**2018 HAWAII UNIVERSITY INTERNATIONAL CONFERENCES**
**STEAM -** SCIENCE, TECHNOLOGY & ENGINEERING, ARTS, MATHEMATICS & EDUCATION
JUNE 6 - 8, 2018 PRINCE WAIKIKI, HONOLULU, HAWAII

# MEETING ENGINEERING STUDENTS' NEEDS THROUGH THE INVESTIGATION AND DEVELOPMENT OF EFFECTIVE MENTORING PRACTICES

CRUMPTON-YOUNG, LESIA ET AL
TENNESSEE STATE UNIVERSITY
NASHVILLE, TENNESSEE

Dr. Lesia Crumpton-Young
Mrs. Shabnam Etemadi Brady
Ms. Germysha Emily Little
Tennessee State University
Nashville, Tennessee

**Meeting Engineering Students' Needs through the Investigation and Development of Effective Mentoring Practices**

**Synopsis**:

The present research study was comprised of students who have successfully obtained a STEM (Science, Technology, Engineering, and Math) undergraduate degree. The researchers were interested in capturing the mentoring practices that led to the successful completion of their undergraduate degree. The present study aims to share an innovative model of mentoring from these findings. The model will include mentor and mentee perspectives and significant current literature on mentoring in STEM.

# Meeting Engineering Students' Needs Through the Investigation and Development of Effective Mentoring Practices


## Abstract

Mentoring has proven to be an effective support program for students pursuing higher education. Mentoring serves as a pedagogical method that has commendably improved students' academic success. Thus, it is important to identify and analyze key components of mentoring practices and the mentoring relationship that effectively assist students. The purpose of the present research study is to identify mentoring practices that aided students in completing their undergraduate degrees, in STEM fields, such as in Engineering. The present research study was comprised of students who have successfully obtained a STEM (Science, Technology, Engineering, and Math) undergraduate degree.

Sixty-four students (N=64) with an undergraduate degree in the STEM fields participated in the present research investigation. The majority (49%) of participants identified as Black or African-American, while others identified as Hispanic or Latino, Asian or Pacific Islander, White, Mixed, or Other. Therefore, the present research study provides insight into the mentoring experiences of Engineering and underrepresented minority students while in undergraduate studies. The results indicated that out of the 22 mentoring practices listed, the participants rated the following survey items as the best mentoring practices that they experienced: *The mentor created opportunities for the mentee; The mentor accepted the mentee*; and *The mentor broadened the mentee's experiences*. The present research study aims to share a supportive model from these findings and from previous findings to include both the mentees' and mentors' perspectives on best practices in mentoring.

## Introduction

Mentoring has been linked to student success both historically and nationally. According to Tillman (2001) as referenced by McCoy, Winkle-Wagner, Luedke [4] mentoring involves the following key factors: "networking, counseling, guiding, instructing, modeling, and sponsoring" as well as "personal, professional, and psychological processes" encompassed within a relationship with "a more experienced individual" and a "protégé." Mentoring can involve a formal or informal relationship and process [4]. Mentoring is often conceived as a developmental relationship in which the experienced individual guides the unexperienced or novel student entering the same or similar field [2]. With such a challenging task expected of the mentor, much research has been dedicated to developing models and strategies for supportive mentoring [5], [2]. With concerns of retention rates of students in STEM (Science, Technology, Engineering, and Mathematics) majors in higher education, mentoring has played an essential role in supporting student success in completion of degrees in STEM fields, such as the method of hierarchical mentoring in one STEM program [5].

Mentoring's potential impact on the professional development of STEM students has led to publications and research from scholars urging and providing mentoring methods. Akili [1] advocates that engineering educators become more involved as mentors. Akili [1] identifies that engineering educators are at the forefront of student learning and can engage students further in a mentoring role. Additionally, Akili [1] provides steps for consideration in the mentoring process for engineering educators. For example, mentoring can comprise academic planning or even support of identity development of students [3]. Mentoring relationships can occur naturally or within program protocol of assigning students to a mentor. Mentoring is often considered a pivotal factor for student training [3]. Specifically, mentoring students has been supportive of student success in educational advancements as well as degree completion [5], [3]. The goal of the present research study is to highlight findings from mentee perspectives as well as the mentors' perspectives from a previous study to develop a supportive mentoring practice model for Engineering student success. The study intends to gather data from the mentee (student receiving mentoring) and from underrepresented minority students in STEM to expand on data gathered from the mentors' perspectives as an inclusive process to establish a helpful mentoring model. The study also seeks to add to the body of literature in STEM and particularly in Engineering with its findings, such as with the establishment of the practice model.

## Methods

*Participants*

The study included 64 students ($N = 64$) with a STEM undergraduate degree from 6 different universities (Please see *Figure* 1). Over 90% of participants held degrees in various fields of Engineering including Environmental Engineering, Civil Engineering, Electrical Engineering, and many more concentrations. Participants self-identified from numerous different ethnic backgrounds including 49% Black or African American, 21% as White, 13% as Hispanic or Latino, 3% students as other ethnicities and 6% as mixed (Please see *Figure* 2). Therefore, underrepresented minority students in STEM including those in Engineering made up the larger percentage of the sample population of the present study.

The results of this study were compared to a previous study administered to award-winning mentors [6]. These award-winning mentors rated the same mentoring practices that the participants of this study rated. Mentors answered these questions based on previous and current mentoring relationships.

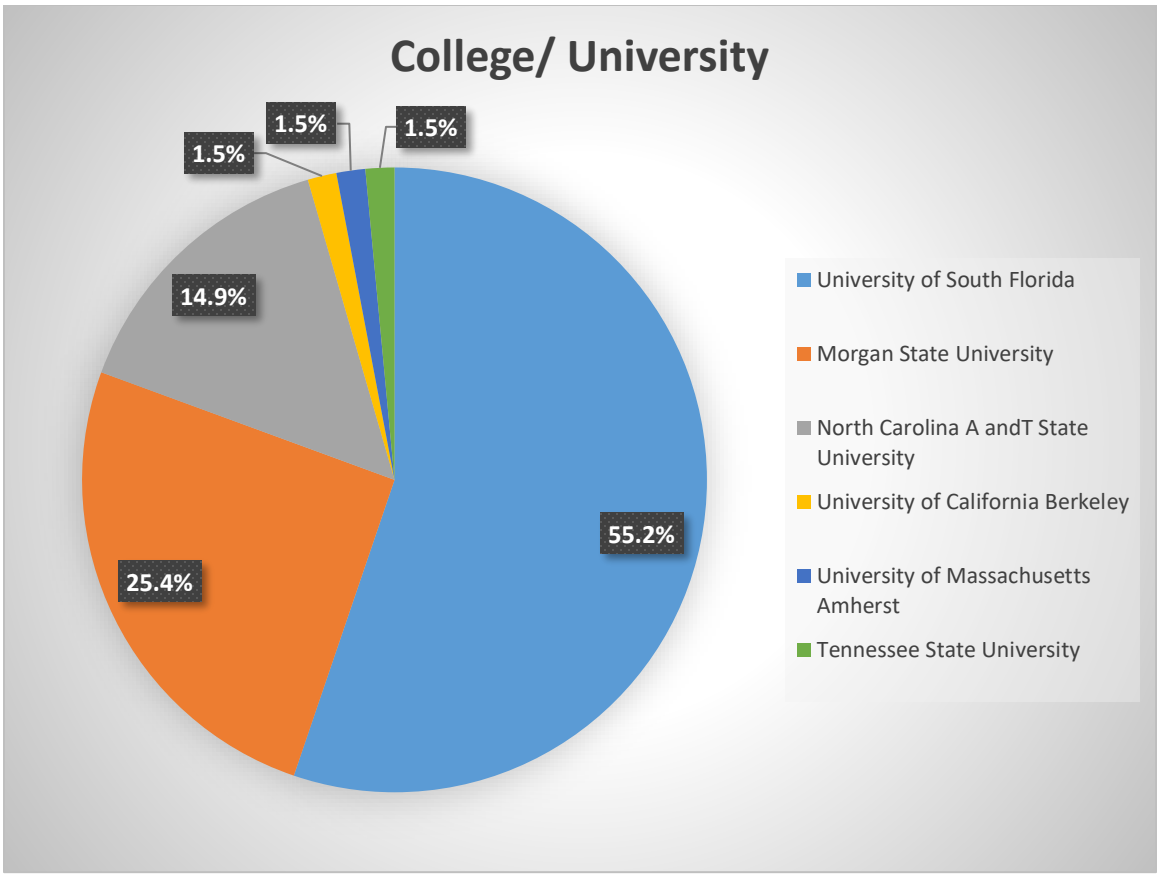


*Figure 1.* A graph representation of the universities that student participants attend.

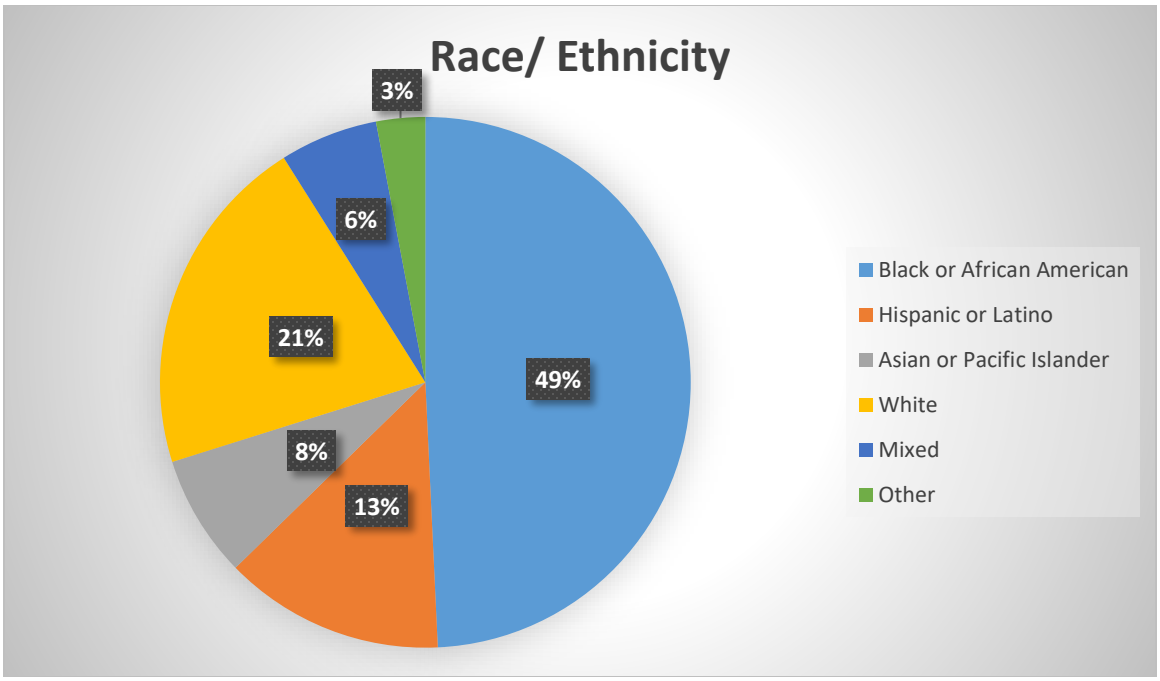


*Figure 2.* A graph representation of the ethnic background and race of student participants.

*Materials and Procedures*

Participants were nationally recruited to volunteer in educational settings, such as national conferences and professional workshops. Participants were administered a 22-item survey. The survey consisted of questions about the participants' undergraduate mentoring experiences, including their mentoring program elements, benefits, structure, and additional areas that evolved during the research investigation process. The participants used a Likert scale (Well=1, Very Well=2, and Exceptionally Well=3) in order to rate mentoring practices based on their undergraduate experiences. A Likert scale was used for quantitative data to be gathered to evaluate participants' experiences of mentoring. Some of the survey items regarding mentoring practices are as follows:

1. Be passionate about my mentees and their development
2. Create opportunities for mentees
3. Set high expectations of mentees performance
4. Provide needed support for mentees
5. Respect the confidentiality of my mentees

**Results**

The participants provided various responses to open-ended qualitative questions. For example, when the participants were asked to list factors that were used to choose a mentor during their undergraduate experience, many reported that professionalism, personality, knowledge, financial support, interest in mentor's research, and availability were key factors. These features were taken into consideration in order to develop a successful relationship.

Participants reported that their mentor helped them most prominently by providing funding and opportunities, writing recommendation letters, and providing guidance with future career and academic goals.

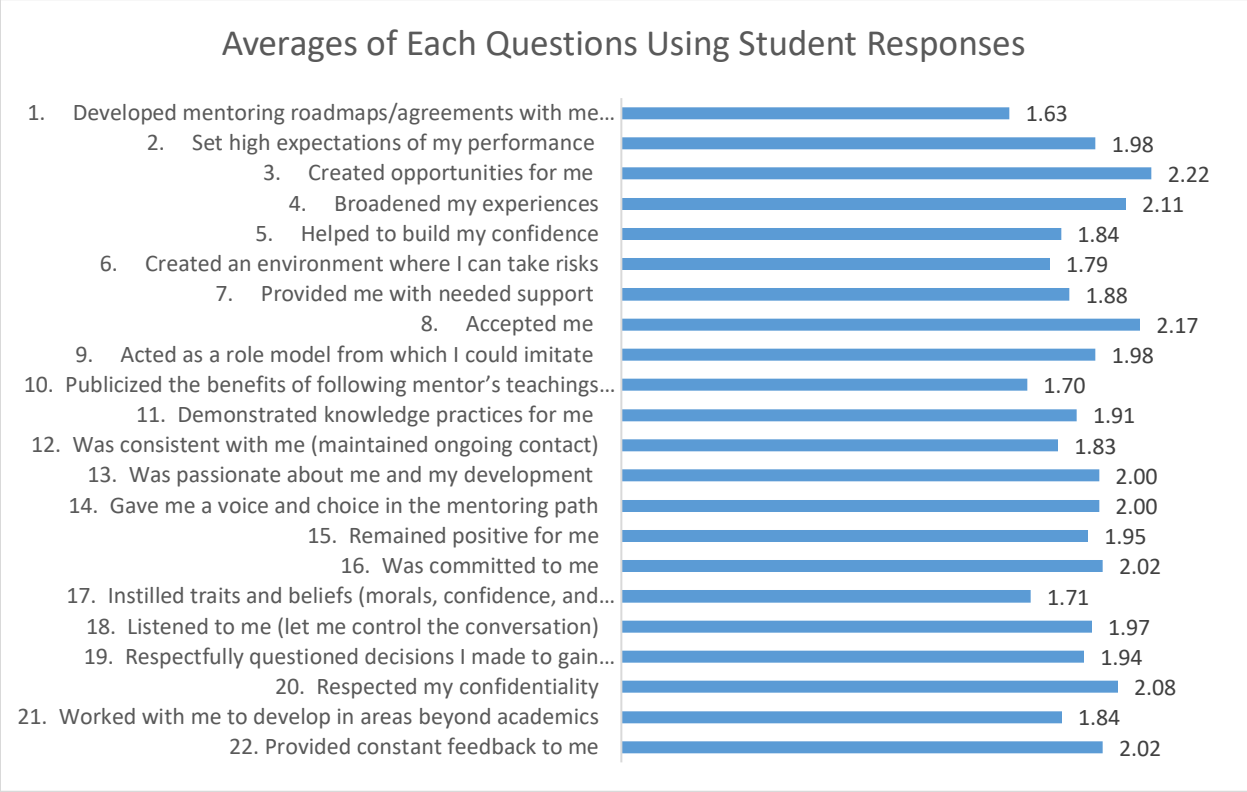


*Figure 3.* A graph representation of mentoring practices rated by mentees.

Results also indicated that out of the 22 mentoring practices listed on the survey, the participants rated the following as the topmost strategies as practiced by their mentors: 1) The mentor created opportunities for the mentee; 2) The mentor accepted the mentee, and 3) The mentor broadened the mentee's experiences (please see *Figure* 3). Comparisons of the top mentoring practices from the mentee and mentor perspective from previous studies indicated that only one of the three are in agreement, which is the following: The mentor created opportunities for me. It is important to note that both mentees and mentors rated the following practice highly as depicted in both *Figures* 3 and 4: "Respect my confidentiality" or "Respect the confidentiality of my mentees."

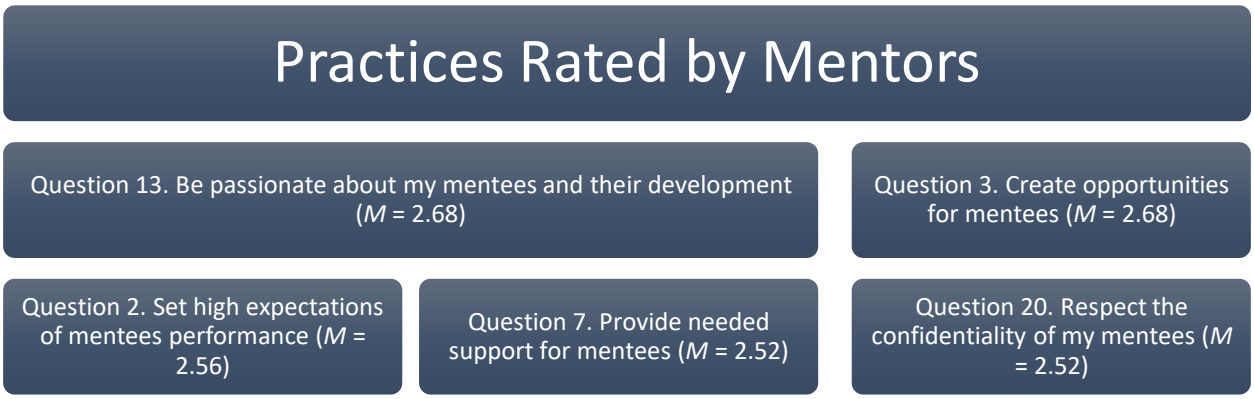


*Figure 4.* A diagram representation of mentoring practices rated by mentors.

Results of a previous mentoring study in which the same mentoring practices were rated by mentors indicated that the top-rated practices included the following: 1) Be passionate about my mentees and their development; 2) Create opportunities for mentees, and 3) Set high expectations of mentees performance [6]. Other top practices included "Provide needed support for mentee" and "Respect confidentiality of my mentees" (please see *Figure* 4).

**Discussion**

Two complementary models were developed from the top mentoring practices rated highly by both mentors and mentees as displayed below in *Figures* 5 and 6. Creating opportunities was shown to serve as a central mentoring practice identified by both mentors and mentees. Thus, the mentee participants used various factors such as professionalism, common research interest, and work ethic when choosing a mentor. Such factors identify that mentor characteristics, such as professional identity and specific field of work contribute to the mentees' decision-making process of selecting a mentor. Perhaps this was due to the opportunities offered or provided through the mentoring relationship.


*Figure 5.* Mentoring Practices Model from the Mentee's perspective.


*Figure 6.* Mentoring Practices Model from the Mentor's perspective.

Engineering students could greatly advance in their studies and in the field from a mentoring relationship creating opportunities, such as internships or externships in the industry and research and portfolio development. The implications for Engineering students to progress in their professional development from such mentoring practices as displayed in the models are remarkable.

It is important for the mentors to also display professional behaviors as they serve as role models for many mentees. Common research interest and strong work ethic may be important in keeping the mentor-mentee relationship long-lasting and beneficial by providing the mentee with opportunities within their shared research or Engineering field concentration. Besides choosing a mentor, it is important that the mentor provide the mentee with help in various ways to help the student succeed. Participants reported that their mentors helped them succeed by setting goals, providing positive and constructive feedback, and prioritizing the initiation and development of respect among other factors. Respect also seems to be a key factor guiding and sustaining the mentor-mentee relationship. Additionally, mentors that provided constructive and positive feedback helped the mentee to advance and grow within their studies. The open dialogue involved in feedback supports rapport building and may be a form of encouragement advancing student experiences and contributing to mentee acceptance by the mentor. Acceptance is prioritized by mentees, which has implications of Engineering students' perspectives regarding acceptance by their mentors or perhaps in the field that may contribute to a sense of belonging.

## Conclusion

A mentor has the potential to enrich the mentee's experiences by revealing Engineering career pathways in industry or graduate school. Undergraduate students are often new to Engineering fields, unaware of opportunities, and may be intimidated by the overall independent collegiate experience. Therefore, it is the responsibility of the mentor to support students in Engineering to identify their strengths, overcome their limitations, and to share with them opportunities for professional growth. Findings of the present research study indicated that acceptance, opportunities, experiences, and respect are key components that impacted the mentees' mentoring experiences in their undergraduate careers in Engineering. Through the findings and the current literature, mentoring is determined to serve as an incredibly influential and necessary element to student success in Engineering fields. The two sister models developed from the mentors and mentees' perspectives have implications to lead to further supportive practices fostering mentoring relationships for students and leaders in Engineering fields.

**References**

[1] Akili, W. (2013, October). On mentoring relationships: How to become a good mentor. In *Frontiers in Education Conference, 2013 IEEE* (pp. 710-716). IEEE.

[2] Chesler, N. C., & Chesler, M. A. (2002). Gender-informed mentoring strategies for women engineering scholars: On establishing a caring community. *Journal of Engineering Education*, *91*(1), 49-55.

[3] Cuervo, A. A. V., Escobedo, P. A. S., Nenninger, E. H. E., & Zuñiga, S. P. A. (2016). Scientific Skills in Mexican Graduate Students: Curriculum, Mentoring and Institutional Support. *International Journal of Higher Education*, *5*(3), 70-78.

[4] McCoy, D., Winkle-Wagner, R., & Luedke, C. (2015). Colorblind mentoring? Exploring white faculty mentoring of students of color. Journal of Diversity in Higher Education, 8(4), 225-242.

[5] Wilson, Z. S., Holmes, L., Sylvain, M. R., Batiste, L., Johnson, M., McGuire, S. Y., & Warner, I. M. (2012). Hierarchical mentoring: A transformative strategy for improving diversity and retention in undergraduate STEM disciplines. *Journal of Science Education and Technology*, *21*(1), 148-156.

[6] Young, L. (2014). Mentoring Practices Proven to Broaden Participation in STEM Disciplines. *American Society for Engineering Education.*