

Graduate Student Perceptions of an Ideal Mentor in Engineering and Computing at a Minority-Serving Institution: Preliminary Results

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Abstract

Reports from the National Academies and Council of Graduate Schools suggest that high quality mentorship can enhance the recruitment and retention of traditionally marginalized students by providing these students with mutual and lasting relationships. We define marginalized as those individuals who have been discriminated against, ignored or misrepresented due to inequities within our systems. Most graduate programs do not have established mentorship programs, which puts significant responsibility on students to seek out informal mentorship or leading to students not having mentors beyond their research advisor. To support the design of effective mentorship structures that meet the needs of all students and their respective identities, this exploratory study examines the perceptions of mentoring and mentoring experiences of traditionally marginalized graduate students in engineering and computing.

To better represent students from marginalized populations, we employed the use of Community Cultural Wealth (CCW). Contrary to typical deficit-based categorization methods, CCW focuses on the unique strengths students possess through the use of different capitals (Aspirational, Familial, Social, Linguistic, Resistance, Navigational). By implementing the CCW framework, we were able to understand how different assets of students are supported through their experiences with mentorship.

This paper presents preliminary results of the quantitative section of a mixed-methods sequential exploratory study. Survey data was collected from graduate students at a Minority Serving Institution about their perceptions of mentorship and what qualities an ideal mentor should exhibit. We performed a factor analysis of the acquired survey responses, uncovering two factors that students identify with ideal mentorship: *Disciplinary guidance* and *Value me as a person and my professional goals*. These factors are mostly agreed upon by different student populations, but differ with students pursuing a Master's Thesis vs a Doctoral Degree, African Americans or Blacks vs Latin Americans, and those who view mentors as their Research Advisors vs Educators. Further analysis is necessary to fully understand the differences in perceptions by these students. Nevertheless, doing so is critical for the creation and improvement of holistic and inclusive graduate mentorship programs.

Introduction

Within graduate education, there is a lack of proper mentorship and mentoring programs at institutional and college levels [1]. Mentorship is so highly correlated to student success and program satisfaction [2], as such, there is a critical need to establish and improve mentorship programs at these institutions. The National Academy of Sciences suggests that with improved mentoring, "students' educational experience, morale, career planning and placement, and professional competence" [3, p. 65] will be enhanced. However, for this mentoring relationship to flourish and be satisfactory, it requires effort by both parties which would ultimately create a 'mutually beneficial' partnership between the faculty mentor and the graduate student mentee [4].

The Origin of Mentorship

The concept of mentoring first originated from the character Mentor, from Homer's *Odyssey*, circa 3000 years ago [5]. In the epic poem, Mentor takes care of Odysseus' young son for decades as Odysseus goes to fight the Trojan War.

The concept of mentoring was derived from the above story as providing support and guidance to another individual. Being a derived concept, the definition of mentoring is largely left up to interpretation by those who engage as mentors and those who seek out mentorship. The Council of Graduate Schools describes these mentoring relationships as a mutual and lasting relationship in comparison to what one might have with an academic advisor, supervisor, or dissertation chair [6, p. 2–3]. Typically, the role of an academic advisor is to help navigate the student through the coursework to fulfill degree requirements, a supervisor instead acts as a gatekeeper to the student employee's funding, whereas a dissertation chair is a gatekeeper to graduation. With that said, the differentiation between these roles warrants further examination into how a mentoring relationship is formed, student's perceptions of that relationship and its implications on their experience.

Experiences of underrepresented students within Science, Technology, Engineering, Math, & Medicine (STEMM) disciplines are impacted by structural and cultural challenges around marginalization, discrimination, tokenism, isolation, and imposter syndrome [1], [7]. Mentoring is one approach shown to mitigate the sensations of these experiences and improve overall student retention and satisfaction within programs [8], [9]. As a result, the purpose of this study is to explore mentoring experiences and approaches in the engineering and computing college at a Minority Serving Institution (MSI) and to investigate the effect of mentorship on groups of students from various identities. Characterizing the effect mentorship has within the graduate student population at this institution can serve as an example for other programs and institutions to improve student support systems and enhance the student experience.

To develop an understanding of the mentoring experiences and perceptions of graduate students from diverse backgrounds and identities, we designed a sequential mixed methods study. The first phase is a survey of graduate students within the college and the second phase includes interviews of faculty that were identified as mentors by the graduate students. This paper will focus on preliminary results of the survey. Specifically, we will share students' perceptions of mentorship and what defines an ideal mentor. The survey and overall study were designed to explore mentoring through the Community Cultural Wealth (CCW) lens. CCW is an asset-based model of human and cultural resources which considers the cultural knowledge, skills, abilities, and contacts of marginalized groups that typically go unrecognized, ignored, or unsung due to the use of standard categorization criteria. By utilizing such a framework, we can provide a holistic understanding of how the assets of this traditionally marginalized group impacts their mentorship experiences. Therefore, understanding what is successful for students in mentoring relationships and what can be improved upon, enables programs and colleges to better support students' experiences throughout a program.

This paper begins with an overview of mentoring within graduate programs. We transition to discussing the different perceptions of mentoring and how traditionally marginalized students experience mentoring. Afterwards, we provide a description of the theoretical framework guiding the study and how it is being used. Results from the administered survey are then

analyzed using quantitative research methods. We later present the limitations of the study, then review and discuss the findings from the study. Finally, we conclude by explaining how these findings can transform mentorship within engineering and computing graduate education.

Mentoring Overview

Previous literature on mentorship discusses shifting the informal culture of mentorship to “a more formal, institutionalized, and widespread practice,” while working towards inclusivity, diversity, and talent development for future generations of STEMM professionals [10, p. 1]. Atkins and colleagues [11] explain that even though mentorship has been prioritized by several academic programs to increase the diversity and support of these future leaders, an in-depth understanding of mentorship within these contexts remains limited.

Within engineering and computing graduate education, research on mentorship as a tool to broaden the participation of underrepresented students is scarce. As the demographics in the United States diversifies, there is a need for an “attitudinal, behavioral, and cultural adjustments” within the graduate education system [14, p. 970]. Departments and graduate programs are being encouraged to shift to a more student-centered approach and assist each student in identifying advisors and mentors that can support their individual academic and career development [14]. In the Science of Effective Mentorship in STEMM report, it is suggested that “program design should take into account the stages of mentoring relationships and ensure that the evolving needs of undergraduate and graduate students are met as they shift to career stage—appropriate independence” [1, p. 8]. Still, work is needed to make appropriate and effective change as well as develop inclusive mentoring programs. Crisp and Cruz suggest the need for a “solid theoretical understanding of how mentoring is perceived by different groups of students and the major components and characteristics involved in a mentoring experience” [15, p. 541]. While there are many studies of mentoring, generally they are limited in scope, and they often present conflicting definitions and frameworks for stages of mentorship [12], [13]. It becomes imperative to examine mentoring within graduate contexts and account for the diverse mentoring needs of graduate students as we strive for the improvement of mentorship in graduate programs.

Traditionally Marginalized Students and Mentoring

As the previous literature suggests, the current environment in graduate programs does not account the mentorship needs and expectations of all students. Griffin explains that mentoring relationships are particularly significant “for individuals who have minoritized identities, or are members of groups that are more subject to oppression and marginalization based on social constructs like race, gender identity and expression, ethnicity, religion, and sexual identity” [18, p. 94]. The challenge in the development of successful mentoring for students from traditionally marginalized groups is more critical as explained by Holley and colleagues [19] as these students at times tend to find it very difficult to identify faculty mentors or find professional guidance to support them during their graduate program. Similarly, Crumpton-Young and colleagues [20] suggest that mentoring is especially significant for women and underrepresented minority students in STEM because there is a lack of representation of these groups in these programs and professions. Mentoring is seen as one of the top factors that support these students’ success due to the mentor’s guidance and support provided to adapt to the program's setting and structure [20, p. 10]. However, as previously discussed, there is an overreliance on informal mentorship

and a burden on students to define their mentoring needs and find mentors. This issue is compounded with the lack of mentoring training and experiences of many faculty. Thomas and colleagues [21] explain that when faculty members do mentor minority graduate students, it is out of this perception that it is the ‘moral thing to do’ which will not always result in an effective form of mentoring regardless of their good intentions. Therefore, it is important to recognize this lack of defined mentoring structure in graduate programs as well as the mentoring needs of graduate students which may extend beyond the disciplinary guidance. With graduate students’ desire for a more personalized guidance, there is a growing need for institutions to establish these formalized mentoring practices while considering the various social constructs of a student which becomes crucial to developing future professionals.

Theoretical Framework

The study is grounded in Yosso’s [22] CCW, an asset-based framework which emphasizes individual experiences by considering cultural knowledge, skills, and abilities that typically go unsung. To appropriately capture the diversity of identities and perspectives of graduate students and to consider how to best support and enhance the assets that they bring to their programs, we chose a framework that builds on the foundation of Critical Race Theory, and which acknowledges existing sources of oppression and utilizes an asset-based approach. Yosso [22] identified six types of capitals that form the CCW theory which include: *Aspirational, Linguistic, Familial, Social, Navigational, and Resistance*. This framework was used to frame how graduate students access and experience mentoring and are defined below in Table 1.

<i>Type of Capital</i>	<i>Definition</i>
<i>Aspirational</i>	Ability to maintain hopes and dreams for the future even in the face of real and perceived barriers.
<i>Linguistic</i>	Intellectual and social skills attained through communication experiences in more than one language and/or style.
<i>Familial</i>	Cultural knowledges nurtured among familia (kin) that carry a sense of community, history, memory, and cultural intuition.
<i>Social</i>	Networks of people and community resources.
<i>Navigational</i>	Skills of maneuvering through social institutions.
<i>Resistant</i>	Knowledges and skills fostered through oppositional behavior that challenges inequality.

Table 1: Capitals in Yosso’s [22] Community Cultural Wealth (CCW) Theory [23, p. 558]

Research Design

The study presented in this paper is a part of a larger sequential mixed method study. The overarching research seeks to understand students’ and faculty members’ perceptions of mentorship so that we may be able to intentionally design and improve mentorship programs. For this paper, we focused on a critical component of this process; understanding a student’s perception of an ideal mentor. To do so, we sought to answer the following research questions:

1. How do graduate research students conceptualize and experience mentorship in their engineering programs?
2. How does mentorship impact the development of traditionally marginalized graduate students?

This paper focuses on the development of the survey and a preliminary analysis of the results.

Research Site and Sample

We distributed a survey to the entire graduate student population in the engineering and computing college at an MSI. Within the college, there are over 1000 graduate students. Of these students, 68% are pursuing a Master’s Degree and 31% are pursuing a Doctoral Degree. The students predominantly identify as male (72% male, 28% female). Most students within the graduate programs are domestic, with 45% identifying as International Students. Racial and Ethnic statistics of the graduate students are separated based on international status, where only domestic students’ demographic information is available. The race/ethnic backgrounds of our domestic students are 35% Hispanic/Latinx, 8% Black or African American, 7% White (Non-Hispanic/Latinx), and 3% Asians.

The mentorship literature tends to emphasize the experiences of doctoral students while neglecting students enrolled in master’s programs [24]. The experiences of master’s students matter, and improving their experiences is critical in their success. Since mentorship has been shown to improve the experiences and success of doctoral students [25], we believe that it can be applied to master’s students, particularly those on a thesis track as well. Therefore, we administered the survey to both master’s thesis and doctoral students to understand mentorship more comprehensively within our graduate student community.

Survey Development

We created a survey to capture (1) students’ perspectives of what mentoring should look like, (2) students’ experiences with mentorship, (3) students' experiences within their programs, and (4) demographics and degree progress. The section focused on students’ perceptions of mentorship consisted primarily of questions based on the Ideal Mentor Scale (IMS). Rose’s IMS [26] allowed us to capture the qualities that our graduate students perceive to be most necessary for their ideal mentor using three ratings (Integrity, Guidance, and Relationship). We define these dimensions in Table 2 below.

<i>Integrity</i>	Represents virtue through principled action by respecting self and others.
<i>Guidance</i>	Assists in the day-to-day work of a graduate student such as solving research problems and planning presentations of one’s work.
<i>Relationship</i>	Shares aspects about oneself that are traditionally viewed as private.

Table 2: Rose’s [26] Three Ratings of a Mentor

We adapted Rose’s survey by categorizing the questions with regard to the Community Cultural Wealth (CCW) framework. From the original ideal mentor scale, we were able to successfully reclassify 29/34 of the original items (see Appendix A). For example, in the original survey the

question “... inspire me by his or her example and words,” was classified by Rose [26] as belonging to the Integrity Attribute. In our reclassification using the CCW framework, we reclassified this question as belonging to the Aspirational capital due to the question’s motivational aspect. This work-in-progress describes preliminary results from the first section focused on students’ perceptions of an ideal mentor. To better understand the study’s adaptation of the IMS, we have included a list of the original questions from the IMS, the original factor analysis classification, and our reclassification using the CCW framework in the Appendix.

Survey Administration

The complete Qualtrics survey was emailed to all graduate students through the college’s listserv mailing list. Graduate Program Directors were also asked to distribute the survey to their departments. In total, the survey was sent to over 1000 graduate students. Of those, 72 students started the survey and of those, 59 students completed the survey. We omitted incomplete submissions and the data of four students which were missing responses which negatively affected the analysis. This analysis was conducted using the remaining 55 student responses (see Table 3 for demographics). We attribute the overall low response rate due to the time at which we administered the survey, which was just prior to the winter break.

Graduate Level			Thesis Forms		
Doctoral	48	87.27%	Thesis Committee Established	5	55. %
Master’s Thesis	7	12.28%	Thesis Proposal Submission and Defense	4	44.44%
Gender			Request for Thesis Defense	0	0.00%
Female	16	29.09%	Thesis Defense Completed and Thesis Submission to Institution	0	0.00%
Male	34	61.82%	Dissertation Forms		
Other/No response	1	1.82%	Dissertation Committee Established	33	43.42%
Prefer not to answer	4	7.27%	Applied for Candidacy	20	26.32%
Age			Dissertation Proposal Submission and Defense	18	23.68%
18-23	3	5.45%	Request for Dissertation Defense	2	2.63%
24-29	23	41.82%	Dissertation Defense Completed and Submission to Institution	3	3.95%
30-34	19	34.55%	Race/Ethnicity		
35-39	2	3.64%	African American or Black	4	8.77%
40 or older	4	7.27%	American Indian or Alaska Native	0	0.00%
Prefer not to answer	4	7.27%	Asian	19	33.33%
First Generation Graduate			Native Hawaiian or other Pacific Islander	0	0.00%
Yes	22	38.60%	White (Non-Hispanic/Latinx)	12	21.05%
No	28	49.12%	Latin American	14	26.32%
I am not sure	2	3.51%	Prefer not to answer	7	12.28%
Prefer not to answer	5	8.77%	Parental Status		
International Student			Parent	10	18.18%
Yes	34	62.96%	Guardian	1	1.82%
No	16	29.63%	N/A	38	69.09%
Prefer not to answer	4	7.41%	Prefer not to answer	6	10.91%

Table 3: Student Demographics of Analyzed Responses

Results

For this work-in-progress, we focused on an exploratory factor analysis of the questions within the IMS and compared those with students' responses to other questions in this section and demographic questions. Future work will explore the rest of the survey results as well as the relationships among students' perceptions of and students' experiences with mentorship. Tests were run to explore differences in students' perceptions of an ideal mentor by gender, first-generation status, international student status, age, parental status, semesters in the program, level of dissertation completed, graduate degree type, race/ethnicity, and their believed role of a mentor. For the purposes of this conference paper, we report only the results of the latter three as they were the only ones that showed significant differences amongst the students.

Factor Analysis

We performed a factor analysis on the collected data from the IMS to assess patterns amongst the questions indicating students' underlying perceptions of their ideal mentor. To do so, we conducted a principal-axis factor analysis with an oblique rotation on the 15 questions numbered in Table A within the Appendix. In the initial analysis, there were several correlation coefficients below 0.3, which would lead to issues with multicollinearity. We removed questions 2, 3, 4, 5, 10, and 11 from the analysis to reduce this problem. Doing so resulted in a final factor analysis with a correlation matrix determinant of 0.002 which is larger than the necessary acceptable level of collinearity (10^{-6}). We also obtained a sampling adequacy for the analysis of KMO = 0.796 and a highly significant Bartlett's test of sphericity ($p < 0.001$) [27]. Communalities for the items also supported adequate sampling (mean = 0.686, range = 0.478-0.858), which indicates at least a 99% chance of convergence [12], [28]. The first two factors explained approximately 68.56% of the variance and were retained due to having an eigenvalue of greater than 1 [27]. Figure 1 and Table 4 show the scree plot and eigenvalues obtained and Table 5 shows the pattern matrix and the factor score for each question analyzed.

Emergent Factors

Factor analysis is conducted to reduce the number of variables in a study to a smaller set of "factors" in which patterns can then be deduced from. Two factors emerged from the factor analysis conducted which contained the 9 items listed in Table 5. The first factor, *disciplinary guidance*, related to 4 of the items. When referencing to the CCW framework, this factor connected to the discipline capital as it captures students' needs for guidance in navigating their discipline. Whereas the second factor, *Value me as a person and my professional goals*, captures aspects of aspirational, navigational and community capitals. This factor focuses on a student's desire to have a mentor who cares about who they are as a person and supports their specific professional goals [22]. The regression scores for both these factors were recorded and used in the subsequent data analysis to explore relationships between students' perceptions and their responses to other parts of the survey.

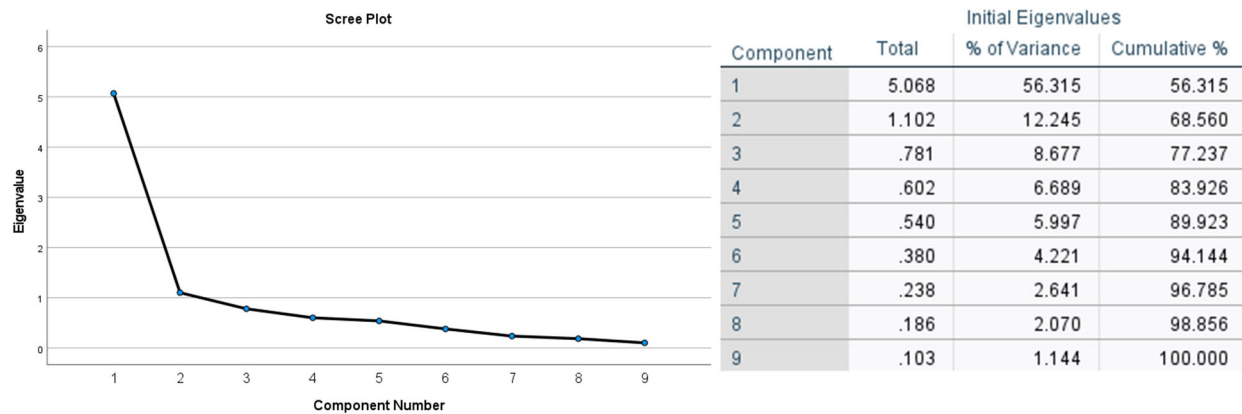


Figure 1 and Table 4: Scree Plot, Eigenvalues, and % of Variance

		Capital	Factor	
			Disciplinary Guidance	Value me as a person and my professional goals
1	... show me how to employ relevant research techniques.	Discipline	0.864	
8	... help me investigate a problem I am having with research design.	Discipline	0.85	
13	... help me plan a timetable for my research.	Discipline	0.536	
14	... provide information to help me understand the subject matter I am researching.	Discipline	0.964	
6	... treat me as an adult who has a right to be involved in decisions that affect me.	Aspirational		0.731
7	... inspire me by his or her example and words.	Aspirational		0.726
12	... recognize my potential.	Aspirational		0.963
15	... advocate for my needs and interests.	Navigational		0.448
9	... value me as a person.	Community		0.69

Table 5: Pattern Matrix of the Factor Analysis of the Ideal Mentor Scale

Statistical Analysis

In the following section, we conducted comparison tests between students’ factor scores and their responses to several demographic items. We report significant findings below and give a summary of other tests run as well.

Graduate Degree Type: In the survey, 48 students were pursuing a doctoral degree and 7 were pursuing a Master’s degree with a thesis. Their responses were then compared to the factor scores using the Mann-Whitney test. When looking at *disciplinary guidance*, we found no significant difference between the responses of students pursuing doctoral degree versus those pursuing a Master’s degree ($p=0.406$). However, when comparing doctoral to master’s thesis

students to the *Value me as a person and my professional goals* factor, there was a significant difference between the student populations ($p=0.025$). Figure 2 illustrates how doctoral students' perceptions of the *Value me as a person and my professional goals* factor varied while master's thesis students were more concentrated above the mean. As such, master's thesis students are more likely to associate with this factor when considering their ideal mentor. While the sample size for the master's student population is small, this finding still may hold true, and warrants further analysis with larger samples to ensure its validity.

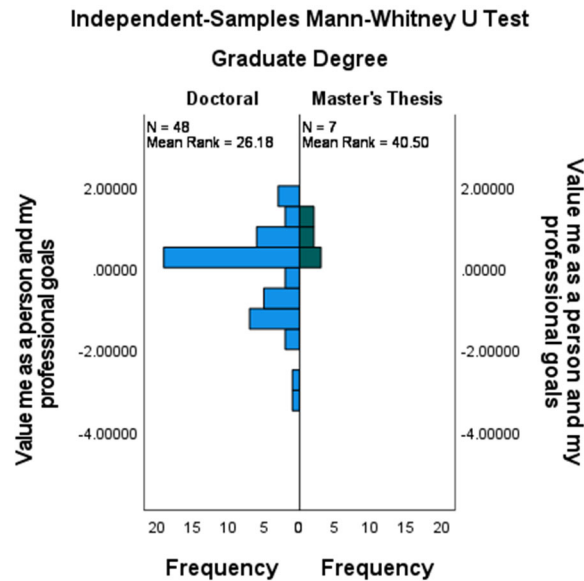


Figure 2: Mann-Whitney U Test Independent-Samples Histogram comparing Graduate Degrees to *Value me as a person and my professional goals*

Race/Ethnicity: In the demographics, students were asked to select the race(s) that they most identified with. Of the responses obtained, students identified as either African American or Black ($n=4$), Asian ($n=18$), White ($n=26$), and Other ($n=2$). We separately asked students if they identified themselves as being from a Spanish speaking country from Latin America and/or the Caribbean. Several students identified as both being White (Non-Hispanic/Latinx) and from a Latin American country ($n=14$), so to capture their Latinx background we created a new category, Latin American. The final categories were African American or Black ($n=4$), Asian ($n=18$), White (Non-Hispanic/Latinx) ($n=12$), and Latin American ($n=14$) (Refer to Table 3). These four groups were then compared against the factor scores using the Kruskal-Wallis test. Results showed no significant differences amongst these groups for the *Value me as a person and my professional goals* factor ($p=0.729$) but did show a significant difference compared to the *Disciplinary Guidance* factor ($p=0.044$) (refer to figure 3). Post-hoc pairwise comparisons of race/ethnicity versus *Disciplinary Guidance* when adjusted with the Bonferroni correction for multiple tests (Dinno, 2015; Dunn, 1961) indicated a significant difference between the responses of African American or Black students and Latin American students ($p=0.037$). In particular, African American or Black students perceived the role of an ideal mentor as providing *Disciplinary Guidance* to a lesser extent than their Latin American counterparts. While there is a small number of African American and Black students in this sample, the result still raises questions about the differences among perceptions of an ideal mentor and the role of disciplinary

guidance in those perceptions. For example, are there multiple types of ideal mentors, some more closely tied to academic/disciplinary capital and others tied to different forms of capital as defined by CCW?

Role of a Mentor: Students were asked to select one word they felt best defined the role of a mentor. They were given several options, educator, motivator, supervisor, research advisor, career advisor, skills consultant, role model, and other. Of the responses obtained, most students chose words such as motivator (n=13) or research advisor (n=19) with less responses for the others, educator (n=9), role model (n=6), supervisor (n=1), skills consultant (n=2), career advisor (n=2), and other (n=3). We performed a Kruskal-Wallis test comparing the selection choices of these words to the factor scores. The analysis indicated that for the *Value me as a person and my professional goals* factor there was no significant difference (p=0.721) while for the *Disciplinary Guidance* factor there was a significant difference (p=0.013) (refer to figure 4). After performing Post-hoc, pairwise comparisons of the samples and accounting for the Bonferroni Correction, we found that there were significant differences regarding the *Disciplinary Guidance* factor when comparing students who chose the role of a mentor to be a motivator to students who chose it to be an educator (p=0.05). As can be seen in Figure 4, students who viewed their mentor as an educator also had higher factor scores for *Disciplinary Guidance* than students who viewed their mentor as a motivator. This difference makes theoretical sense as an educator would be someone who provides academic or disciplinary capital, while a motivator is more likely to provide and support aspirational, navigational, or other forms of capital.

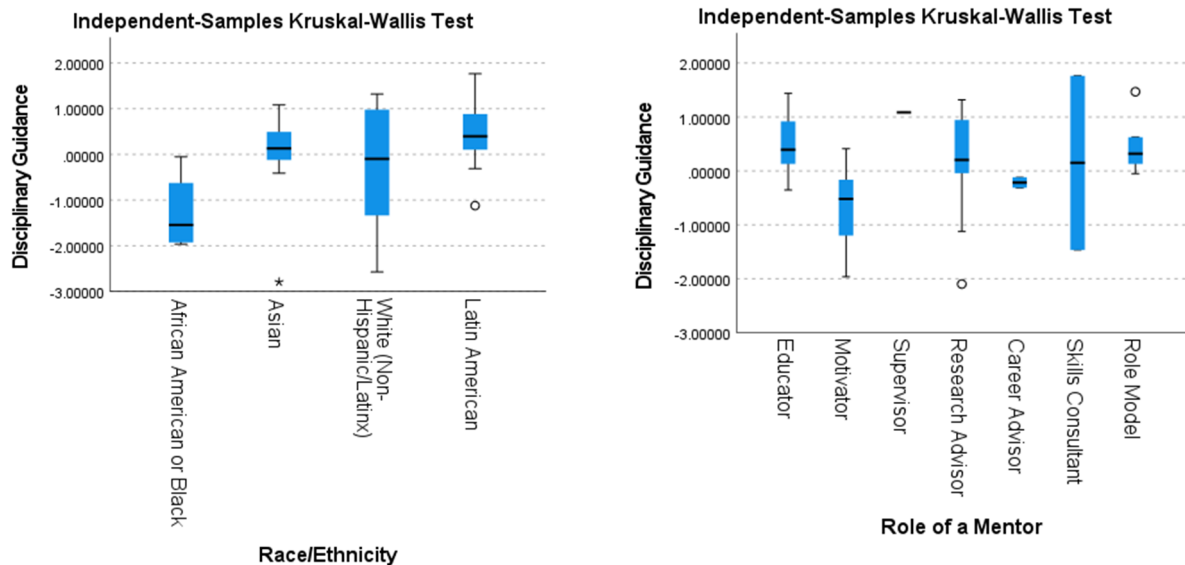


Figure 3 and 4: Kruskal-Wallis Independent Samples for *Disciplinary Guidance* versus Race/Ethnicity and Role of a Mentor

Limitations

We recognize that our preliminary analysis has limitations. First, the overall response rate was low. Given the nature of this study as exploratory, the results can provide areas for future research and serve as a basis for future distributions of the survey to other larger populations. The resulting small sample size impacted the groups sizes within the analysis, which limited our

ability to explore students' perceptions at the intersection of their social identities (i.e., Latinx men, Black women). In addition, the differences found for graduate students may be due to the small sample size of the master's thesis student population and possibly would not hold true for larger samples. Similarly, due to the low number of African American or Black students surveyed, the differences observed may or may not hold for larger populations. Further research should be conducted to ensure the validity of these observations. To align more strongly with the theoretical foundations of this work, we will be exploring person-centered approaches (e.g., cluster analysis) and qualitative examinations of the open-ended questions that will enable us to examine students' responses inclusive of their multiple identities. As such, future work will enable us to better understand this sample and explore these relationships in other samples.

Discussion

Our exploration of the perceptions of graduate students from a MSI illustrate two dimensions to an ideal mentor: *Disciplinary Guidance* and *Value me as a person and my professional goals*. Disciplinary guidance connects to students' need for assistance in navigating their academic field which often supports seeking mentorship from an individual such as a research advisor. Value me as a person further bridges students' need for motivation and encouragement as they traverse through graduate school. In addition, this factor emphasizes a mentor seeing value in one's professional goals, which research has shown is not always the case with research advisors of students pursuing alt-academic or non-academic career pathways [29].

Our analysis of the Ideal Mentor Scale is grounded in Rose's research on group differences in graduate students [30]. Rose examined the relationship between doctoral students' academic as well as demographic characteristics and their preferences for three styles of mentoring assessed by the Ideal Mentor Scale (IMS): Integrity, Guidance, and Relationship. In her analysis, significant differences emerged when it came to demographics such as age, gender, and international status. For example, "women scored higher than men on Integrity, international students scored higher than domestic on Relationship, and age was inversely related to Relationship scores. No group differences were found on the Guidance scale" [30, p. 53].

Rose's study was conducted at two Midwestern Research I institutions and had a large sample of over 500 participants. Of her participants, 55% were female, 45% were male, and 63% were non-U.S. citizens (2005) and were either from Social Sciences and Education, Humanities and arts, or Natural Sciences disciplines. Our study was conducted at a Research I, MSI and had a different demographic distribution. We had 55 participants, of which 62% were male, 29% were female, and 63% were international students and our students were all from the engineering and computing college. Compared to Rose's study, we had a much smaller sample size and a different distribution of gender, but similar international student status. Our disciplines were also extremely different and may be the reason for the different distributions across genders, as engineering is a traditionally male-dominated field.

In our analysis of the IMS we found two factors, *Disciplinary Guidance*, and *Value me as a person and my professional goals*. These two factors encompassed many different aspects of CCW but were also similar to Rose's original classification. *Disciplinary Guidance* was primarily composed of Guidance items, and *Value me as a person and my professional goals* was composed of Integrity items. The items from the Relationship factor were removed given their

redundancy with other items in the survey that will be discussed in future work. Our results differed significantly to Rose's original study. We did not have significant findings for age nor for gender and did not have any findings for international student status though this was expected as our questions did not encompass the original Relationship factor. We did however have significant findings in terms of graduate degree, race/ethnicity, and perceived role of a mentor when compared to the two factors.

Our findings illustrate how Doctoral and Master's thesis students viewed the factor, *Value me as a person and my professional goals*, significantly differently. Master's thesis students in particular valued this factor more commonly than doctoral students. This difference may be due to these students' personal reasons for wanting their specific degree. Students who pursue a master's degree generally do so for better job opportunities and subsequently leave academia upon completion [31], [32]. These students would therefore require a mentor to be supportive of this decision and be able to connect them to resources and other professionals working within the field. Doctoral students generally are taught to be independent researchers and often must find their own connections and build their own networks [33], [34]. Though our sample size for master's students was small, we believe that these results may be significant for larger populations and would like to assess these findings across more students within the college to confirm.

We also observed differences between African American or Black students and Latin American students with regard to the *Disciplinary Guidance* factor. In this analysis, it was found that Latin American students valued *Disciplinary Guidance* more strongly than African American or Black students. This result requires additional exploration considering both the context of the institution (an MSI with a higher percentage of Latin American students) and the theoretical foundations of this study. Academic and Discipline capital are commonly included among traditional forms of capital [12] which do not consider the structures of systematic oppression faced by marginalized populations. In addition, students may value different forms of capital at different points in the program. Therefore, additional data collection and possibly person-centered analysis of the existing data would enable a deeper understanding of students' perceptions of an ideal mentor.

Furthermore, students felt differently about the role of a mentor. Students who viewed their mentor as a motivator or as an educator differed with regard to the *Disciplinary Guidance* factor. Those who saw their mentor as a motivator viewed this factor as less important than those who saw them as an educator. Fundamentally this makes sense due to the semantics of these words as an educator is typically someone who provides instruction or guidance to students, hence *Disciplinary Guidance*. However, a motivator is someone that promotes interest and inspires others, which stems more with the capitals described from the CCW framework. We would like to conduct further analysis in this area to determine the extent to which students' perception of an ideal mentor and the role of a mentor evolve over the course of a program.

Conclusion

In summary, we reported the results of part of the first phase of an exploratory study looking at students' and faculty's perceptions of mentorship at an MSI. The data collected has thus far allowed us to better understand the attributes that graduate students perceive an ideal mentor should possess. Through the incorporation of the CCW framework, we have also been able to see

which capitals are most necessary from the perspective of the students. The data collected warrants and motivates us to continue the analysis of the survey, in an attempt to fully comprehend the student perspective. The second phase of the study will focus on faculty who mentor students, which will permit us to gain insight into their own unique perspective of mentorship as well. Ultimately, the two sets of collected data will allow us to create a holistic interpretation of mentorship at our institution, allowing us to reform our mentorship programs where necessary to improve the experiences of both students and faculty. More so, the final study will ideally serve as a model for other institutions conducting research and reforming their mentorship programs so that all students across all institutions will have the best mentoring experiences possible.

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References

- [1] National Academies of Sciences, Engineering, and Medicine, *MSI Report - STEM workforce*. Washington, DC: The National Academies Press, 2018.
- [2] L. L. Paglis, S. G. Green, and T. N. Bauer, "Does adviser mentoring add value? A longitudinal study of mentoring and doctoral student outcomes," *Res. High. Educ.*, vol. 47, no. 4, pp. 451–476, Jun. 2006, doi: 10.1007/s11162-005-9003-2.
- [3] *Adviser, Teacher, Role Model, Friend: On Being a Mentor to Students in Science and Engineering*. Washington, D.C.: National Academies Press, 1997, p. 5789.
- [4] V. M. Lechuga, "Faculty-graduate student mentoring relationships: mentors' perceived roles and responsibilities," *High. Educ.*, vol. 62, no. 6, pp. 757–771, Dec. 2011, doi: 10.1007/s10734-011-9416-0.
- [5] "QP Stamatia Dova: 'Kind Like a Father': On Mentors and Kings in the Odyssey," *The Center for Hellenic Studies*, Nov. 02, 2020. <https://chs.harvard.edu/qp-stamatia-dova-kind-like-a-father-on-mentors-and-kings-in-the-odyssey/> (accessed Mar. 08, 2021).
- [6] L. G. Lunsford and V. L. Baker, "Great Mentoring in Graduate School:," pp. 2-3.
- [7] L. E. Drane, J. Y. Lynton, Y. E. Cruz-Rios, E. W. Malouchos, and K. D. Kearns, "Transgressive learning communities: Transformative spaces for underprivileged, underserved, and historically underrepresented graduate students at their institutions," *Teach. Learn. Inq.*, vol. 7, no. 2, Art. no. 2, Sep. 2019, doi: 10.20343/teachlearninqu.7.2.7.
- [8] J. H. Waldeck, V. O. Orrego, T. G. Plax, and P. Kearney, "Graduate student/faculty mentoring relationships: Who gets mentored, how it happens, and to what end," *Commun. Q.*, vol. 45, no. 3, pp. 93–109, Jun. 1997, doi: 10.1080/01463379709370054.
- [9] W. Wright-Harp and P. A. Cole, "A Mentoring Model for Enhancing Success in Graduate Education," *Contemp. Issues Commun. Sci. Disord.*, vol. 35, no. Spring, pp. 4–16, Mar. 2008, doi: 10.1044/cicsd_35_S_4.
- [10] N. A. of S. Medicine Engineering, and, P. and G. Affairs, B. on H. E. and Workforce, and C. on E. M. in STEMM, *The Science of Effective Mentorship in STEMM*. National Academies Press, 2020.
- [11] K. Atkins, B. M. Dougan, M. S. Dromgold-Sermen, H. Potter, V. Sathy, and A. T. Panter,

- “‘Looking at Myself in the Future’: how mentoring shapes scientific identity for STEM students from underrepresented groups,” *Int. J. STEM Educ.*, vol. 7, no. 1, p. 42, Aug. 2020, doi: 10.1186/s40594-020-00242-3.
- [12] D. C. Braun, C. Gormally, and M. D. Clark, “The Deaf Mentoring Survey: A Community Cultural Wealth Framework for Measuring Mentoring Effectiveness with Underrepresented Students,” *CBE—Life Sci. Educ.*, vol. 16, no. 1, p. ar10, Mar. 2017, doi: 10.1187/cbe.15-07-0155.
- [13] M. M. Palsa and M. H. Rosser, *Mentoring and Diversity: A Review of the Literature*. 2007.
- [14] A. I. Leshner, “Student-centered, modernized graduate STEM education,” *Science*, vol. 360, no. 6392, pp. 969–970, Jun. 2018, doi: 10.1126/science.aau0590.
- [15] G. Crisp and I. Cruz, “Mentoring College Students: A Critical Review of the Literature Between 1990 and 2007,” *Res. High. Educ.*, vol. 50, no. 6, pp. 525–545, Sep. 2009, doi: 10.1007/s11162-009-9130-2.
- [16] S. Gadbois and E. Graham, “New Faculty Perceptions of Supervision and Mentoring: The Influence of Graduate School Experiences,” *Collect. Essays Learn. Teach.*, vol. 5, pp. 44–49, 2012, doi: 10.22329/celt.v5i0.3416.
- [17] S. Calkins and M. R. Kelley, “Mentoring and the faculty-TA relationship: faculty perceptions and practices,” *Mentor. Tutoring*, vol. 13, no. 2, pp. 259–280, Aug. 2005, doi: <https://doi.org/10.1080/13611260500105915>.
- [18] K. A. Griffin, in *Higher education administration for social justice and equity in higher education: Critical perspectives for leadership and decision-making*, New York, NY: Routledge Press, 2020, pp. 93–110.
- [19] K. A. Holley and M. L. Caldwell, “The Challenges of Designing and Implementing a Doctoral Student Mentoring Program,” *Innov. High. Educ.*, vol. 37, no. 3, pp. 243–253, Jun. 2012, doi: 10.1007/s10755-011-9203-y.
- [20] L. L. Crumpton-Young, S. Etemadi, G. E. Little, and T. D. Carter, “Supportive Practices Used with Underrepresented Minority Graduate Students,” presented at the 2016 ASEE Annual Conference & Exposition, Jun. 2016, Accessed: Sep. 21, 2020. [Online]. Available: <https://peer.asee.org/supportive-practices-used-with-underrepresented-minority-graduate-students>.
- [21] K. M. Thomas, L. A. Willis, and J. Davis, “Mentoring minority graduate students: issues and strategies for institutions, faculty, and students,” *Equal Oppor. Int.*, vol. 26, no. 3, pp. 178–192, Jan. 2007, doi: 10.1108/02610150710735471.
- [22] T. J. Yosso, “Whose culture has capital? A critical race theory discussion of community cultural wealth,” *Race Ethn. Educ.*, vol. 8, no. 1, pp. 69–91, Mar. 2005, doi: 10.1080/1361332052000341006.
- [23] M. Denton, M. Borrego, and A. Boklage, “Community cultural wealth in science, technology, engineering, and mathematics education: A systematic review,” *J. Eng. Educ.*, vol. 109, no. 3, pp. 556–580, Jul. 2020, doi: 10.1002/jee.20322.
- [24] S. Kelly and J. H. Schweitzer, “MENTORING WITHIN A GRADUATE SCHOOL SETTING,” *Coll. Stud. J.*, vol. 33, no. 1, pp. 130–130, Mar. 1999.
- [25] J. L. Brill, K. K. Balcanoff, D. Land, M. Gogarty, and F. Turner, “Best Practices in Doctoral Retention: Mentoring,” *High. Learn. Res. Commun.*, vol. 4, no. 2, p. 26, Jun. 2014, doi: 10.18870/hlrc.v4i2.186.
- [26] G. L. Rose, “Enhancement of Mentor Selection Using the Ideal Mentor Scale,” *Res. High. Educ.*, vol. 44, no. 4, pp. 473–494, Aug. 2003, doi: 10.1023/A:1024289000849.
- [27] A. P. Field, *Discovering statistics using SPSS: and sex, drugs and rock “n” roll*, 3rd ed. Los Angeles: SAGE Publications, 2009.
- [28] R. C. MacCallum, K. F. Widaman, S. Zhang, and S. Hong, “Sample size in factor analysis,” *Psychol. Methods*, vol. 4, no. 1, pp. 84–99, 1999, doi: 10.1037/1082-989X.4.1.84.
- [29] A. Coso Strong and D. Sekayi, “Exercising professional autonomy: Doctoral students’ preparation for academic careers,” *Stud. Grad. Postdr. Educ.*, vol. 9, no. 2, pp. 243–258, Nov. 2018, doi: 10.1108/SGPE-D-18-00005.

- [30] G. L. Rose, "GROUP DIFFERENCES IN GRADUATE STUDENTS' CONCEPTS OF THE IDEAL MENTOR," *Res. High. Educ.*, vol. 46, no. 1, pp. 53–80, 2005, doi: 10.1007/s 11162-004-6289-4.
- [31] C. Woolston, "Nature's 2017 PhD survey reveals that, despite many problems with doctoral programmes, PhD students are as committed as ever to pursuing research careers.," *Nature*, vol. 550, pp. 549–552, Oct. 2017.
- [32] A. Bone, "Pursuing a master's degree: Opportunity cost and benefits," *Educ. Q. Rev.*, vol. 8, no. 4, p. 16, Oct. 2002.
- [33] A. S. Douglas, "Engaging doctoral students in networking opportunities: a relational approach to doctoral study," *Teach. High. Educ.*, pp. 1–17, Aug. 2020, doi: 10.1080/13562517.2020.1808611.
- [34] A. Holbrook, K. Shaw, J. Scevak, S. Bourke, R. Cantwell, and J. Budd, "PhD Candidate Expectations: Exploring Mismatch with Experience," *Int. J. Dr. Stud.*, vol. 9, pp. 329–346, 2014, doi: 10.28945/2078.

Appendix: Ideal Mentor Scale (adapted from [26])

<i>Right now, at this stage of my development, my ideal mentor would . . .</i>	<i>Original Classification</i>	<i>Reclassification using CCW</i>
(1) ... show me how to employ relevant research techniques.	Guidance	Discipline
(2) ... give me specific assignments related to my research problem.	Guidance	Discipline
(3) ... give proper credit to graduate students.	Integrity	Social
... take me out for dinner and/or drink after work.	Relationship	Social
(4) ... prefer to cooperate with others than compete with them.	Integrity	Social
(5) ... help me to maintain a clear focus on my research objectives.	Guidance	Discipline
... respect the intellectual property rights of others.	Integrity	Discipline
... be a role model.	Integrity	Aspirational
... brainstorm solutions to a problem concerning my research project.	Guidance	Discipline
... be calm and collected in times of stress.	Integrity	Aspirational
(6) ... treat me as an adult who has a right to be involved in decisions that affect me.	Integrity	Aspirational
... help me plan the outline for a presentation of my research.	Guidance	Academic/ Discipline
(7) ... inspire me by his or her example and words.	Integrity	Aspirational
(8) ... help me investigate a problem I am having with research design.	Guidance	Discipline
... accept me as a junior colleague.	Integrity	Navigational
(15) ... advocate for my needs and interests.	Integrity	Navigational
... talk to me about his or her personal problems.	Relationship	Community
(9) ... value me as a person.	Integrity	Community
(10) ... have coffee or lunch with me on occasion.	Relationship	Social
... believe in me.	Integrity	Aspirational
(11) ... meet with me on a regular basis.	Guidance	Navigational
... relate to me as if he/she is a responsible, admirable older sibling.	Relationship	Aspirational
(12) ... recognize my potential.	Integrity	Aspirational
(14) ... provide information to help me understand the subject matter I am researching.	Guidance	Discipline
... help me to realize my life vision.	Relationship	Aspirational
(13) ... help me plan a timetable for my research.	Guidance	Discipline
... work hard to accomplish his/her goals.	Integrity	Aspirational
... be generous with time and other resources.	Guidance	Navigational