepresented groups in cybersecurity. Some organizations support these groups in various ways, including supporting underrepresented populations through training, employment assistance, mentorship and networking opportunities, and scholarships (see Table 2) [10].

Table 2. Organizations Supporting Diversity in Cybersecurity

Organization	**Supports**
Secure Diversity [11]	Supports women/minorities in finding cybersecurity roles
Women in Cybersecurity [12]	Provides mentorship and networking opportunities to women in cybersecurity
Black Cybersecurity Association [13]	Provides career training and mentoring to Black cybersecurity students and professionals
Minorities in Cybersecurity [14]	Offers leadership development opportunities and resources to underrepresented groups in cybersecurity

Cyversity [15]	Offers career resources, trainings, and scholarship opportunities to underrepresented groups in cybersecurity
Women's Society of Cyberjutsu [16]	Provides career training, mentoring, and leadership opportunities to women in cybersecurity
Women in Security and Privacy [17]	Provides resources, mentoring, and leadership opportunities to women in the privacy and security fields

Purpose

The purpose of this study was to explore the ways in which students prioritized (or did not prioritize) diversity in the field of cybersecurity through their sorting of statements into a fixed structure. The Q-sort method was used [18], as it is a context-sensitive methodology that emphasizes understanding complexity and variety in patterns of responses and uses forced choice to compel respondents to order statements in terms of negative (in this case, 1) and positive (in this case, 7) regard. Q-sorts have been used in studies of careers [19], education [20], and perspectives on student diversity [21].

The numeric Q-sort results anchor the study of diversity perspectives in cybersecurity, and the data are supplemented with focus group and interview data to assist in the interpretation of response patterns. The goal of the study is to enrich our understanding of diversity perspectives in the field, and so we sought complexity of interpretation over a narrowing or codifying of viewpoints [22]. The research questions that drive the study are: How do students conceptualize diversity in the field of computer science? Which elements of diversity do students prioritize, and in what ways?

Methods

Data for this exploratory research study come from three sources: Q-sort rankings completed by student participants, group and individual interview transcripts that occurred following the Qsort activity, and individual interview transcripts (when applicable) that occurred as part of the annual research data collection for the NSF program. Participants from this study participate as S-STEM scholars in a collaborative National Science Foundation (NSF) grant serving students from two four-year institutions in the same state. One institution (Institution A) is described on the Carnegie classification structure as a "Four-Year, Full-Time, Selective, Lower Transfer-In" institution. The institution is predominantly male (more than 70% male) and white, though its institutional enrollment of Hispanics reach approximately 30%. The enrollment diversity of the computer science department is not at parity with the enrollment of the institution—it is predominantly white and male, and these demographics are apparent in our demographic data, below.

The second institution (Institution B) is designated by Carnegie as "R2" and described in terms of undergraduate student body in this way: "Four-Year, Full-Time, Inclusive, Lower Transfer-In." Demographic information from grant-related documentation (rather than from self-report) for responses used in the Q-sort portion of the study appear below in Table 3.

Table 3: Demographic Descriptions of Participants

Intersectional category of demographic markers	**Number**	**%**
Caucasian female	0	0
Caucasian male	6	43%
Hispanic/Latino (male)	4	29%
Hispanic/Latina (female)	2	14%
Asian Male	1	7%
Asian Female	0	0%
African American female	1	7%

Research participants included in this case study were those who completed the Q-sort task as instructed, with sorts placed in the "fixed" settings of an inverted triangle, with the assigned number of statements in the categories as directed. Q-sort participants were recruited in person during a site visit the researcher held at each institution. While 25 completed the task, only 16 did so in the way that fit within the fixed categories necessary for implementing the Q-sort analysis as designed, and so they remained in the initial data set for analysis. For example, participant Q-sorts that were ineligible for the analysis would choose 6 items for "strongly disagree," rather than 3 (such as in Figure 1) and were not conforming to the model that the KADE software requires. Fourteen of these respondents had Q-sort patterns that fit into a factor with a 0.50 correlation or higher.

Q-sort collection and analysis

Q-sort is a context-sensitive methodology that makes meaning of patterns of responses of different individuals, rather than making meaning at the item level. The goal of a Q-sort is to better understand the spectrum of responses from multiple respondents rather than to measure how items fare compared to one another. In this study, the Q-sort statements related to multiple facets of cybersecurity, from its inclusion of differing groups to its academic rigor to its emphasis on policy. The full list of statements was developed based on curricular guidelines and job information, and then vetted by cybersecurity faculty involved with the project. A resource used to develop the concept statements was the National Institute of Standards and Technology (NIST) cybersecurity framework (https://www.nist.gov/cyberframework). The full list of statements can be found in the Appendix.

Q-sorts were completed using slips of laminated paper, which were shuffled by each participant until they were satisfied with the way the statements captured their beliefs about cybersecurity. When a participant did not line the statements in the prescribed format (3, 4, 5, 6, 5, 4, 3, see figures for visual representation), they were asked to restructure their responses. Not all

respondents were willing to place the statements in the prescribed format after prompting. Videos of each Q-sort were captured, with the participant information stated orally to match data to other sources. The Q-sorts were processed using the free software Qsortware—this involved entering the statements from each video into the web-based Q-sort product [23]. Once the data was entered into a matrix, the data was imported along with the statements into the free software KADE [24]. The Q-sorts were run on all statements with 16 participant rankings. Multiple models were tested for fit—the model utilized with these 16 respondents had 3 factor loadings. The full Q-sort analysis is pending [25].

For the purposes of this study of students' perceptions of diversity in cybersecurity, we emphasize the placement of four statements in relation to other statements in the Q-sort statement list that relate to other elements of cybersecurity as a field, such as its relationship with government, its rigor, its emphasis on research, and other elements of the field. We acknowledge that demographic diversity has many additional features (e.g., sexuality, financial need, socioeconomic status)—we imagine a fuller list of diversity items would improve future work. See statements used in this pilot study below.

- Diversity is important in Cybersecurity. (#27)
- Cybersecurity is a field where people of all genders could feel valued. (#28)
- Cybersecurity is a field where people of all ethnicities could feel valued. (#29)
- Cybersecurity is a field where people of all US residency statuses (citizens, undocumented individuals, permanent residents) could feel valued. (#30)

This paper does not address in detail how students prioritize other statements about cybersecurity—instead, it focuses on how students prioritize ideas about diversity among many other relevant ideas. The relative prioritization may provide a nuanced understanding of how undergraduate students make sense of diversity in the field when social desirability of responses is mitigated through forced choice [26].

Individual and Group Interviews: Collection and Analysis

Upon completion of the Q-sort activity, participants were asked to answer questions in a semi-structured interview that related first to their experience of the Q-sort and next to their understanding and experiences with cybersecurity more generally. The interviews were group or individual, based on the self-selected timeslots of interviewees—in all, five participated in individual interviews and 17 in group interviews of 2 to 5 people.

Individual telephone interviews supplemented the data collected from Q-sort data and focus groups that occurred following Q-sort completion. Individual interviews are requested annually from each S-STEM scholar to discuss program activities, support, and student progress in their academic and career pathway. Multiple requests are made annually, with support from program coordinators and faculty to contribute to the research project. A total of 18 programmatic interviews were available for the 16 key participants for whom we had Q-sort data in the correct

format for analysis. An additional question regarding diversity was added to the protocol for the 2022 data collection: The NSF, which funds this scholarship program values diversity in computing. Have you noticed ways that your department may also value diversity?

All interviews were recorded, and the recordings were transcribed using a transcription service (rev.com). The transcriptions were uploaded to Dedoose, a qualitative analysis program. All interview transcripts were read for passages related to the themes of diversity, equity, inclusion, as well as to the lack of these features (e.g., bias, stereotype threat, microaggressions). Each relevant interview passage was sorted by individual, so that responses were viewed in relation to the factor with which the individual had the highest correlation.

Our first pass at coding, which was an open coding process where themes were derived *close to* the data, led to a first set of codes (e.g., "diverse populations are not present in cybersecurity," "cybersecurity is a 'diversity neutral' career path,") these codes were combined using axial coding processes [27] that collapses themes under larger categories. In this case, some of the second stage codes were "diversity of thought," "diversity through demographic characteristics," and "valuing diversity as a societal good."

Our analysis was designed to look for confirming and disconfirming evidence of students' perceptions of (and their perceptions of the need for) diversity in cybersecurity. While the Q-sort analysis creates categories among participants' responses, our goal was not only to label patterns of response related to diversity, but also to unearth the complexity inherent in social factors work. Qualitative data are used to further interpret Q-sort categorical findings. While we utilize categories via the Q-sort to describe differing points of view, we problematize the discussion of diversity by including qualitative data regarding participants' perceptions of diversity.

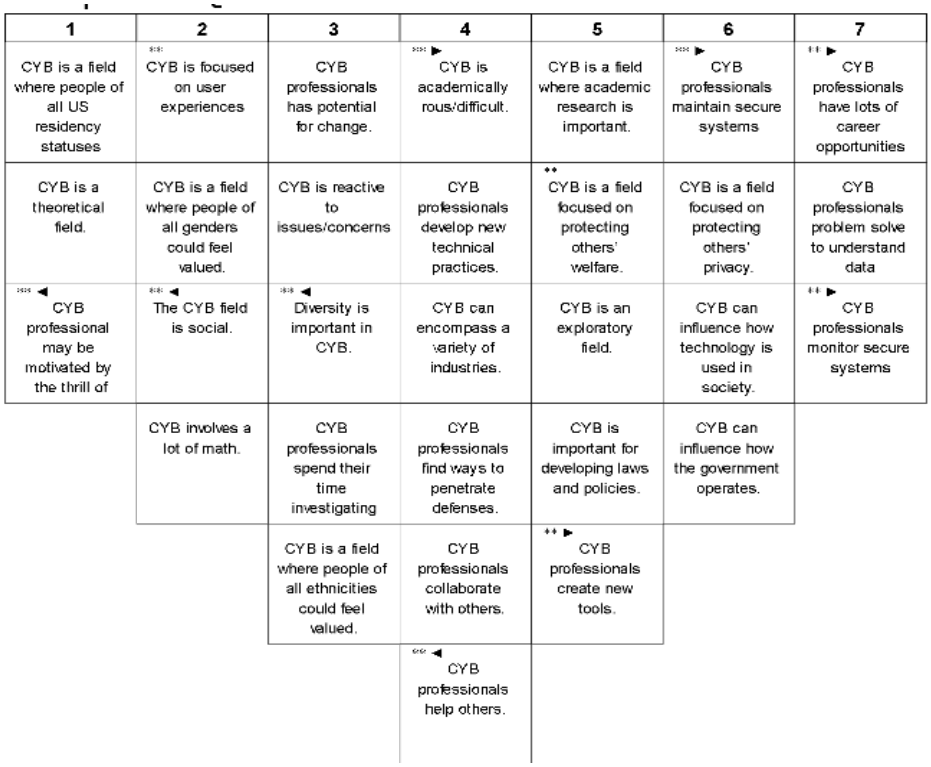
Results

Three patterns emerged in the factors that relate to diversity items, that align to the factors or subsets of Q-sort participant responses. In this paper, we summarize the initial patterns of priorities as they relate to diversity—in our other work we detail the patterns of responses across all content areas. Participants were selected into the factor if their factor loading score was greater than 0.50—the range of factor loadings was from 0.53 to 0.70. Two participants were not placed in a specific factor, because none of their factor loading scores reached the 0.50 threshold.

Factor 1: Diversity "neutral"

The first factor, or subset of Q-sort responses that show a statistical similarity, includes six respondents. The group of respondents aligned with factor 1 have limited patterns that relate to diversity. The group is not likely to place high importance on statements of diversity, nor do they disagree strongly, on the whole, with statements that relate to diversity. The statement "diversity is important in cybersecurity" was statistically different from the other groups as it was scored with a neutral 4 out of 7. Instead, the concepts that connect them are related to the relationship between cybersecurity and government applications as well as monitoring and maintaining secure systems. The composite Q-sort for factor 1 participants appears below.

Figure 1: Q-Sort Composite Responses for Factor 1



1	2	3	4	5	6	7
CYB is a field where people of all US residency statuses	CYB is focused on user experiences	CYB professionals has potential for change.	CYB is academically rous/difficult.	CYB is a field where academic research is important.	CYB professionals maintain secure systems	CYB professionals have lots of career opportunities
CYB is a theoretical field.	CYB is a field where people of all genders could feel valued.	CYB is reactive to issues/concerns	CYB professionals develop new technical practices.	CYB is a field focused on protecting others' welfare.	CYB is a field focused on protecting others' privacy.	CYB professionals problem solve to understand data
CYB professional may be motivated by the thrill of	The CYB field is social.	Diversity is important in CYB.	CYB can encompass a variety of industries.	CYB is an exploratory field.	CYB can influence how technology is used in society.	CYB professionals monitor secure systems
	CYB involves a lot of math.	CYB professionals spend their time investigating	CYB professionals find ways to penetrate defenses.	CYB is important for developing laws and policies.	CYB can influence how the government operates.	
		CYB is a field where people of all ethnicities could feel valued.	CYB professionals collaborate with others.	CYB professionals create new tools.		
			CYB professionals help others.			

A student from factor 1 responded to a question about diversity in a one-on-one interview. He described his perspective of his undergraduate department this way:

"I just treat people like they're normal human beings like any other person. And I think the rest of the department does the same. I haven't seen any... Then again, I am a straight White dude, and I haven't seen any sign of bias or racism or anything, any bigotry like that. ... I don't care what you identify as just be a nice person."

-White male, Institution B

In describing the way the computing department addresses diversity, the respondent indicates a neutral stance, in which the ways individuals may have differing demographic markers was not important, and "treating people like normal human beings" was valued. This statement reflects the "colorblind" approach to diversity, in which differences are not acknowledged, with the emphasis on treating people "normally."

A second student whose responses aligned with factor 1 communicated the view that diversity was somewhat important, but that forcing inclusion was not a useful approach, from the respondent's perspective.

"I put "Diversity is important" - near the top because I feel the actual work produced is valued more than just what your race is. It's important to be inclusive, but it's not important to force inclusion, if that makes sense. So it's still important, but it's not the most important thing in the field."

-African American female, Institution A

For the second respondent, there is some inherent value in diversity, yet other aspects of the field of cybersecurity were more salient, in the respondent's view. The quote also shows a reticence to "force" inclusion in the field.

Factor 2: Inclusion Conscious

The second factor includes five respondents. The ranking pattern of statements that distinguishes them from other factors are the items related to diversity examined in this study—for this group, the statements were listed with the highest number of points, greatest agreement, or highest priority among the statements. Three of the four statements were distinguishing statements of this group, meaning the pattern of these statements' rankings (along with nine other statements) helped define the group as different from others in the dataset. The other items that are more highly rated for this group than for others relate to the role of cybersecurity in improving society. The composite sort for this factor appears below. One Q-sort participant in group 2 placed all four diversity items in the highest two priority categories. In his justification of his selections, he describes the importance of diversity for solving complex problems.

"I put "Diversity is important" near the top because… if you have three of me looking at the same thing, I'll only find what I find. But if you have three totally different people looking at it, then they'll come at it from different angles and find more things."

White male, Institution A

In this quote, the student describes the importance of difference among the members of a team working on a problem, as difference can increase the efficacy of the team to view more angles of the problem. In this statement, it is unclear what type of difference is desired—there is a lack of clarity regarding whether demographic diversity, diversity of thought, or a combination of the two would be expected to lead to better problem solving.

Composite Q sort for Factor 2

1	2	3	4	5	6	7
CYB professionals spend their time investigating	CYB professional may be motivated by the thrill of	The CYB field is social.	CYB is a field where academic research is important.	Diversity is important in CYB.	CYB professionals help others.	CYB is a field where people of all genders could feel valued.
CYB involves a lot of math.	CYB professionals create new tools.	CYB is reactive to issues/concerns	CYB professionals problem solve to understand data	CYB professionals has potential for change.	CYB is a field focused on protecting others' welfare.	CYB is a field where people of all ethnicities could feel valued.
CYB is focused on user experiences	CYB professionals find ways to penetrate defenses.	CYB professionals monitor secure systems	CYB professionals develop new technical practices.	CYB professionals collaborate with others.	CYB is a field where people of all US residency statuses	CYB can influence how technology is used in society.
	CYB is a theoretical field.	CYB professionals maintain secure systems	CYB can influence how the government operates.	CYB is important for developing laws and policies.	CYB professionals have lots of career opportunities	
		CYB is academically rous/difficult.	CYB is an exploratory field.	CYB is a field focused on protecting others' privacy.		
			CYB can encompass a variety of industries.			

Figure 2: Composite Q-Sort for Factor 2

A second Q-sort participant in factor 2 described how diversity of ethnicity and gender can influence cybersecurity because people have differing experiences on the internet.

"I think it's important because people of different ethnicities and genders can have different experiences on the internet, good to bring all different kinds of people to the table."

Hispanic female, Institution A

The second quote brings the notion that demographic diversity through ethnicity and gender would in fact lead to differential experiences in the internet, and that those differential experiences would be beneficial in the field of cybersecurity. A third participant in factor 2 stated the importance of representation of different ethnic, country of origin, and gender identities in the field. The participant was describing choices related to citizenship, ethnicity, and gender in the high priority categories in this way:

"So, I think it's very important to, especially now that I'm in CS, I see a lot of... I don't know. I would never picture myself being a Hispanic woman in the CS field, so I think it just really caught my eye. It just comes to my attention when I see like, 'Oh, look at this person. He's from a whole different country.' And I think that's very important for me."

Hispanic female, Institution B

The above participant indicates the importance of diversity in the field to her, as a Hispanic woman in the field. The statements related to gender, ethnic, citizenship, and a general "diversity" statement were all important for her to consider in the field. Another participant whose responses led to a factor 2 categorization had a different view on the importance of diversity. While the participant sorted the "ethnicity", "gender", and "citizenship" item as high priority, the generalized diversity item was sorted low in priority.

"Cybersecurity is a field where people of all ethnicities could feel valued... everybody can use cybersecurity. Diversity is not necessarily important to cybersecurity. It'd be nice but not a necessity. I don't think viewpoints or different cultures really matter much, we're all using the same system."

Asian male, Institution A

In this participant's view, generalized concepts of "diversity" did not hold much weight, yet the sorting of specific statements about markers of demographic diversity through gender, ethnicity and citizenship were highly ranked. The assumed neutrality of the systems used to secure technology meant diversity was not seen as a value to the participant.

Factor 3 Diversity of thought

The third categorical factor includes three respondents. This factor regards "Diversity is important in cybersecurity" as a highly ranked statement – it is listed in the top three of the aggregate Q-sort for the factor. However, this group distinguishes the abstract notion of diversity from demographic diversity—in fact, #30 (residency) and #28 (gender) are slated in the 'least agree' column, and this placement defines the group—these statements are distinguishing statements of factor 3. See composite Q-sort.

Composite Q sort for Factor 3

1	2	3	4	5	6	7
CYB is a field where people of all US residency statuses	CYB involves a lot of math.	CYB professionals spend their time investigating	CYB is important for developing laws and policies.	CYB is a field focused on protecting others' privacy.	** ▶ CYB professional may be motivated by the thrill of	** ▶ CYB is focused on user experiences
* ◀ CYB professionals monitor secure systems	CYB professionals create new tools.	CYB professionals maintain secure systems	CYB can influence how the government operates.	CYB can influence how technology is used in society.	** ▶ CYB is reactive to issues/concerns	CYB professionals problem solve to understand data
CYB is a field where people of all genders could feel valued.	CYB is a field where people of all ethnicities could feel valued.	* ◀ CYB is a field where academic research is important.	CYB can encompass a variety of industries.	CYB professionals develop new technical practices.	Diversity is important in CYB.	** ▶ CYB is an exploratory field.
	CYB is academically rous/difficult.	CYB is a theoretical field.	The CYB field is social.	CYB professionals have lots of career opportunities	CYB professionals help others.	
		** ◀ CYB is a field focused on protecting others' welfare.	CYB professionals has potential for change.	CYB professionals collaborate with others.		
			CYB professionals find ways to penetrate defenses.			

Figure 3: Composite Q-Sort for Factor 3

Respondents in this group were pragmatic, reporting on the "way things are" regarding elements of demographic diversity, and considered inclusion as an area of needed improvement in the field. One participant whose statements aligned with factor three mentioned this perspective regarding individuals whose citizenship status was in question:

"People that are undocumented … I don't think a company will trust them."

Caucasian male, Institution A

Another participant noted that diversity was an area in which tech fields could improve:

"I felt like cybersecurity needs more diversity in genders and ethnicities. It's an exploratory field and it should be a place where everybody is and everybody feels welcome. It might be, but you always have room for improvement."

Hispanic Male, Institution B

A third participant used current understanding of the field from the position as a student to interpret the field in terms of how women could or could not participate.

"I don't know if cybersecurity is a field where all genders could feel valued. I'm not sure, but in most of my computer science classes, there's not many women, so I'm not sure like how much women are in cybersecurity field, if any."

Hispanic Male, Institution B

A participant whose Q-sort responses were closest to factor 3 indicated that men seemed to prefer cybersecurity while women did not—in the participant's view, differing interests were not problematic, as long as everyone had access to the field.

"Men typically want to do cybersecurity more than women.... not necessarily a bad thing as long as there's equality of opportunity."

Caucasian male, Institution A

Another element of factor 3 was the high regard for a generalized "diversity" in the field of cybersecurity. A participant described the benefit of speaking with students who have different ways of approaching problems in the quote below:

"With principles of programming languages, there was a concept that was really confusing this semester. And so I asked a couple of my friends, do you understand this? And they understood it in a different way than I thought. I thought it was this X, but they kind of explained it in a different perspective Y and then I was able to understand it more."

Caucasian male, Institution A

This perspective regarding diversity of thought mirrors a statement in factor 2 in which a participant saw the value of having different people working together to solve a problem—they both note the benefit of diversity of thought. The difference between factors appears to be the way in which a generalized notion of diversity is viewed as related to demographic markers of diversity.

Discussion

Diversity, equity, and inclusion (DEI) is ubiquitous in the current computer science higher education climate, yet definitions vary, as do perspectives regarding what forms of diversity are valued in educational spaces. As DEI plans become commonplace for securing federal funding [28], understanding how students, staff and faculty conceptualize the value of diversity will only increase in importance.

The Q-sort provided a way of entering discussion regarding relative conceptual priorities in the field of cybersecurity by a set of high achieving undergraduate students enrolled in Hispanic Serving Institutions who are well versed in the subfield because of their programmatic experience in [GRANT FUNDED PROGRAM]. Patterns of responses were examined in relation to other topics to understand how students made sense of diversity across four items in the Q-sort concourse of 30 statements—specifically, they addressed gender, citizenship, ethnicity, and a broader concept of "diversity." Responses from our pilot study indicated three major patterns of responses, all of which include nuance within the categories delineated in the Q-sort. We draw three themes from our mixed method analysis.

Stereotypes and Bias in Cybersecurity

Research participants acknowledged some biases and stereotypes regarding certain populations, such as women and undocumented residents in the United States. The biases described, in some cases, were mirrored in the ways in which students prioritized statements related to diverse populations—for example, groups 1 and 3 placed statement 30 regarding residency status as the lowest category, in effect mirroring the bias they viewed in the field. While some students were critical of the biases they perceived, others were pragmatic—noting the ways in which the field appeared to favor some groups over others. *As institutions, departments, and communities consider diversity and inclusion, it is vital that biases held across stakeholder groups, and including students themselves- are addressed. Creating opportunity for dialog is important, as is indicating institutional, departmental, and community values through clear inclusive language, policy, and action.*

Diversity "Neutral"

The factor 1 participants tended to support a "neutral" stance on diversity—their focus group responses indicate a lack of interest in "forcing" diversity, and promote "treating everyone the same," without acknowledging difference. This neutral stance can be harmful, as it negates individuality and the benefits of diversity that can improve the workforce [29]. Understanding student perspectives on diversity can guide departmental efforts to support DEI—faculty, staff, and students may all need to shift perspectives to create inclusive learning environments in cybersecurity.

Diverse Perspectives with and without Demographic Diversity

A major difference between the factor 2 and factor 3 Q-sort categories was the ways in which they acknowledged the role of difference in experience and demographic markers with a diversity of perspective. For factor 2, differences in ethnicity, gender, and citizenship status were equally valued with a more general sense of "diversity"—yet for factor 3, only the diversity of thought was valued, while the other categories were not valued. While demographic differences are not the only ways in which diversity of thought can be achieved, it could be beneficial to consider how demographic diversity could shape perspectives, leading to enriched technical products and services.

Next Steps/Conclusion

We acknowledge multiple limitations of the study, specifically, the student participants were not as diverse as we had hoped, given our implementation in Hispanic serving institutions. Second, our failure to convince participants to utilize the Q-sort structured format led to a loss of participant data—in further work we hope to develop strategies for inputting data that does not fit the framework. In addition, in

future efforts we hope to develop tools that can support dialog among students and faculty regarding diversity in cybersecurity to mitigate stereotypes and biases that are evident in our results.

As we continue our efforts to understand perspectives on diversity in cybersecurity, we plan to: expand our student participant pool to include students from Hispanic Serving Institutions in other regions of the country to better understand potential regional differences, explore student-developed definitions of diversity in technical work, contrast perceptions of diversity held by students with perceptions of diversity held by faculty and cyber professionals.

This study illuminates the different facets of diversity and the importance of understanding the many facets of DEI issues, especially those in fields with diversity gaps. While DEI programs exist in the cybersecurity world, diversity is a complex concept with multiple definitions. Given the expansion of the cybersecurity field and the disproportionate representation of women and people of color in this area, it is critical to examine DEI initiatives, and learn how people value and understand the concept of diversity.

As academic departments grapple with appropriate policies, practices, and actions related to diversity in technical disciplines such as cybersecurity, this study indicates that perspectives of student stakeholders are complex, and in some cases mirror societal biases and stereotypes. Institutional and departmental leadership have a role in framing discussions of diversity in engineering. Developing clear language regarding diversity values held by leaders and departmental actors, honoring the educational debt as well as the systemic racism and sexism that perpetuate biases and stereotypes regarding who belongs in technical fields [30, 31, 32], and addressing voiced student perspectives regarding diversity that can be harmful to minoritized peers are important steps to further DEI work in technical fields.

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Appendix A: Corpus of Q-sort Statements

CYB is focused on user experiences.

CYB is reactive to issues/concerns.

CYB professionals maintain secure systems.

CYB professionals monitor secure systems.

CYB is a field where academic research is important.

CYB is academically rigorous/difficult.

CYB is a theoretical field.

CYB involves a lot of math.

CYB is important for developing laws and policies.

CYB can influence how technology is used in society.

CYB professionals have lots of career opportunities in government.

CYB can influence how the government operates.

CYB professionals help others.

CYB is a field focused on protecting others' welfare.

CYB is a field focused on protecting others' privacy.

CYB professionals create new tools.

CYB professionals develop new technical practices.

CYB is an exploratory field.

CYB professionals has potential for change.

CYB can encompass a variety of industries.

CYB professionals collaborate with others.

The CYB field is social.

CYB professionals spend their time investigating breaches.

CYB professionals problem solve to understand data vulnerability.

CYB professionals may be motivated by the thrill of entering places they are not allowed.

CYB professionals find ways to penetrate defenses.

Diversity is important in CYB.

CYB is a field where people of all genders could feel valued.

CYB is a field where people of all ethnicities could feel valued.

CYB is a field where people of all US residency statuses (citizens, undocumented individuals, permanent residents) could feel valued.