Board 339: Mentoring Competencies From the Perspective of Mentors and Their Racially Marginalized STEM Mentees

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Mentoring Competencies from the Perspective of Mentors and their Racially Marginalized STEM Mentees

Abstract

Despite various efforts to broaden participation, racially marginalized students (i.e., Black, Hispanic/Latinx, and American Indian/Alaskan Native identifying people) continue to be underrepresented in Science, Technology, Engineering, and Math (STEM) fields and careers. Mentoring is recognized as a mechanism that has been shown to support the persistence and success of racially marginalized students in STEM through providing relevant resources, psychosocial support, and fostering identity development. This quantitative work aims to understand the mentoring competencies of mentors who support racially marginalized students in STEM. To promote effective mentoring, it is essential to understand the mentoring competencies of mentors from the perspective of both mentors and mentees. Understanding how mentees perceive various mentoring competencies can help mentors understand deficiencies in their skills to improve their mentoring practices.

Using survey data collected from mentors and racially marginalized mentees, we assessed the mentoring competencies of mentors from the perspective of both mentors and mentees. The survey data includes demographic and academic information about mentors and mentees. In addition, using a pre-validated survey instrument, mentors and mentees rated the mentoring competencies of the mentors on a Likert scale across five constructs of mentoring. The five mentoring constructs include maintaining effective communication, aligning expectations, assessing understanding, fostering independence, and promoting professional development. Each construct consists of multiple items for a total of 26 survey items. We compared the mentors' self-rated competencies with the ratings provided by the mentees to identify differences across demographics. Preliminary findings identify differences in the mentoring competencies of mentors from the perspective of both mentors and mentees. Recommendations for research and practice are also presented.

1. Introduction

Despite various efforts to broaden participation, historically marginalized students (Black, Hispanic/Latinx, and American Indian/Alaskan Native identifying people) and women continue to be underrepresented in Science, Technology, Engineering, and Math (STEM) fields and careers. For example, women continue to receive less than 30% of engineering degrees, 35% of computer science degrees, and 25% of physics degrees at all levels [1]. Further, from 2008-2018 the percentage of Black students earning a bachelor's in science or engineering remained at 8% [1]. This continues to have detrimental effects on students who are underrepresented as well as the future STEM workforce. For example, in a study performed by Dancy et al. [2], undergraduate students noted how "being a minority can lead to students feeling intimidated,

feeling pressure to work harder, or feeling out of place, and these feelings have a negative impact on their educational experience" [2, p. 14]. Some of these issues stem from the meritocratic values of STEM, which ignore larger structural issues that students experience [3], [4].

Past research has shown that students with mentors are more likely to self-identify as belonging in their respective STEM fields and have higher self-efficacy, both of which are linked to persistence in STEM fields [5], [6]. Mentees also have "increased job satisfaction, higher salary, faster promotion, firmer career plans, and the increased probability that a protégé will also become a mentor" [7, p. 204]. Also, those who identified as having mentors reported more career mobility, recognition, satisfaction, and promotions in their corporate jobs [8]. In addition to benefitting all students, mentoring is recognized as a mechanism that has been shown to support the persistence and success of historically marginalized students in STEM through providing relevant resources, psychosocial support, and fostering identity development [5], [9], [10]. Marginalized students with mentors were more likely to identify as belonging in their field [5] and have higher self-efficacy [11]. Specifically, Black students who had research-related mentors had higher college satisfaction scores [12]. These factors not only increased the students' likelihood of obtaining a STEM degree but also increased students' likelihood of persisting in STEM fields past graduation [11]. Outcomes of mentoring have proven successful enough to produce a myriad of programs to increase diversity and inclusivity at institutions [10].

However, to promote effective mentoring, it is essential to understand the mentoring competencies of mentors from the perspective of both mentors and mentees. Understanding how mentees perceive various mentoring competencies can serve as feedback to mentors and help them understand deficiencies in their skills to improve their mentoring practices. This quantitative work aims to understand the mentoring competencies of mentors who support racially marginalized students in STEM. Using survey data collected from mentors and racially marginalized mentees, we assessed the mentoring competencies of mentors from the perspective of both mentors and mentees. The research questions guiding this work are 1) How do mentors and racially marginalized mentees rate the mentoring competencies of their mentors? 2) Are there any differences in the mentoring competencies ratings of mentors from the perspective of both mentors and mentees? 3) Are there any differences in the mentoring competencies ratings of mentors from the perspective of both mentors and mentees when grouped by gender and race/ethnicity?

2. Methods

2.1 Measures

The Mentoring Competencies Assessment (MCA) survey used to collect data from the mentors and mentees contains 26 Likert-scale questions to assess mentoring competencies in five different constructs of mentoring. The five mentoring constructs are maintaining effective

communication which includes seven questions, aligning expectations which includes four questions, assessing understanding which includes three questions, fostering independence which includes seven questions, and promoting professional development which includes five questions. These items come from a pre-validated survey instrument [13] and were rated on a 7-point Likert-scale (1=not skilled at all to 7 =extremely skilled) with a score of 8 corresponding to instances where the participants did not have experience with the particular competency question listed. In addition to items assessing mentoring competencies, the mentor and mentee surveys also collected demographics and background information such as gender identity, racial/ethnic identification, age, citizenship status, current title/role (mentor survey), total number of years mentoring undergraduate students (mentor survey), current academic status (mentee survey), undergraduate major (mentee survey), and years since being an undergraduate student (mentee survey).

2.2 Recruitment and Data Collection

After receiving institutional IRB approval, mentors were recruited using a crowdsourcing method. This method involved surveying more than 10 National Academies mentoring experts and faculty and students from more than 60 research, teaching, MSI, and HBCU institutions, student professional organizations like the National Society of Black Engineers, the Society of Hispanic Professional Engineers, SACNAS, and more to ask them to identify highly effective mentors who help racially minoritized students persist in STEM. Next, identified mentors were invited to participate in a survey and interview. After the interview, they were asked to identify up to five racially minoritized students in STEM that they have a mentoring relationship with. The identified mentees, current students or graduates, were then invited to participate in completing the MCA survey online using Qualtrics and interview (interview details not reported in this paper).

2.3 Data Analysis

A total of 68 mentors and 64 racially minoritized mentees completed the survey. The responses of the mentors and mentees were first imported into an Excel sheet. The Excel sheets were then cleaned and imported into RStudio, a software program, for statistical analysis. Mentors and mentees who indicated more than one race/ethnic identity were grouped with participants who selected multiracial/multicultural for their racial/ethnic identification. Using R, we converted all Likert responses corresponding to a score of 8 to N/A. One of the 64 mentees was excluded from the analysis because they indicated a Likert response of 8 on a large number of survey questions which indicates not having experience with that particular mentoring competency question. For each of the constructs of mentoring, we divided the mentors' and mentees' responses by gender and race/ethnicity and averaged the corresponding Likert-scale responses. When grouping the responses by gender, we excluded two mentors and two mentees who indicated other genders

from the analysis because there were not enough responses in the other genders category to draw quantifiable conclusions in the current work. Next, we performed independent Welch's two-sample t-tests for each of the five constructs of mentoring to compare group differences within the men and women gender identity independent variable for both the mentors and mentees. For the race/ethnicity independent variable, we performed a one-way ANOVA to compare group differences in each of the five constructs of mentoring for both the mentors and mentees. When grouping the responses by race/ethnicity, we excluded one mentor who identified as Asian or Asian American, one mentor who identified as American Indian or Alaska Native, and one mentee who identified as Asian or Asian American from the ANOVA because they were the only participants in the respective racial/ethnic identification groups and therefore there were not enough responses in the Asian or Asian American and American Indian or Alaska Native race/ethnicity categories to draw quantifiable conclusions about group differences. Finally, we calculated the effects size using Cohen's d when significant differences emerged between groups. We carried out the statistical analysis using RStudio software (version 4.2.2) and set the alpha level for significance at 0.05.

3. Results

3.1 Mentors Responses

A total of 68 mentors responded to the survey. Of the 68 mentors who responded, 46 identified as female, 20 identified as male, one identified as transgender (other), and one did not provide a response. Seven of the mentors held the title of administrator, 10 held the title of assistant professor, 16 held the title of associate professor, 19 held the title of professor, 4 held the title of staff, and 12 held other titles. The largest racial group represented in the sample were Black or African American mentors (n=28), followed by mentors who identified as non-Hispanic white (n=21), Multiracial/Multicultural (n=9), Hispanic or Latino (n=8), Asian or Asian American (n=1) and American Indian (n=1). The mentor demographic and background details can be found in Table 1. Finally, out of the 68 mentors who responded to the survey, 10 mentors had three or more mentees respond to the mentee survey.

Table 1. Demographics and background information of the mentors who responded to the survey.

	Number	Percentage
Gender		
Female	46	68%
Male	20	29%
Other/No response	2	3%

Title		
Administrator	7	10%
Assistant Professor	10	15%
Associate Professor	16	24%
Professor	19	28%
Staff	4	6%
Other	12	18%
Postdoc	2	
Chief Programs Officer	1	
Teaching Professor (Tenure Track)	1	
Educational Consultant	1	
Teaching Assistant Professor (Non-Tenure Track)	1	
Senior Associate Professor	1	
Postdoctoral Assistant Professor	1	
Associate Professor of Practice	1	
Research Scientist	1	
Associate Professor of Instruction	1	
Lecturer	1	
Racial and/or Ethnic Identification		
American Indian or Alaska Native	1	1%
Asian or Asian American	1	1%
Black or African American	28	41%
Hispanic or Latino	8	12%
Multiracial/Multicultural	9	13%
White/Non-Hispanic	21	31%

The group means of each of the five mentoring competencies as rated by the male and female mentors are listed in Table 2. When grouped by gender, there was no statistically significant difference between how the male and female mentors rated their competencies in any of the five mentoring constructs. The competencies that each of the genders rated as highest were different. The male mentors rated their ability to maintain effective communication highest (mean score of 5.83 out of 7), while the female mentors rated their ability to align expectations highest (mean score of 5.79 out of 7). On the other hand, both the male and female mentors rated their ability to assess understanding lowest.

Table 2. ***Mentors - Mean scores of each of the five mentoring constructs when grouped by gender.***

Competency	Men (n=20)	Women (n=46)	Difference in Mean Score
Maintaining Effective Communication	5.83	5.75	0.08
Aligning Expectations	5.37	5.79	0.42
Assessing Understanding	5.23	5.26	0.03
Fostering Independence	5.70	5.74	0.04
Promoting Professional Development	5.35	5.73	0.38

*$p < 0.05$

The group means of each of the five mentoring competencies as rated by the mentors of different racial/ethnic identification are listed in Table 3. When grouped by racial/ethnic identification, there was no statistically significant difference between how the Black/African American, Hispanic/Latino, Multiracial/Multicultural, and white/non-Hispanic mentors rated their competencies in any of the five mentoring competencies. The Black/African American, Hispanic/Latino, and Multiracial/Multicultural mentors, and the one Asian/Asian American mentor rated their ability to maintain effective communication highest. The white/non-Hispanic mentors rated their ability to align expectations highest, and the one American Indian/Alaska Native mentor rated their ability to promote professional development highest.

Table 3. ***Mentors - Mean scores of each of the five mentoring competencies when grouped by race/ethnicity.***

Competency	Asian/ Asian American (n=1)	American Indian/ Alaska Native (n=1)	Black/ African American (n=28)	Hispanic /Latino (n=8)	Multiracia/ Multicultu ral (n=9)	White/ Non-Hispanic (n=21)

Maintaining Effective Communication	5.57	5.42	5.88	6.14	5.58	5.50
Aligning Expectations	4.00	5.50	5.76	5.56	5.52	5.63
Assessing Understanding	4.00	5.00	5.56	5.16	4.63	5.15
Fostering Independence	5.14	5.28	5.82	6.08	5.47	5.54
Promoting Professional Development	3.80	5.80	5.72	5.98	5.20	5.44

*$p < 0.05$

3.2 Mentees' Responses

Of the 64 mentees who responded to the survey, 37 identified as female, 25 identified as male, 1 identified as genderqueer, and 1 identified as non-binary. All the individuals indicated that they identified as a minoritized person. The largest racial group represented in the sample were Black or African American mentees (45%), followed by participants who identified as Hispanic or Latino (36%), Asian or Asian American (3%), and American Indian (2%). In addition, 11 of the participants chose more than one racial and/or ethnic identification or chose multiracial/multicultural. A variety of majors were also represented in the data, including 6 from computer and information technology sciences, 21 from engineering, 14 from life sciences, 13 from social sciences, 8 from traditional science, and 2 participants selected other. In this study, social sciences included anthropology, economics, psychology, and sociology majors and traditional sciences referred to students in biology, chemistry, geoscience, and mathematical sciences. The background and demographic details of mentees can be found in Table 4.

Table 4. Demographics and background information of the mentees who responded to the survey.

	Number	Percentage
Gender		
Female	37	58%
Male	25	39%
Other	2	3%
Major		
Computer and Information Technology Sciences	6	9%

Engineering	21	33%
Life Sciences	14	22%
Social Sciences	13	20%
Traditional Science	8	13%
Other	2	3%
Academic Status		
Undergraduate Student	27	42%
Graduate Student	23	36%
Not a current student	6	9%
Other	8	13%
Racial and/or Ethnic Identification		
Asian or Asian American	1	2%
Black or African American	29	45%
Hispanic or Latino	23	36%
Multiracial/Multicultural	11	17%

The mean values of each of the five mentoring competencies as rated by the male and female mentees are listed in Table 5. When grouped by gender, there was a statistically significant difference between how the mentees rated the mentors' competencies as shown in Table 5. Compared to the male mentees, the female mentees rated mentors' competencies significantly higher in every category: maintaining effective communication ($p = 0.011$), aligning expectations ($p = 0.036$), assessing understanding ($p = 0.025$), fostering independence ($p = 0.032$), and promoting professional development ($p = 0.033$). The competencies that each of the genders rated as highest and lowest were different. The male mentees rated mentors' ability to foster independence highest (mean score of 6.37 out of 7), while the female mentees rated the mentors ability to maintain effective communication highest (mean score of 6.71 out of 7). On a similar note, the male mentees rated mentors' ability to assess understanding lowest (mean score of 6.08 out of 7), while the female mentees rated the mentors ability to align expectations lowest (mean score of 6.57 out of 7). The largest difference in the mean score was observed for the assessing understanding competency (difference of 0.52) and the smallest difference in the mean score was observed for the fostering independence competency (difference of 0.34).

Table 5. Mentees - Mean scores of each of the five mentoring constructs when grouped by gender.

Competency	Men	Women	Difference in Mean Score	Cohen's d
Maintaining Effective Communication	6.24	6.71	0.47*	0.78
Aligning Expectations	6.15	6.57	0.42*	0.56
Assessing Understanding	6.08	6.60	0.52*	0.67
Fostering Independence	6.35	6.69	0.34*	0.66
Promoting Professional Development	6.21	6.59	0.38*	0.59

The group mean of each of the five mentoring competencies as rated by the mentees of different racial/ethnic identification are listed in Table 6. When grouped by racial/ethnic identification, there was no statistically significant difference between how the Black/African American, Hispanic/Latino, and Multiracial/Multicultural mentees rated the competencies of mentors in any of the five mentoring constructs. The Black/African American, Hispanic/Latino mentees, and the one Asian/Asian American mentee rated mentors' ability to foster independence highest, while the Multiracial/Multicultural mentees rated mentors' ability to promote professional development highest.

Table 6. Mentees - Mean scores of each of the five mentoring constructs when grouped by race/ethnicity.

Competency	Asian/ Asian American (n=1)	Black/ African American (n=29)	Hispanic/ Latino (n=23)	Multiracial/ Multicultural (n=11)
Maintaining Effective Communication	6.71	6.51	6.58	6.42
Aligning Expectations	6.25	6.22	6.62	6.50
Assessing Understanding	6.67	6.26	6.52	6.46
Fostering Independence	6.86	6.86	6.75	6.64
Promoting Professional Development	6.40	6.29	6.64	6.55

*$p < 0.05$

3.3 Comparing Mentors and Mentees Responses

The mean scores for the five mentoring competencies as rated by mentors and mentees in the study are listed in Table 7. When comparing the mentoring competencies as rated by the mentors and mentees, there was a statistically significant difference across all the five mentoring constructs. The mentors in the study rated themselves significantly lower compared to the scores assigned by the mentees. The mentees rated mentors ability to foster independence highest (6.56 on a scale of 7) while the mentors rated their ability to maintain effective communication highest (5.75 on a scale of 7). Further, both the mentors and mentees rated mentors' ability to assess understanding lowest.

Table 7. ***Mean Scores of Mentoring Competencies - Mentor and Mentees Comparison.***

Competency	Mentors	Mentees	Difference in Mean Score	Cohen's d
Maintaining Effective Communication	5.75	6.53	0.78**	1.10
Aligning Expectations	5.64	6.40	0.76**	0.87
Assessing Understanding	5.24	6.39	1.15**	1.29
Fostering Independence	5.70	6.56	0.86**	1.30
Promoting Professional Development	5.57	6.46	0.89**	1.01

*$p < 0.05$, **$p < 0.01$

There was no statistically significant difference in the scores reported by mentees when comparing mentees who had mentors with the same or different gender identity (Table 8). Similarly, there was no statistically significant difference in the scores reported by mentees when comparing mentees who had mentors with the same or different race/ethnic identity (Table 9). In other words, having mentors with the same gender or race/ethnic identity did not significantly impact the mentoring competency scores given to mentors by the mentees.

Table 8. ***Impact of Mentee and Mentor Gender Matching - Mentee Scores.***

Competency	Match Gender (n=39)	Do Not Match (n=25)	Mean Score Difference
Maintaining Effective Communication	6.57	6.46	0.11
Aligning Expectations	6.47	6.31	0.16
Assessing Understanding	6.45	6.28	0.17
Fostering Independence	6.62	6.47	0.15

Promoting Professional Development	6.46	6.45	0.01

*p < 0.05

Table 9. Impact of Mentee and Mentor Race/Ethnicity Matching - Mentee Scores.

Competency	Match Race (n=36)	Do Not Match (n=28)	Mean Score Difference
Maintaining Effective Communication	6.52	6.53	0.01
Aligning Expectations	6.41	6.42	0.01
Assessing Understanding	6.48	6.26	0.22
Fostering Independence	6.58	6.53	0.05
Promoting Professional Development	6.36	6.59	0.23

*p < 0.05

4. Discussion

Examining how racially marginalized students experience mentoring is crucial given that effective mentorship has been documented as one strategy to retain and combat the negative experiences faced by marginalized undergraduate students [14]. In this study, there were no statistically significant differences in the self-rated competencies of mentors by gender. However, there was a statistically significant difference between how the racially marginalized male and female mentees rated the mentors' competencies. Compared to the male mentees, the female mentees in our study rated the mentors' competencies higher in all five constructs of mentoring. A possible explanation for this finding is that racially marginalized women have better experiences with their mentors compared to racially marginalized men. However, it is also possible that racially marginalized women are more generous in their ratings of their mentors. Further, the racially marginalized male mentees in our study rated their mentor's ability to foster independence the highest while the racially marginalized female mentees rated their mentor's ability to maintain effective communication the highest. A possible reason for this could be that men are viewed as self-directed and requiring less support by their mentors, while women are seen as requiring more guidance in STEM fields which are predominantly male. For the next significant finding, the mentors rated themselves significantly lower in all the five mentoring constructs compared to the scores assigned to them by mentees, with both the mentors and mentees rating mentors' ability to assess understanding the lowest. This might represent an area of opportunity for mentors who mentor racially minoritized students to improve upon to enhance their mentoring relationships. Further, even though women and racially minoritized students are

underrepresented in STEM, 68% of the mentors in this study identified as female, and 41% identified as Black/African American. This suggests that the labor of mentoring might be distributed disproportionately amongst people of different races and/or gender identities.

Finally, having mentors with the same gender or race/ethnic identity did not significantly impact the mentoring competency scores given to mentors by the mentees in this study. Some previous research indicates that shared values, more than matching demographics, is an important factor associated with a high-quality relationship from the perspective of mentees [15] and that gender or race matching in mentoring does not significantly impact academic outcomes [16]. However, students also indicate the importance of having mentors with whom they share gender or racial identity [16]. The mentoring constructs examined in this study include maintaining effective communication, aligning expectations, assessing understanding, fostering independence, and promoting professional development, which might not fully reflect or describe all the constructs that mentors who mentor racially marginalized students might need to be competent in. For example, mentors who are engaged in cross-race and cross-gender mentoring might not always fully understand the racial and gendered experiences of their mentees who are of another race and/or gender [17]. And as such, race and gender are important characteristics to consider in mentoring relationships, and mentoring might also need to be assessed on other competencies, such as cultural sensitivity.

Investigating the experiences of individuals who persist in STEM environments is important because STEM fields represent areas where resources are often directed. One example is salary. A study about individuals who worked year-round and were at least 25 years old found that STEM employees earn an average of two-thirds more than employees in non-STEM fields. “Even among workers with similar levels of education, STEM workers earn significantly more than non-STEM workers” [18, p. 37]. Resources such as personal finance are currently not available to all individuals. Women and racially marginalized individuals are not positioned to thrive in STEM spaces. Therefore, they face many obstacles to gaining access to the resources that STEM possesses. Even when they advance into the STEM job market, they continue to be paid less [19]. Strategies such as mentoring could provide a solution to improving the access and success of marginalized students in STEM.

5. Limitations

The method of sampling relied on mentors reaching out to mentees. Therefore, the mentors most likely reached out to mentees that they had continuing relationships with, resulting in a selection bias in our sampling. This can be seen by the fact that the most given result was a 7 or “extremely skilled” when ranking a mentor's ability. Likely, the mentees who responded to the survey had very positive interactions with the mentor. Otherwise, the mentee would not be in contact with the mentor, or the mentee would not be willing to complete the survey. With regards

to the survey, not all individuals had experience with all mentoring competencies. There was an option on the survey that allowed students to note that they had no experience with that specific competency. Therefore, some individuals' mean score encompassed their responses from all the survey items corresponding to a competency while other individuals' mean scores for each of the constructs excluded some of the corresponding questions. A larger sample size where a majority of the participants report a score for all the competency questions could reduce any bias related to no responses.

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant No. 1942274. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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