Mentoring Practices Proven to Broaden Participation in STEM Disciplines

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Abstract

Mentoring is the process of transferring knowledge from a person with more experience and expertise in a field (mentor) to a less experienced person (protégé or mentee) to help them grow personally and professionally. Mentoring has proven to be an effective mechanism for ensuring student success in Science, Technology, Engineering and Mathematics (STEM) fields. Select mentoring programs for women, minorities, and underrepresented groups have shown significant gains in increasing the presence of students from various backgrounds in the STEM fields. The Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) program recognizes both individuals and organizations that have successfully implemented mentoring activities that have helped minority students in STEM disciplines. Given the efficacy of their mentoring methods, PAESMEM recipients serve as a national resource for researching best practices in mentoring. Thus, in this research investigation PAESMEM recipients were analyzed to characterize effective strategies for mentoring minorities within STEM fields. Twenty-five randomly selected PAESMEM recipients were asked to participate in a descriptive research study designed to assess mentoring practices. The results of the survey reveal five practices that the majority of PAESMEM recipients identified as having performed “very well” in their own mentoring programs. These research results can inform recommendations for mentoring practices that should be implemented in future mentoring programs to help underrepresented groups successfully navigate STEM fields.

Introduction

Mentoring is a pedagogical method defined as a relationship between an individual with potential and an individual with expertise. It is a two-way, developmental relationship defined by individual interactions involving guidance, support, advice, and encouragement. The relationship varies depending on the experience levels of the mentor and protégé, but ideally, a successful mentor possesses a desire to help, treats the protégé with patience, acts as a knowledge resource, understands the protégé, leads by example, aids the protégé in learning from their mistakes, and encourages protégé independence.

Mentoring has proven to be effective in increasing the protégés’ academic performance in formal educational settings among all age groups. The literature on mentoring reveals that 82.4% of protégés report positive outcomes from their mentoring relationship. Typically, students who participate in mentoring programs have a higher GPA, take more credit hours, and have a lower drop-out rate. Traditionally, mentors challenge students to develop critical thinking, self-discipline and good study habits. Moreover, the mentors also benefit from their experience of working with mentees and report heightened career satisfaction and commitment as a result.

Additionally, students belonging to disadvantaged groups have been shown to significantly benefit from mentoring relationships. Research has shown that many women, minorities, and disabled students that are interested in STEM disciplines may lack the self-confidence, social connections and information to pursue a career in one of these fields; moreover, some may feel as if they do not belong in STEM fields, because these occupations predominantly employ white
Note: It is evident in fields such as mathematics, physics, computer science and engineering that females are underrepresented at all levels. According to the National Science Board, in the last ten years, the proportion of bachelor's degrees awarded to women has declined in computer sciences, mathematics, and engineering and has not grown in other STEM fields. In addition, only 38% of the college-educated workforce in STEM fields is female and 31% of full-time STEM faculty and 27% of STEM deans and department heads are women.

Mentoring is one programmatic initiative that provides participants from underrepresented groups with exposure to role models, support networks, and personal interaction with experienced professionals to help them succeed in STEM fields. Attracting and retaining more personnel from underserved populations in the STEM workforce will maximize innovation, creativity, and competitiveness. Given that completion rates for STEM degrees by students in the United States have been projected to fall behind students in other countries, it is highly important to increase the engagement of students from all backgrounds and support their efforts through formal mentoring programs, which are directly correlated with increased retention of degree-seeking students in STEM fields.

One option for enhancing the impact of mentoring on student success is through the implementation of empirically-based and evidence-based practices in formal mentoring programs. Research has shown that the usage of best practices for youth mentoring programs is a significant moderator of mentoring effect size; specific practices that have been identified as being responsible for positive trends in youth mentoring outcomes include ongoing mentor training, organized activities between the mentor and protégé, and monitoring of program implementation. Additional research, evaluating practices in mentoring, determining which ones yield the most positive results, and subsequently implementing these best practices in formal mentoring programs, will increase the positive effects of mentoring on protégés. Therefore, this research was conducted to describe evidence-based practices of mentoring successfully implemented with underrepresented students in STEM fields.

Methodology

Participants

Twenty-five recipients of the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) participated in this study. PAESMEM recipients are selected for the award by demonstrating excellence in effectively mentoring underserved individuals in STEM fields over a period of five years or more. Therefore, randomly selecting our participants from this population ensured that all research participants had successfully implemented effective mentoring programs and practices.

Materials and Procedure

A twenty-two item survey instrument utilizing a contextually customized semantic differential rating scale was administered to participants (see Fig. 1). Participants anonymously completed the survey at a meeting of PAESMEM award recipients. The survey items consisted of practices commonly used by mentors. Participants were instructed to describe the degree to which they thought they performed each practice using the following semantic rating scale: Well, Very Well, Exceptionally Well, and N/A.
Results

The data collected from the surveys were analyzed using descriptive statistics (see Fig. 2). Each semantic response was assigned a numerical value in order to quantitatively analyze the data. Thus, N/A was assigned a value of 0, Well was assigned a value of 1, Very Well was assigned a value of 2, and Exceptionally Well was assigned a value of 3. Overall, participants reported a mean score of 2.18 for all practices (SD = 0.30).

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**Best Mentoring Practices Questionnaire**

Check the box which describes the degree in which you feel you perform each practice. If you feel the practice does not apply to you then please check Not Applicable (N/A).

| Practice                                                                 | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          | Level          |
|--------------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1. Developing mentoring roadmap with mentees (i.e., goals, factors,     | Well           | Very Well      | Exceptionally Well | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 2. Set high expectations of mentees performance                         | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 3. Create opportunities for mentees                                    | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 4. Broaden my mentor’s experiences                                     | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 5. Help to build my mentees’ confidence                                | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 6. Create an environment where mentees can take risks                   | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 7. Provide needed support for mentees                                  | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 8. Provide needed acceptance of mentees                                 | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 9. Be a role model from which my mentees can imitate                    | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 10. Publicize the benefits of following my teachings to my mentees       | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| 11. Demonstrate knowledge practices for my mentees                      | N/A            |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |

Figure 1. Survey administered to PAESMEM recipients to determine mentoring best practices.
Two survey items (Question 3, “Create opportunities for mentees,” and Question 13, “Be passionate about my mentees and their development”) share the maximum mean score ($M = 2.68$). The minimum mean score was found in responses to Question 10, “Publicize the benefits of following my teachings to my mentees” ($M = 1.60$).

Overall, the five highest rated mentoring practices include:

- Question 13. Be passionate about my mentees and their development ($M = 2.68$)
- Question 3. Create opportunities for mentees ($M = 2.68$)
- Question 2. Set high expectations of mentees performance ($M = 2.56$)
- Question 7. Provide needed support for mentees ($M = 2.52$)
- Question 20. Respect the confidentiality of my mentees ($M = 2.52$)

In contrast, the mentoring practices receiving the lowest scores included:

- Question 10. Publicize the benefits of following my teachings to my mentees ($M = 1.60$)
- Question 19. Respectfully question decisions my mentees make to gain complete understanding ($M = 1.80$)
- Question 11. Demonstrate knowledge practices for my mentees ($M = 1.84$)
- Question 12. Be consistent with my mentees (maintain ongoing contact) ($M = 1.84$)
- Question 22. Provide constant feedback to my mentees ($M = 1.92$)

**Discussion**

Based on the results, inferences may be drawn about best practices in mentoring aimed at serving students in STEM fields. The top rated mentoring practices revolve around developing a respectful relationship with the protégé, where the mentor extends personal interest and support to the mentee. In contrast, the three lowest rated practices focus on the mentor as an authority figure (i.e., demonstrating more knowledge and questioning the protégé’s decisions). The other two lowest rated practices center on structuring the mentoring relationship to provide consistent contact and feedback.

These factors lend to the implication that PAESMEM mentors excel in developing successful mentoring outcomes for underrepresented students in STEM fields through creating an organic relationship between mentor and mentee characterized by mutual respect and eschewing the rigid structure and hierarchy that would be found in a teacher/student or instructor/client relationship.
(which often utilize the five lowest rated practices). While mentors still attempt to organize the relationship by providing opportunities for the mentee and setting expectations for performance, they focus less on consistent contact and feedback, presumably letting these interactions arise naturally. Through this, PAESMEM scholars foster success in their mentees while allowing them to maintain independence.

The lack of specificity in many of the items in the survey leads to limitations in the study. For example, Question 7 states “Provide needed support for mentees.” The type of support, whether it is academic, emotional, social, etc., is not stated, limiting the conclusions that may be drawn from the survey item. Parsing apart the best practices determined by this study into more specific items for future surveys would be advised in order to generate more specific recommendations for mentors. Moreover, future studies on best practices in STEM mentoring may be strengthened through the collection of participant variables such as average time spent with protégés per week, average or maximum number of protégés, typical structure of mentoring meetings, etc. Again, this would aid in the creation of specific recommendations for mentors working on leading students in STEM fields to success.

**Conclusion**

Mentoring is a pedagogical method that has confirmed efficacy in improving students’ academic success. Through the examination of PAESMEM scholars’ valued mentoring practices, the present study has generated recommendations for mentors seeking to advance their mentees’ efforts in STEM fields. Mainly, mentors should attempt to establish a caring and respectful relationship with the mentee. Mentors should also carefully balance the level of structure present in the relationship so as to allow the protégé to maintain independence while still encouraging their success. More specific suggestions will require additional research to be performed on the practices utilized by PAESMEM recipients.

**Bibliography**