Understanding the Experiences that Contribute to the Inclusion of Underrepresented Groups in Computing

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***Abstract*- The lack of diversity in computing fields in the United States is a known issue. Students enter the computing fields with the intention of graduating; however, a large number leave and do not persist after enrolling, due to discrimination and biases. This particularly concerns groups already underrepresented in computing fields, such as women, Black/African American students, and Hispanic/Latinx students. However, there are various experiences that can make students feel more included or excluded in the field. Some of these experiences include internships, undergraduate research, capstone courses, and projects, etc.**

Drawing on Astin's I-E-O model and applying a random forest algorithm, we measure the feature importance of 14 distinct experiences on 1650 students' feelings of inclusivity in the computing field. We observe that there are gender and racial differences in terms of the opinions of computing fields' inclusivity. For example, tutoring experience, job offers, and job experience are considered some of the most important factors for female's perceived inclusiveness of women. However, men perceived women's inclusivity differently, based on the experiences they engaged in. We also looked at the perceived inclusiveness of computing fields for ethnically and racially underrepresented groups, such as Hispanic/Latinx students. Understanding the effect of different experiences on students of both genders with different races and ethnicities on the perceived inclusion could assist the computing community to provide more cohesive experiences that benefits all students and helps them to feel more welcome.

Keywords—inclusivity, diversity, computing fields

I. INTRODUCTION

Computing-related job openings are growing at a faster pace than the number of qualified candidates who can fill the positions [1]. According to the data, the percentage of students who graduate with a computing degree are only about half of the number of students who enter the field [2]. Furthermore, a large number of students leave computing fields (such as Computer Science (CS), Computer Engineering (CE), and Information Technology(IT)) due to the discriminatory and biased educational environment [3],[4]. More than 80% of the students in computing fields are male, and these are largely White men [5, 53]. Thus, there is an imperative to investigate the factors that contribute to diversity in computing fields.

Diversity is often defined as having people with different races, genders, cultures, and backgrounds in an environment. Increased compositional diversity has been demonstrated to foster a sense of belonging for underrepresented groups, which leads to improvements for enrollment and persistence in STEM fields [6]. Meanwhile, *inclusivity* is defined as having a healthy, welcoming, and strong community which provides opportunity for the growth and productivity of its members [7]. Therefore, to increase representation and diversity in computing, and to create a sense of belonging for all groups, there is a need to create an inclusive educational environment. Doing so can improve recruitment and persistence of diverse populations, as represented by students with different gender and racial/ethnic identities.

According to the Association of American Colleges and Universities, there are 10 high-impact practices that are beneficial for students' education [8]. Some examples of these practices includes: internships, first-year seminars, undergraduate research, collaborative assignments and projects, and community based learning [8]. Offering students these practices gives them an opportunity to engage and participate in their community, which is important to enhancing their learning and to fostering a sense of belonging [8].

However, it is not sufficient to know that these practices are being offered at a school, but rather, it is more important to evaluate what types of educational experiences students may have, and the role that these experiences play in their perceptions of inclusivity. Also, because experience is hugely subjective, it is necessary to also consider the social identities of the individuals themselves. In this study, we focus on how students' self-identifying as belonging to different genders,

and racial and ethnic groups may interpret unique experiences that impact their perceptions of inclusivity in computing fields.

The goal of this study was to assess how specific experiences change perceptions of inclusivity in computing fields for certain groups. Specifically, the research questions (RQs) that guided this work were:

RQ1) To what extent does gender identity of a student influence their perceptions of experiences towards creating inclusiveness in the field?

*RQ*2) *To what extent does races/ethnicity influence student's perceptions of inclusivity in the field?*

To answer these questions, we applied a survey to gather quantitative feedback about perceived inclusivity. Then we applied a Random Forest (RF) algorithm, to assess which experiences have the greatest impact on these perceptions of inclusivity. Using mean decrease in accuracy as a measure of relevance, we ranked the experiences reported from different groups. Additionally, our work considered groups underrepresented in computing fields, women, Black/African Americans, and Hispanic/Latinx students. The results of this work have the potential to inform educators and academia about types of experiences that were the most beneficial to enhancing inclusivity.

The rest of this paper includes a literature review in section II. Then, we discuss the theoretical framework which shapes this study in section III. In section IV we describe the methods applied. We then give the results of our study in section V. Finally, we conclude in section VI with a discussion and contribution to the body of knowledge.

II. LITERATURE REVIEW

In this section we review the background in the field, to present how a sense of belonging can impact different groups. Moreover, we discuss how engagement in different activities can influence how groups perceive inclusivity. More specifically, we will describe the background literature pertaining to inclusivity in subsection IIA and to experiences in subsection IIB.

A. *Inclusivity*

Providing an inclusive education means that different and diverse students learn, attend, meet, and enjoy the same activities [9]. However, students with different racial, gender, ethnicity, cultural, social and economic backgrounds may have experiences in education that shape their perceptions of inclusivity in their own field. In general, the population of the United States consists of the following demographics: 76.5% are White, 13.4% are Black or African American, 5.9% are Asian, 0.2% are Native Hawaiian or Other Pacific Islander, and 18.3% are Hispanic or Latinx [10]. Approximately 50% of the population of the United States is female [10]. Contrarily, these values are not reflected in the demographics in computing. In the United States only 18.1% of computer science graduates are female [5]. In addition, White males comprise the majority of the population, within computing fields, followed by Asian males [11]. Computing fields in the United States are male dominated, and although female participation was as high as 40% in the 1980's [12], in the present day, less than 20% of computing students are women [13].

According to the literature, there are numerous reasons that the participation of female students in the United States faces a steady decline [14],[15]. Among the potential explanations are gender bias, stereotypes, and that the environment in computing fields is not as welcoming for women as for men [16]. Moreover, there are some experiences that occur throughout the duration of collegiate education that impact the sense of belonging or attachment in the computing field. Studies have demonstrated the impact of race, gender, parents, teachers, friends, schools, culture, and role models on students education [17],[18],[19]. Teachers and parents biased perceptions of students' gender identity negatively impacts female students educational paths [20]. Additionally, a large number of female students leave computing fields during their undergraduate programs, and about half of them leave the industry as well [5].

In order to attract and retain more female students and other racial/ethnic minorities in computing fields schools, industries, and social environments should seek to offer alternative programs and opportunities to make computing fields more inclusive by [21],[22],[23]. Presently schools have already established different organizations and scholarship programs with the aim of attracting and retaining students to computing fields. Students at these schools can sign up and become a member of the organization/club or become a part of a community. Different organizations support and provide an environment which students can gather and talk about technology, future job plans, preparations for technical interviews, as well as many other opportunities.

There are several studies that explore students with diverse gender, race and ethnic backgrounds and their experiences on attachment and engagement towards education, and academic and social experiences on students' educational outcomes [18],[24]. In this study, we contribute to the literature on what educational experiences students may have, and further expand this literature by studying how these experiences impact students' perceived inclusiveness of the computing field, for students with different genders and races. In the next section we will discuss the impact of different experiences including internship, tutoring, research, networking, and mentoring on students.

B. *Experiences*

An *experience* is essentially the act of living through an event, or events, and the skill or knowledge resulting from that particular event or activity. It is used to refer to the past events, knowledge and feelings that make up someone's life [25],[26]. In the literature there is discussion about how inequality pertaining to race and gender impacts students' academic achievement in the United States [27]. Male students experience greater encouragement towards pursuing computing fields than female students do from their teachers and parents [15]. There are also differences in how different

groups of students learn best. Whereas Black and Hispanic students are more likely to learn about computing in formal and informal groups or clubs outside the school, White students learn more in class or on their own [18]. Students experience different opportunities throughout the course of their education as well. Such experiences may include internship opportunities, research, tutoring, mentoring, and attending social events, networking experiences, etc. Below we discuss the different experiences and their implications on students according to the literature.

In the United States, student internships are an experience that is known to have a positive correlation with finding full-time jobs [28]. Accordingly, many schools in the country try to offer major-related internship opportunities to their students. A study on STEM students of both genders, with different race and ethnicities, considered how internships impacted the participants. The results of this work demonstrated that internships have a positive impact on students' motivation, and as a result, their educational outcomes as well. The students who participated in the internships noted that it was a beneficial experience, and that ultimately encouraged them to learn about new opportunities in their field [29].

Attending conferences, social events, and networking opportunities are also beneficial experiences suggested by teachers, advising centers, academics, and career success departments to students throughout their education. According to a study by Townsend and Sloan, the majority of the female students attend conferences to network, get inspired by women in technology, and their attendance makes them feel more motivated to find job opportunities [30].

On the other hand, only a small percentage of students actually attend professional development sessions, mentor others, or find their own mentors [30]. However, these experiences are widely considered important for students seeking career opportunities. In addition, there are limited studies on the impact of these experiences on students' educational outcomes.

In models of students' persistence, students' gender, race, ethnicity, demographics, backgrounds, educational environment and learning experiences, attitudes and many other factors contribute to the overall outcome [31], [54]. According to a study by Taheri *et al*., students' development of their computing identity can improve their persistence [31]. Computing identity consists of four sub-constructs; one of which is sense of belonging [32]. Students feel a sense of belonging in an environment where they feel "accepted, welcomed, and well-treated" [33]. This definition lends itself well to inclusivity, since often being included in the community can contribute to students' sense of belonging.

Furthermore, different experiences in computing fields can contribute to how included students feel, and to their sense of belonging in computing. There are numerous studies on the lack of diversity in the computing fields in the United States, and each has a unique perspective on barriers of this field, and they shed light on how offering certain experiences can attract more students to the computing fields to remedy the problem [18],[15]. Among these, research opportunities, tutoring, mentoring, interactive learning sessions, mentoring programs, and teaching and learning assistant programs are some of the many types of potential experiences that are offered in different schools. However, although studies may suggest certain experiences to improve academic outcomes, few directly measure how having these experiences can contribute to the inclusivity in the field. In this study, we aim to shed light on how different experiences impact students' perceptions of inclusivity.

III. THEORETICAL FRAMEWORK

The framework guiding this study is Astin's input-environment-output model, as illustrated in Figure 1. This theory describes how students outcomes are influenced by their characteristics and educational environments [34]. This conceptualization defines the influence of individual traits, as well as allowing for the examination of collegiate experiences towards a specific outcome.

More specifically, in this model *inputs* are defined by the students' characteristics/qualities which they possess prior to their time at the University. As such, these are unyielding features unable to be changed during the course of study such as high school grades or their social identity [35],[36]. By comparison, the *environment* characteristics are more dynamic, and occur during the course of a student's time at a University. In this work, we considered their reported educational experiences. Finally, *outputs* are considered the intended goal or outcome, which in our case is the perceived inclusivity towards certain marginalized groups. Relative to other models it is more parsimonious, which is beneficial since it can be easily comprehended and operationalized within our context. Together, these inputs, environment, and outputs that define Astin's framework are used to model the connections between the experience's students have and our outcome, perceived inclusivity.

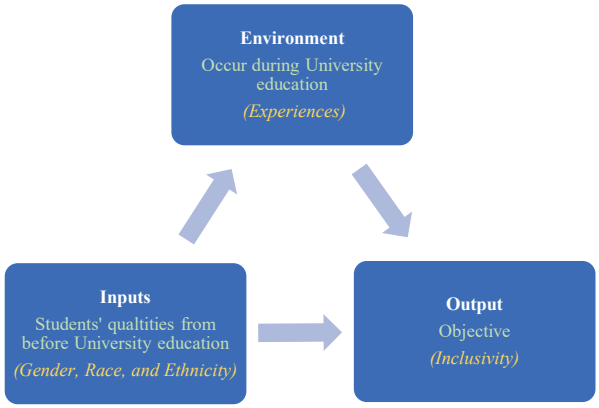

Figure 1 Adaptation of Astin's I-E-O model that considers perceived inclusivity of computing.

More specially, we examined how students having certain experiences perceived the inclusiveness of computing for their peers from different genders, races and ethnicities. In

Relevant Items for Work from Questionnaire	
Question	**Responses**
Which of the following experiences, if any, have you had at your institution with respect to computing? Mark all that apply	Industry Internship; Research experience; Shadowing experience; Job experience; Job offers; Tutoring experience, being a Learning Assistant; Mentoring another student(s); Being mentored by another student(s); Being part of a computing group, club, etc.; Attending symposia or other computing events; Attending social events organized by the department; Presenting work to other students (not classwork); Networking with industry and other professionals; Interacting with students in different year(s) (lower year or more senior students)
How inclusive do you think computing fields are for women?	Likert scale from 0 (Hostile/Discriminatory) to 4 (Welcoming/Inclusive)
How inclusive do you think computing fields are for underrepresented racial/ethnic groups?	Likert scale from 0 (Hostile/Discriminatory) to 4 (Welcoming/Inclusive)

Table 1. Relevant items work from questionnaire

total, we considered 14 different experiences (our environmental contribution), including:

- Industry internship
- Research experience
- Shadowing experience
- Job experience
- Job offers
- Tutoring experience
- Being a learning assistant
- Mentoring other students
- Being mentored by other students
- Being part of computing group, club, attending symposia or other computing events
- Attending social events organized by department
- Presenting work to other students
- Networking with industry and other professionals
- Interacting with students in different years

This framework is used as a theoretical lens to better understand how different experiences impact students perceive inclusion in the computing field. Students with different races, ethnicities, genders, backgrounds and experiences filled out the survey on inclusivity as well as their participation in different experiences. Using the results of this survey, we explored gender on a binary scale – male or female on the basis of not enough participants self-identifying otherwise, Hispanic/Latinx and Non-Hispanic/Latinx students perceptions about inclusivity towards different groups based on unique experiences, when examined with Astin's theory as the guiding framework.

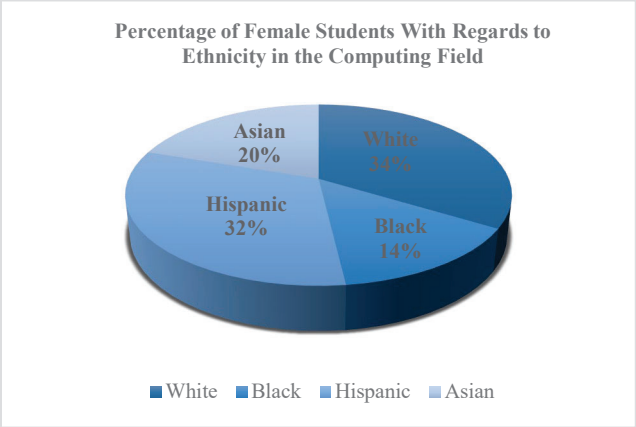

Figure 2. Breakdown of female students in our population, by race and ethnicity

IV. METHODS

In this section we describe the methods employed. In subsection IVA we describe the dataset. In subsection IVB we discuss the methods used to pre-process the data. Then, we review the actual data analysis, performed and the tools used to perform it in subsection IVC. Finally, we address the demographics from the participants in our dataset in subsection IVD.

A. Dataset

Our research team designed and developed a survey, that was distributed to three large public research institutions in Florida as part of a collaborative effort to increase graduation rates in computing. The survey included 39 questions approved by IRB (Institutional Review Board) on topics ranging from demographics to sense of belonging. In addition, we asked, "How inclusive do you think computing fields are for women?" and "How inclusive do you think computing fields are for underrepresented racial/ethnic groups?" Response options for these questions were on a 5-point Likert scale and ranged from "Hostile/Discriminatory" to "Welcoming/Inclusive."

The questions used for the purposes of this work are shown in Table 1. The survey was validated, and also tested for reliability [32]. As part of the study, computing students

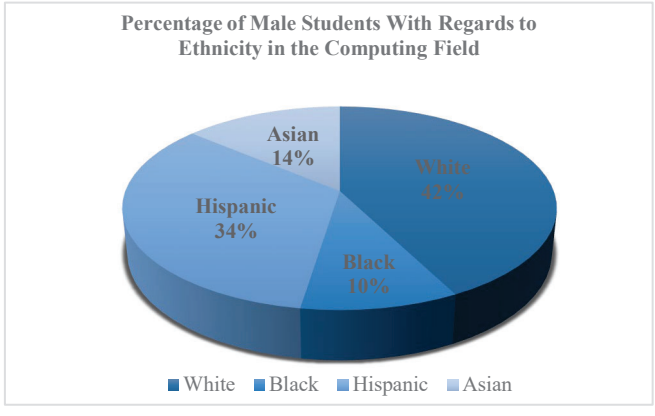

Figure 3. Breakdown of male students in our population, by race and ethnicity

from computer science, information technology, and computer engineering (n= 1654) were surveyed.

B. Demographics

Our sample consisted of 21% females, 78% males, and 1% reported another gender. Furthermore, in terms of race/ethnicity for the total sample, students self-identified as 45% White, 12% Black or African American, 16% Asian, 1% Native Hawaiian or Pacific Islander, 1% American Indian or Alaskan Native, 36% Hispanic, Latinx, or of Spanish origin, 3% Middle Eastern or North African, and 2% reported being another race or ethnicity not listed. Figure 2 shows the percentage of female students for each computing field with regards to their ethnicity [9]. In Figure 3 we show the percentage of male students for each computing field with regards to their ethnicity. Although non-binary values were collected for gender, they represented only 1% of the total population. Due to the small number of these students, we only considered female and male students for the analysis of our data.

C. Data Pre-Processing

All data underwent pre-processing. For racial and ethnic data, all NAs were converted to zeros, taking the assumption that the respondent did not belong to the gender, racial, or ethnic group in question if they did not report otherwise. Furthermore, even though there are numerous ways of handling missing values from deleting individual cases to learning ignoring the absent data, imputation is most often used, and involves replacing the values not present with a meaningful alternative. Among imputation techniques, from mean, median, mode, k-Nearest Neighbor, etc., each has their pros and cons. For example, mean may underestimate variance. Accordingly, we chose the median to impute the data for questions on inclusion [37].

The dataset was split four different ways. The first two involved splitting the data by gender, to compare the experiences of females to the experiences of males on perceived inclusivity. Then, to consider the perceptions of inclusivity for racial/ethnic groups we also divided the data by ethnicity, considering either Hispanic or Non-Hispanic participants. It should be noted that although we did also want to consider the experiences of Black/African American students to non-Black/African American students to assess perceptions of inclusivity for different racial/ethnic groups as well, the population assessed did not have a large enough representation to split the data this way, with sufficient accuracy. Therefore, we only were able to consider Hispanic to non-Hispanic students,

In addition to splitting the datasets as described, we also tested different parameters to find the optimal values for the random forest algorithm, based on accuracy [38],[54]. To optimize the hyperparameters (model-specific properties in a given space) of a RF, either random search or grid search can be used. Random search involves selecting a sample randomly from among a range of values to find the optimal solution for the model. Contrarily, a grid search considers unique combinations from among an already defined list, and all the items within the list are ordered as a matrix. In our analysis, random search proved more effective, and was thus the technique applied to our model. Although overfitting is not a concern with random forest, it is necessary to tune the parameters for feature importance [39]. Therefore, we tested several values for ntree (the number of trees), including 50, 100, 500, and 1000 [39],[40],[54] and observed that based on accuracy, an ntree=500 was the optimal value.

D. Data Analysis

We collected survey responses using Qualtrics, and the data was loaded into the R Studio environment version 1.1.456, for cleaning and analysis [9]. To assess the feature importance, we applied a random forest algorithm. RF is one of the most used machine learning algorithms, because of its simplicity and diversity [41]. A decision tree is a means to split data according to certain categories for the purposes of classification and regression. RF is considered an ensemble method that makes decisions through aggregating a collection of individual decision trees. It is considered to be useful as it can precisely classify observations for various applications [42]. The RF was run using R programming language version 3.6.1.

To assess feature importance, we used mean decrease in accuracy. *Mean decrease in accuracy* is a measure obtained using the "out of the bag" error calculation that occurs during data classification using the random forest algorithm [38],[43]. Ultimately, it defines feature importance based on removal of the variables most relevant to a particular topic.

V. RESULTS

In this work, we calculated the mean decrease in accuracy for different groups to assess their perceptions of inclusivity. However, it should be noted that we considered solely the inclusivity, not students' feeling of belonging for underrepresented minorities in computing. As mentioned earlier in this paper, students' experiences play an important role on their perceived inclusion in computing. The variable importance is determined inversely since increases in the accuracy result from removing individual variables.

A. Inclusivity for Women

Based on the mean decrease in accuracy, we observe that there are gender differences in the perceptions of computing inclusivity for females. Females reporting certain experiences have unique perceptions of inclusivity in the field, as demonstrated in Table 2. Among these, having tutoring, and specifically, being a learning assistant, is the experience most important for their perception of the field as inclusive. In addition, job offers, and job experiences are the next most valuable experiences towards their perceptions of inclusivity. Meanwhile, different experiences for men led to opinions of inclusivity in CS for women, as demonstrated in Table 3.

B. Inclusivity for Underrepresented Racial/Ethnic Groups

Perceptions of inclusivity towards underrepresented racial/ethnic groups are also affected by an individual's self-identification. For Hispanic/Latinx students, having job experience and attending departmental social events are the experiences which lead to the highest perceptions of inclusivity for minorities, as illustrated in Table 4.

Female Perspective: CS Inclusivity towards Women	
Experience	Mean Decrease in Accuracy
Tutoring Experience	6.0494578
Job Offers	6.009457
Job Experience	4.9332607
Attending Symposia	4.1499427
Shadowing Experience	3.7973554
Being Mentored	3.1543842
Interacting w/ Students	0.5200852
Industry Internship	0.4081491
Networking (Industry)	-3.153727
Computing group/club	-4.114868
Mentoring Another	-4.36588
Presenting Work	-6.282925
Research Experience	-7.287945
Dept. Social Events	-8.410546

Table 2. Female Perspective: CS Inclusivity towards Women

These experiences align with the previous literature on how important socializing is in Hispanic/Latinx families, as it encompasses cultural values [44]. Accordingly, socializing has a "positive personal and academic influence on students" [45]. It is understandable that Hispanic students believe if there is more socialization, then they consider the educational environment to be more inclusive. According to the literature, Hispanics do want to pursue careers in computing, however, they don't see themselves as computing people [46]. In other words, they believe they do not fit into computing fields. These findings are consistent with our results, which demonstrate that Hispanic/Latinx students who report having job experience, tend to perceive computing fields as more inclusive towards racial/ethnic minorities.

Hispanic/Latinx Perspective: CS Inclusivity towards Underrepresented Racial/Ethnic Groups	
Experience	Mean Decrease in Accuracy
Job Experience	52.43167
Dept. Social Events	49.996997
Mentoring Another	46.186069
Being Mentored	39.245345
Interacting w/ Students	36.165112
Tutoring Experience	32.517779
Research Experience	32.248451
Industry Internship	19.233522
Job Offers	12.757876
Attending Symposia	2.3213891
Presenting Work	2.1658912
Computing group/club	1.8061709
Networking (Industry)	-14.76069
Shadowing Experience	-25.1281

Table 4. Hispanic/Latinx Perspective: CS Inclusivity towards Underrepresented Racial/Ethnic Groups

Male Perspective: CS Inclusivity towards Women	
Experience	Mean Decrease in Accuracy
Interacting w/ Students	18.804982
Industry Internship	17.588193
Dept. Social Events	10.055111
Computing group/club	8.8594178
Being Mentored	8.1716337
Presenting Work	8.0895694
Attending Symposia	7.7571763
Mentoring Another	7.1564844
Research Experience	4.8264149
Job Experience	2.2510756
Tutoring Experience	1.562449
Job Offers	-0.218045
Networking (Industry)	-0.224562
Shadowing Experience	-1.539888

Table 3. Male Perspective: CS Inclusivity towards Women

As shown in Table 5 for non-Hispanic/ Latinx students; interacting with students, attending social events, and job offers are the most important experiences for students to find computing fields more inclusive towards underrepresented racial/ethnic groups. Contrarily, Non-Hispanic/Latinx students with tutoring experiences are the least likely to perceive computing fields as inclusive towards marginalized groups.

VI. DISCUSSION

The findings presented demonstrate that there are differential perceptions for inclusivity based on students' race/ethnicity or gender. This is important because it sheds light on how discernment of an inclusive environment is perceived differently based on an individual's self-

Non-Hispanic/Latinx Perspective: CS Inclusivity towards Underrepresented Racial/Ethnic Groups	
Experience	Mean Decrease in Accuracy
Interacting w/ Students	85.413988
Dept. Social Events	79.870941
Job Offers	77.440746
Being Mentored	69.335784
Attending Symposia	60.758099
Job Experience	56.911482
Networking (Industry)	53.48809
Computing group/club	50.943907
Mentoring Another	47.7896
Industry Internship	41.914173
Research Experience	41.405861
Shadowing Experience	26.124687
Presenting Work	2.5647832
Tutoring Experience	-3.745079

Table 5. Non-Hispanic/Latinx Perspective: CS Inclusivity towards Underrepresented Racial/Ethnic Groups

identification with a particular race and gender. Furthermore, it shows how having specific experiences shape these perceptions.

Experiences are widely subjective and can contribute to the intersectionality between gender and belonging to a race/ethnicity. Gender socialization early in life has been shown to influence females' self-perception, and their opinions about computing fields CITE HERE. In addition, it has been identified as an important factor that contributes to decreased participation in this field [15],[47].

One of the important factors which mediates self-perception is social acceptance [48]. Unfortunately, many Black students reported feeling a lack of social acceptance [49].

Hispanic students have also been shown to experience doubts about their skills, as measured through a lack of confidence that results in lower participation in computing fields [46]. Thus, students' self-perceptions, along with their experiences, can impact their perceptions of inclusion. The intersection between these groups can play a significant role in internalizing the experiences and their perception. For example, Hispanic students find tutoring experiences, and getting mentored by mentors of the same ethnicity as positive experiences [50]. Black students report greater interest and feelings of belonging when enrolled in Black-serving institutions [51]. Additionally, being enrolled with peers sharing a cultural background enhances social support, and provides feelings of acceptance within the educational community [51].

While all schools may not have equally proportional demographics, these findings demonstrate the need for offering an inclusive environment to ensure all students feel welcome. Such social diversity can greatly enhance their happiness and may also impact persistence. Furthermore, there is an interaction between academic advising from teaching assistants (TAs), and females, with the intersection seeing a rise in computing identity.

RQ1: To what extent does the gender of students influence their perceptions of experiences towards creating inclusiveness in the field?

The results reveal gender differences in the opinions of computing fields' inclusivity for women. Tutoring experience, being a learning assistant, job offers, and job experiences are considered some of the most important factors for women's perceptions of inclusiveness. Contrarily, interacting with students in different years, industry internships, attendance to social events organized by the department, and being part of the computing group, club, etc. were influential in men's perception of women's inclusivity. Although we did not perform a qualitative analysis of the underlying causation, we hypothesize that this is because obtaining a position from the industry encourages feelings of legitimacy and a sense of belonging. Prior work [52] has demonstrated that having a greater computing identity, as measured through the subconstructs of sense of belonging, interest, competence/performance, and recognition, can positively impact students computing persistence. Accordingly, obtaining a position from the industry encourages feelings of legitimacy and a sense of belonging.

RQ2: To what extent does the experiences of students with different races/ethnicities influence their feelings of inclusivity in the field?

We also looked at the perceived inclusiveness of computing fields for ethnically and racially underrepresented groups, such as Black/African Americans and Hispanic/Latinx students. However, as previously mentioned, we did so through exploration of the experiences undertaken by Hispanic/Latinx students relative to non-Hispanic/Latinx students. Feature importance demonstrates that job experience, attending social events organized by the department, and mentoring other students had an impact on the inclusivity perceptions for Hispanic students relative to non-Hispanics. Interestingly, these results both display a strong predilection for social events. Although the literature suggests that Hispanic/Latinx populations may place a higher emphasis on communication, the list of experiences did not appear to impact the perceived inclusivity. Having a supportive environment can greatly enhance feelings of inclusion and social support. Previously, a study comparing Black students in predominantly White institutions against students in predominantly Black institutions observed that Black students feel a significantly greater sense of belonging in the predominantly Black institutions[51]. Furthermore, there were gender differences in the perception of the campus atmosphere, and social life. For both, females reported higher satisfaction. These results confirm with our own that feeling included may contribute to enhanced friendliness and inclusivity.

VII. LIMITATIONS

In this work we examined perceptions towards inclusivity. However, we were limited in asking about perceptions for all groups since we only asked about perceptions towards underrepresented groups and females in an abstract sense. Going forward, it would be beneficial to expand this study to include greater numbers from each group, and also to consider inclusivity for males and specific racial/ethnic groups as well. In addition, if larger numbers could be obtained of Black/African American respondents, it would enable comparison of Black/African American students to non-Black/African American students.

Furthermore, we presently only use quantitative analysis to measure inclusivity. As such, we don't know if these occur at different levels, for example, is the inclusivity slightly present or hugely present. Moreover, the experiences included are fairly broad and likely vary from student-to-student. We also cannot draw causational conclusions and can only hypothesize about why having these experiences may affect perceptions. In the future, we suggest complimenting with qualitative methods to obtain a more comprehensive look at these relationships.

Intersectionality refers to the theory which involves the convergence of race, ethnicity, gender, sexuality and class

which may cause a bias experience by an individual. In this work we focused solely on inclusion with a particular group, however there may be additional effects mediated through intersectional belonging across gender and race/ethnicity. In this survey, we did also ask about how individuals felt about the perceptions of inclusivity for others (i.e., how a male felt about the perceptions towards females in computing). It should be noted that although they may see instances of discrimination or inclusion, they opinions are based solely on observation for the responses provided by those not part of the group in question.

VII. CONCLUSION AND FUTURE DIRECTIONS

In this study, we examined the perceptions of inclusivity on different underrepresented groups. As it is clear from the results, the perceptions of inclusivity are different by gender and race. The inclusiveness of computing fields towards female students, from the male students' perspective, is based more on social experiences, and interactions with students. Contrarily, the experience that has the greatest impact on inclusiveness in the computing field towards women, from the female point of view, is tutoring. These findings reveal that although male and female students in the United States experience the same classroom and social environment, their perceptions towards the inclusiveness in the computing fields are different.

In addition, the results of this study illustrate that the perceptions of inclusion for underrepresented minorities in computing fields are different for Hispanic/Latinx students and non-Hispanic/Latinx students. As Hispanic/ Latinx students' perceptions of inclusion aligns more with job experiences, Non-Hispanic students in computing fields found interacting with students as an inclusive experience. Both Hispanic/Latinx and Non-Hispanic/Latinx students found department social events as an inclusive experience. Interestingly, female students found tutoring experience as inclusive experience for female students in the computing fields, however, Non-Hispanic/Latinx students found tutoring experience as a discriminatory experience for Non-Hispanic/Latinx students.

Female students' experiences with social events meant lower perceptions of inclusivity for female students in the computing fields. Shadowing experiences by males also led to lower perceptions of inclusivity experience for female students, and lower perceptions of inclusivity by Hispanic/ Latinx students for underrepresented minority students. In addition, it is found although social events are interpreted as inclusive for underrepresented groups in computing by Hispanic/Latinx and Non-Hispanic/Latinx students, they tend to result in lower perceptions of inclusivity for female students in the computing fields by other females.

To conclude, we understand that the perceptions of inclusivity for students with different races and genders may be the result of their unique reactions to specific experiences. In the literature review we mentioned the importance of internships and how different schools provide this type of opportunity to their students. Yet, from the perspective of the minorities and female students, having an internship did not play an important role on their perception towards inclusion in computing fields.

We would like to dig deeper into students' educational experiences, to better understand their impact and to learn how different experiences lead to computing persistence. To gain more insight, it would be beneficial to assess what factors contribute to inclusivity using qualitative analysis as well. The results from this study may guide educators, academic advisors, and professionals in the industry to create a more inclusive environment for all students in the computing fields. Additionally, the work presented here has tremendous potential to drive forward initiatives that can seek to improve diversity in education.

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