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A Mixed-Methods Approach to Explore Student Perceived Needs for Peer Mentorship in a College of Engineering

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A MIXED-METHODS APPROACH TO EXPLORE STUDENT PERCEIVED NEEDS FOR PEER MENTORSHIP IN A COLLEGE OF ENGINEERING

by

Darcie Christensen

A dissertation submitted in partial fulfillment
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ABSTRACT

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by

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"Nobody makes it alone. Nobody has made it alone" (NOVA SHRM & Dulles SHRM, 2012, p. 5). Mentoring in its many forms has been shown to have generally positive outcomes, such as increased productivity, career and academic retention, identity development, career placement, confidence, and others (Campbell & Campbell, 2007; Crisp & Cruz, 2009; Eby et al., 2008; NASEM, 2019; Pfund et al., 2016). This study was focused on peer mentorship, which according to the literature, can serve to fill gaps in traditional mentorship and provide less power differentials by having mentors and mentees at similar levels, increasing interpersonal comfort and emotional support (Allen et al., 2017; Haggard et al., 2011; Kram & Isabella, 1985; Meyers et al., 2010; NASEM, 2019).

While peer mentorship programs exist within undergraduate education, there is a lack of consensus on what constitutes student need, meaningful experiences, and

positive outcomes of such a relationship because of limited definitions, theories, and methodologies within the realm of research (Crisp & Cruz, 2009; Gershenfeld, 2014; Jacobi, 1991). Past studies have primarily focused on evaluation of peer mentoring programs, seeking to determine programmatic issues instead of determining what students are in need of (Crisp & Cruz, 2009). Needs assessments, which are systematic reviews to examine and prioritize needs before setting priorities and making future decisions about programmatic development or improvement (Office of Migrant Education, 2001; Witkin & Altschuld, 1995), assist in gaining consensus and meeting students' perceived needs. Participant perceptions can be fundamental in successfully developing and implementing a peer mentorship program (Gershenfeld, 2014).

There are few evidences of studies being designed to explore the needs, as expressed by students, for any type of formal mentorship program (Allen et al., 2017; Binkley & Brod, 2013; Breakey et al., 2018; Riley et al., 2014; Sawatzky & Enns, 2009; Sinclair et al., 2015; Tran et al., 2012; von der Borch et al., 2011). In the context of undergraduate engineering education, only one study was found that evidences use of an assessment tool being used to explore the needs of students with regard to engineering peer mentorship (Jones & Waggenspack, 2017). The study by Jones & Waggenspack (2017) was limited in the sense that the needs assessment was implemented with students *reflecting* on their needs in conjunction with the evaluation of an already implemented mentoring program instead of *before* the program was designed. The lack of an assessment of needs *before* design of mentoring programs is of concern since institutions are investing money to retain their students without

appropriate evidence to support the need, utility, and effectiveness of those programs. Moreover, without an understanding of student perceptions about formal peer mentoring programs, universities may risk inadvertently catering to certain populations but not others since participant perceptions can be fundamental in successfully developing and implementing a peer mentorship program.

This dissertation aimed to determine undergraduate engineering students' common needs for peer mentoring in connection with training and matching/initiating considerations. For this work, student needs were considered an essence of the student experience in a higher education environment. As such, this dissertation first developed and validated a survey instrument to collect and allow for analysis of qualitative and quantitative data to better understand the existing landscape of this phenomenon. One unique element of this survey was that the validity, reliability, and collection procedures were conducted during COVID-19, which presented an opportunity to consider students' perceived needs for both in-person and virtual mentoring relationships. The results serve to inform the process of developing and implementing appropriate training and matching/initiating standards of practice for peer mentorship program within a College of Engineering.

(305 pages)

PUBLIC ABSTRACT

A Mixed-Methods Approach to Explore Student Perceived Needs for Peer Mentorship in a College of Engineering

Darcie Christensen

"Nobody makes it alone. Nobody has made it alone" (NOVA SHRM & Dulles SHRM, 2012, p. 5). Mentoring generally has positive outcomes, such as increasing output, staying in work or school, increasing confidence, and others (Campbell & Campbell, 2007; Crisp & Cruz, 2009; Eby et al., 2008; NASEM, 2019; Pfund et al., 2016). This dissertation study focused on student perceived needs for peer mentorship in engineering, which can fill in gaps of traditional mentorship by pairing mentors and mentees at similar levels, increasing comfort and emotional support to mentees (Allen et al., 2017; Haggard et al., 2011; Kram & Isabella, 1985; Meyers et al., 2010; NASEM, 2019).

While there are peer mentorship programs in higher education, there is a lack of agreement on what is important. This is because of limited understanding (Crisp & Cruz, 2009; Gershenfeld, 2014; Jacobi, 1991). Most studies have focused on evaluating peer mentoring programs to find program issues instead of finding what students perceive as a need (Crisp & Cruz, 2009). Needs assessments are used to look at needs before building a program (Office of Migrant Education, 2001; Witkin & Altschuld, 1995). These can help in finding out and meeting student needs. Participant ideas can

be vital in successfully making and running a peer mentorship program (Gershenfeld, 2014).

There are few examples of studies being designed to explore student perceived needs for any type of formal mentorship program (Allen et al., 2017; Binkley & Brod, 2013; Breakey et al., 2018; Riley et al., 2014; Sawatzky & Enns, 2009; Sinclair et al., 2015; Tran et al., 2012; von der Borch et al., 2011). In undergraduate engineering education, only one work shows an assessment tool being used to explore the peer mentoring needs of engineering students (Jones & Waggenspack, 2017). The study by Jones & Waggenspack (2017) was limited because the needs assessment asked students to *reflect* on their needs while evaluating the existing program instead of *before* the program was designed. The lack of assessments of needs before the design of mentoring programs is concerning since institutions are investing money to keep students without ample evidence to support the need and success of those programs. Also, without understanding student ideas about formal peer mentoring programs, universities may cater to some students but not all.

This dissertation aimed to find undergraduate engineering students' common perceived needs for peer mentoring. This was in connection with training and matching/initiating considerations, which are important to the formation of a mentoring program. For this work, student perceived needs were considered an essence of the student experience in a higher education environment. As such, this dissertation focused on developing and validating a survey instrument. The instrument allows for collection and analysis of qualitative and quantitative data to better understand this essence. One unique element of this survey was that the procedures were conducted during COVID-19, which gave an opportunity to consider student perceived needs of both in-person and virtual mentoring relationships. The results serve to inform the process of developing and implementing appropriate training and matching/initiating standards of practice for peer mentorship programs within a College of Engineering.

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Ultimately, all my thanks come back to my Heavenly Father, Jesus Christ, and the Holy Ghost. Without the three of them, I would not have had the motivation, drive, or guidance I would have needed to navigate my education.

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CHAPTER I

INTRODUCTION

Mentoring in academia, specifically in science, technology, engineering, mathematics, and medical (STEMM) disciplines, has mostly been left to happen "organically or on an ad hoc basis" (National Academies of Sciences, Engineering, and Medicine [NASEM], 2019, p. 16) with little empirical support to its benefits (Campbell & Campbell, 2007; Crisp & Cruz, 2009; Jacobi, 1991; NASEM, 2016; Pfund et al., 2016). Mentoring is defined as two individuals whose relation is premised on the notion of mutual psychosocial support, personal and professional growth, and career guidance (NASEM, 2019). Traditionally, mentors are thought to be older and/or more experienced when compared to the mentee (Kram & Isabella, 1985).

The focus on studying mentoring was beginning to appear in the latter half of the 20th century and has steadily increased since (Campbell & Campbell, 2007; NASEM, 2019). However, there still remains a gap between our understanding of what effective mentoring looks like, how it is implemented, and how it is sustained in higher education (NASEM, 2019). National reports suggest that mentoring programs lack intentionality and consensus when both designing and evaluating them, meaning that there is not a coordinated and consistent method for determining and meeting a person or a population's need (NASEM, 2019). A need is defined as the gap between what currently is happening and what should be (Altschuld & Watkins, 2014, p. 6).

Crisp & Cruz (2009) argue that while there are many definitions of mentoring, many of them focus on programmatic issues instead of the actual services provided to students. Similarly, the development of mentorship programs is oftentimes informed by existing statistical results based on retention numbers, desired grade point average (GPA) gains, among others (Crisp & Cruz, 2009) instead of focusing on student perceived needs, which may not be metric-based. As recommended by the National Academies of Sciences, Engineering, and Medicine (NASEM, 2019), it is critical to "examine mentorship assets at the individual, department, and institutional levels to assist STEMM researchers and universities in creating targeted recruitment and retention programs" (p. 14).

The purpose of this dissertation was to obtain foundational information about the need, as perceived and communicated by students, for establishing peer mentoring programs within the College of Engineering at a land-grant university in the western United States. As stated by Collier (2015), "The quality and effectiveness of a peer-mentoring program is largely contingent on the commitment of the program coordinators and the extent to which the program is specifically designed to meet the unique contextual characteristics of the population to be served" (foreward). To achieve this purpose, a validated measure to explore undergraduate engineering students communicated and commonly perceived needs for peer mentoring, specifically with regard to training and matching/initiating was developed.

1.1 Purpose

The following was stated in the 2019 National Academies of Sciences, Engineering, and Medicine (NASEM) report on the science of effective mentorship:

> Mentorship is one catalytic factor to unleash individuals' potential for discovery, curiosity, and participation in STEMM and subsequently improve the training environment in which that STEMM potential is fostered. Mentoring relationships provide developmental spaces in which students' STEMM skills are honed and pathways into STEMM fields can be discovered…Its occurrence should not be left to chance or idiosyncratic implementation. There is a gap between what we know about effective mentoring and how it is practiced in higher education. (p. ix-x)

In this dissertation study, a survey was developed and validated as part of a pilot study (Chapter 3) to employ a comprehensive exploration of needs to determine what priorities and practices are important in meeting student needs with regards to peer mentorship in a College of Engineering. An assessment of needs consists of a systematic review to examine and prioritize needs before making future decisions (Office of Migrant Education, 2001), which can be critical in gaining consensus and adequately addressing collective student needs.

The purpose of this dissertation was to obtain foundational information about student perceived need for establishing peer mentoring initiatives within a College of Engineering at a land-grant university in the western United States, specifically with regard to training and matching/initiating considerations. These constructs originated from the six standards of practice by Garringer et al. (2015), which are (1) recruitment; (2) screening; (3) training; (4) matching and initiating; (5) monitoring and support; and (6) closure. Training relates to providing education in regards to basic knowledge, attitudes, and skills needed to support an effective mentoring relationship (Garringer et al., 2015). Matching and initiating relates to pairing participants and assisting in building the relationship to help it become productive, long lasting, and effective (Garringer et al., 2015). Training and matching/initiating were chosen as the conceptual framework for this dissertation because of their nature being highly reliant on the needs of the population of interest (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017; Eby et al., 2013; NASEM, 2019).

Pertinent stakeholders (i.e., students, advisors, administrators) were strategically included in the study to holistically understand the context and limitations that may exist when considering students' perceptions of needs for a peer mentoring program in engineering. The newly developed and validated mixed-methods instrument allowed for preliminary exploration of students' perceived needs for a peer mentoring program within a College of Engineering, which can also be used or transferred to other colleges and institutions. While unintentional, it is important to note that the data collected within this study occurred during the COVID-19 pandemic. As such, the work explored the experiences of undergraduate engineering students who may have experienced part of their education transitioning from an in-person to virtual format.

1.2 Research Questions

This research study was guided by three fundamental research questions. Each research question was connected to a portion of the parallel convergent mixed-methods research design (Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017). A convergent parallel mixed-methods design was chosen to allow for both qualitative and quantitative data to be collected simultaneously (Creswell & Plano Clark, 2018; R. B. Johnson & Christensen, 2017; Schoonenboom & Johnson, 2017). This work is not considered to be multi-method research because that would involve the use of multiple methods of research, such as multiple forms of qualitative or quantitative research that are not integrated, contrary to mixed-methods which combines at least one qualitative and one quantitative research method (Fetters & Molina-Azorin, 2017).

The first research question of this dissertation was related to the analysis of the quantitative items while the second research question involved the qualitative analysis by coding open-ended questions that asked students to record their perceptions regarding their needs for peer mentoring in engineering. Both the quantitative and qualitative items were embedded in the same instrument and were connected to the same constructs. This allowed for a convergent parallel mixed-methods study to occur (Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017). The third research question considered the integration and interpretation of the results from the first two research questions. It should be noted that, while these research questions were designed for in-person peer mentoring, the questions also apply to virtual peer mentoring needs as this study was conducted during the COVID-19 pandemic where higher education institutions transitioned from an in-person to virtual environment. The research questions are as follows:

RQ1. (Quantitative) What relationships, if any, exist between participant identifiers around perceptions of needs for training and matching/initiating constructs within the scope of peer mentorship in engineering?

RQ2. (Qualitative) What common needs relating to training and matching/initiating constructs are expressed amongst undergraduate students within a College of Engineering?

RQ3. (Integrated) What are the priority student communicated needs with relation to training and matching/initiating constructs in peer mentoring?

Each of these questions directly related to determining the common perceived needs within the training and matching/initiating constructs of peer mentorship, which originated from the standards of practice in mentorship from Garringer et al. (2015). The questions related to student experiences both in-person and virtually. A more thorough discussion of these standards of practice will be provided in Chapter 4. For simplicity in this dissertation, training and matching/initiating were chosen as the standards of practice to focus on. This is because training and matching/initiating are highly influenced by student perceived needs. These standards would be most critical in decision-making, though ultimately, all the standards of practice influence the decisions a program makes (Garringer et al., 2015).

1.3 Research Paradigm

This study was designed from a pragmatic worldview. Pragmatism is a problem-centered world view where the goal of the research is focused on practical or feasible outcomes, consequences, and real-world practice (Creswell & Plano Clark, 2018; Ormerod, 2006). John Dewey promoted pragmatism throughout his career and sought to model the process of inquiry to show how actions and beliefs are related (Dewey, 1938; Morgan, 2014). Inquiry is aimed at turning a situation with unknowns, questions, or problems into a situation with known solutions or limits (Dewey, 1938). This process of inquiry as developed by Dewey (1938) and summarized by Morgan (2014) begins with recognizing an issue and asking questions about the situation. The second step calls for a more thorough definition of the problem and in-depth consideration of the nature of the problem (Dewey, 1938; Morgan, 2014). The third step is a determination and development of plausible solutions (Dewey, 1938; Morgan, 2014). The fourth step is an evaluation of the meaning, reasoning, and consequences of each of the solutions (Dewey, 1938; Morgan, 2014). The last step is to operationalize the decision and take action (Dewey, 1938; Morgan, 2014). This process is shown in Figure 1.

Figure 1

Dewey's Process of Inquiry (Dewey, 1938) Adapted from Morgan (2014)

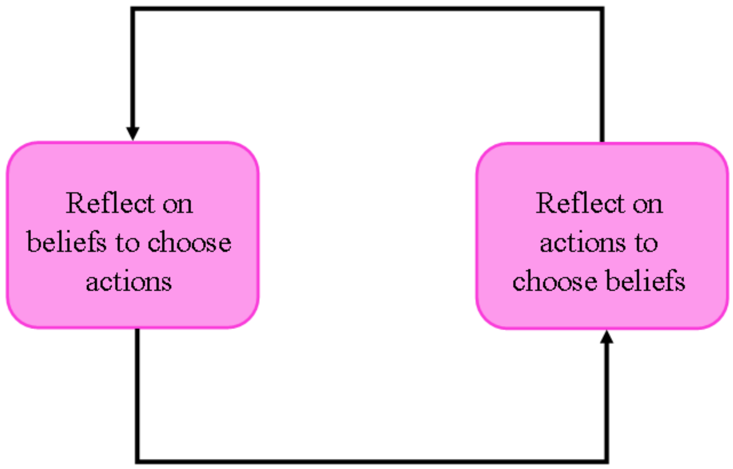
In the case of this dissertation, the process of inquiry began when a problem was recognized in discussions with pertinent stakeholders (i.e., students, advisors, and administration): a lack of a consistent and accessible peer mentoring program within the College of Engineering studied. The nature of the problem was considered around the foundational training and matching/initiating considerations since there was only a very limited peer mentorship program in existence at the given institution. An extensive literature review served to provide possible suggested outcomes (Chapter 2) that were then complimented with the findings from a newly developed and validated assessment of perceived needs for students (Chapter 5). The beginning actions were taken in the form of an informational infographic (Appendix D) and presentation of results to pertinent stakeholders based on data analysis (Dewey, 1938; Morgan, 2014). While the action of information sharing may not solve the problem, it serves as an easily accessible way to create awareness for staff and/or other administrators within a College of Engineering about key considerations to account for when developing such a peer mentoring program at their institution.

The idea behind pragmatism is to provide both singular and multiple perspectives by approaching research from a practical stance, which can be accomplished by combining both qualitative and quantitative data via mixed-methods research (Creswell & Plano Clark, 2018). The researcher aimed to provide multiple perspectives in order to show realities by being self-conscious, self-reflective, and self-critical, reflecting on how the reality has been influenced by given contexts (Creswell & Plano Clark, 2018; Morgan, 2014; Ormerod, 2006).

Within pragmatism, knowledge exists to produce action and change, not to simply exist as belief (Ormerod, 2006). Pragmatism also acknowledges that context, need, and individual nature are consistently changing and recognizes that uncertainty must be acknowledged (Dewey, 1938; Ormerod, 2006). In pragmatism, the model of experience (Figure 2) shows that present beliefs and actions are in a consistent cycle, influencing and impacting one another (Morgan, 2014). It should be noted as well that experiences are socially shaped, which must be a consideration when studying beliefs and action (Morgan, 2014). The aim of this dissertation was to explore student perceived needs *before* establishing a formal peer mentoring program. The information can lead to the intentional and evidence-based design of a peer mentorship program. This can lead to a cycle of continually reviewing and revising the program based on current beliefs and needs, implementing systematic change to the design of peer mentorship programs.

Figure 2

Model of Inquiry Adapted from Morgan (2014)



1.4 Overview of Methodology

The following sections will give a brief overview of the methodology for this dissertation study that includes the researcher's positionality and each of the stages of the research process. In this dissertation, a parallel convergent mixed-methods study was conducted where both qualitative and quantitative data were collected simultaneously, analyzed separately, and integrated to explore a phenomenon (Creswell & Plano Clark, 2018; R. B. Johnson & Christensen, 2017; Schoonenboom & Johnson, 2017). The quantitative portion of the data collected foundational information and relationships while the qualitative portion served to guide, enhance, expand, and supplement the quantitative findings (Schoonenboom & Johnson, 2017).

1.4.1 Positionality

I, the researcher, have been involved with the College of Engineering of interest, within a public land-grant university in the western United States, for many years and am familiar with student resources, stakeholders, and culture within the institution. My experience positions me as an insider (Herr & Anderson, 2015) within the institution. An insider is someone within an organization or community where the research is to be conducted (Herr & Anderson, 2015). In the case of this dissertation, this is defined as someone within the given College of Engineering and who may have served as or interacted with pertinent stakeholders such as students, staff, faculty, or administrators. As an insider, I was previously an undergraduate student of this program, and the prospect of assisting the improvement of the student experience within the College of Engineering was of interest to me. Also, as a pragmatist, I recognize the importance of translating research to practice. Research should not be simply conducted for the mere act of knowledge acquisition. Rather, I would like my work to be useful to enact meaningful and positive programmatic changes. This positionality will be further discussed in Chapter 4.

1.4.2 Assessment and Exploration of Needs as an Essence of Student Experience

To fully address gaps that may be filled by peer mentorship, the gaps must be identified and understood. As stated by Gershenfeld (2014), “Gathering data on participant perceptions and the influence on program improvement are important elements in understanding the relevance of the mentoring process on those who matter most” (p. 387). Stakeholder perceptions, which are contextually connected, must be understood adequately to develop a foundation of change. Within the realm of engineering education in the U.S., it is becoming more prominent to have peer mentorship programs, but there is still a lack of formalized instruments and research on what parameters should be considered 'essential' to the perceived needs of students for the formation of mentorship programs (Allen et al., 2017; Altschuld & Watkins, 2014)

Because of the gaps in formalized instruments and research, this complete study was conducted in two parts (1) a pilot study; and (2) rigorous analysis and interpretation of survey instrument results. The pilot study in this dissertation study was used to develop and validate a convergent mixed-methods (Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017) instrument that includes both quantitative and qualitative data to explore students' need for (or lack of) peer mentorship. This instrument served as a foundation for this dissertation work, which involved the analysis and interpretation of the qualitative and quantitative data obtained from the survey instrument. The insight obtained from the analysis was shared with pertinent administrators, staff, and students to support future development of peer mentorship within the given College of Engineering.

To avoid simply gathering quantitative data from the research instrument, which would result in a breadth-level knowledge of the problem (Creswell & Plano Clark, 2018), two fundamental (analyzed in this study) and six supplemental (these six will be analyzed in future studies) qualitative questions were also embedded into the instrument. The design of these qualitative questions followed the guidelines of phenomenological research (Moustakas, 2011a) in order to more deeply explore student perceived needs and experiences. Phenomenology is a research methodology commonly used in educational research aimed at determining the essence of a phenomenon based on individual's lived experiences (R. B. Johnson & Christensen, 2017; Larsson & Holmström, 2007; Shotton et al., 2007). Since "need" is an apparent gap between where one is and where they want to be (Office of Migrant Education, 2001), need and the perception of need are considered to be essences of the human experience. The phenomenological approach allows scholars to determine a meaning that was commonly experienced among participants (R. B. Johnson & Christensen, 2017) and aims to explore both the "what" and "how" of lived experiences, giving a way for researchers to learn from others' experiences (Neubauer et al., 2019). As suggested by Meyers et al. (2010), mentorship work "should include…qualitative studies, where survey data are informed by the voice of student experience" (p. 176). Thus, within the mixed-methods instrument, open-ended questions helped provide additional context for students' communicated needs and barriers for peer mentorship.

While this instrument had some specific contextual elements housed in the College of Engineering of interest in this study, its design can be easily transferred to other contexts. This instrument was distributed to both professional and pre-professional students who have declared an undergraduate major within the College of Engineering or were computer science students in an engineering course. The participants in this dissertation were chosen to fully capture both the early years of engineering undergraduate studies, before students are committed to a professional engineering major, as well as the later stages when students are closer to graduation and have had more opportunities for mentoring experiences within the college. The early stages are especially important because this is when retention of students is most critical (American Society for Engineering Education, 2016b). Also, participant perspectives were provided during the COVID-19 pandemic, so the exploration of student needs provided experiences of those who had transitioned from an in-person to virtual format at the institution and those who had just started college in a primarily virtual environment. More discussions surrounding the implications of data collection during the COVID-19 pandemic will be provided in the Results (Chapter 5) and Discussion (Chapter 6) chapters of this dissertation.

1.4.3 Face and Content Validation

Both face and content validation were performed to determine the relevance, feasibility, clarity, consistency, and essentiality of items within the instrument in an iterative process (Lawshe, 1975; Lewinski et al., 2017; Taherdoost, 2016; Vrbnjak et al., 2017) for the pilot study. The survey instrument was developed based on literature review and seven rounds of revision between the primary researcher and advisor took place. This version was provided to the dissertation committee, who are engineering education experts, for feedback and then revised again in multiple rounds with a construct development expert serving as a consultant.

Also, a more formal face and content validation of three rounds was conducted with like-population undergraduate and graduate engineering students, recent engineering alumni, and pertinent staff as content experts (Polit et al., 2007) in the realms of engineering and/or mentorship. An intentional effort was made to include

English second language learners to ensure a breadth of participants could understand the survey items. The dissertation committee also provided additional feedback. Overall, it was agreed that the instrument was worded clearly and addressed mentorship adequately. This entire validation process will be described more fully in Chapter 3, but based upon this face and content validation, changes were made to the language, content, and format of the survey instrument to create a more refined measure for needs regarding peer mentorship.

1.4.4 Participants

For the Fall 2020 academic semester, there were 2,132 students enrolled in the College of Engineering of interest, and this included graduate students (Office of Analysis Assessment and Accreditation, 2020a). In Fall 2020, there were 246 graduate students (M. Snow, personal communication, September 25, 2020). This gives a total of 1,886 undergraduate students enrolled within the College of Engineering. Following recommendations from Pawley (2017) in reporting participant demographics in engineering education research, participant demographics are reported fully in the results (Chapter 3, Figure 9 and Figure 10).

The research instrument from the pilot study contained 33 total quantitative items. For validation and reliability purposes, eigenvalues (from Exploratory Factor Analysis [EFA]) were used, thus according to typically accepted research standards, it was desired to have between five and ten participants per quantitative item (Gorusch, 1983; Nunnally, 1978). This put the desired minimum number of participants between 165 and 330. According to typical survey response rates, emailed and web-based surveys receive between 25% to 30% response rates, which would be between 472 and 566 participants (Lindemann, 2019; People Pulse, 2018). With the minimum numbers stated above, an 8.5% to 17.5% response rate was the minimum expectation. This is lower than typical response rates, but due to circumstances outside my control (e.g., COVID-19 pandemic and classroom access to participants), between 165 and 330 participants were considered an acceptable number. After cleaning the 320 submitted responses, there were 223 final responses considered in the analysis. Since it is impossible to know how many students received the survey due to virtual distribution methods, it is unknown what percent return rate was obtained. However, it is important to note that the number of participant responses obtained for this dissertation was within acceptable ranges of participation as indicated previously. This dissertation focused on the qualitative, quantitative, and integrated data analysis and interpretation of the survey findings.

Participants were recruited by four primary methods approved by the Internal Review Board (IRB), which were college-wide emails distributed through the advising office, online learning management system (LMS) announcements, live recruitment via Zoom at the beginning of class followed by an online LMS follow-up, and communication with club representatives or leadership. Written communication, flyers with a Quick Response (QR) code, and video introductions were included in these recruitment methods. The survey was created to be mobile friendly to provide easy access to the instrument.

1.4.5 Analysis

Descriptive statistics were used to summarize the quantitative results of the survey. Statistical analysis was used within the quantitative data analysis to determine what relationships existed among the participant identifiers and student needs, specifically with regards to expectations and desires for matching and training. The qualitative responses were in-vivo and focus coded (Saldaña, 2009) with a phenomenological lens and organized in coding categories, which were then translated to themes for ease of interpretation. In conjunction with quantitative findings, representative quotes from the identified qualitative findings were analyzed to describe the essence of student needs with regards to peer mentorship. Based upon the emerging quantitative findings and supporting qualitative findings, a set of priority needs with regards to training and matching/initiating in future peer mentorship initiatives within the College of Engineering were identified.

1.5 Significance of Study

According to literature in higher education, about 58% of students in any major who start at a four-year college complete a bachelor's degree in six years and only about 28% of students who start at a two-year college complete an associate's or bachelor's degree in three years (Collier, 2015). In 2011, the average four-year graduation rate for those who started and ended in engineering was 33% with Black or African-American and Hispanic or Latin American students being closer to 20%, Asian being closer to 40%, and White similar to the national average (American Society for

Engineering Education, 2016a). The six-year graduation rate was approximately 20% higher than the four-year graduation rate in engineering (American Society for Engineering Education, 2016a). This can imply costs for the individual, college, institution, and state and federal governments (Collier, 2015). With studies indicating that mentorship may provide a support system in which to retain more students at the college level (Campbell & Campbell, 2007), but whose outcomes are not well understood or validated (Crisp & Cruz, 2009; Gershenfeld, 2014), there is merit in investigating how mentorship programs can be intentionally designed and implemented. This intentional design would include making programmatic design decisions based on participant needs.

As stated by Oprah Winfrey, "Nobody makes it alone. Nobody has made it alone" (NOVA SHRM & Dulles SHRM, 2012, p. 5). The significance of this study is that it is providing an opportunity for students' perceived needs to be heard. It is known that mentor support is critical to success. Instead of simply creating a peer mentorship program ad hoc, student needs and perspectives were explored in a way that has not been done before in the realm of engineering education. This dissertation developed and validated a mixed-methods instrument as part of the pilot study, but it was expanded to include data analysis and interpretation as the main part of the dissertation findings to demonstrate a process that could potentially be transferred to other Colleges of Engineering seeking to create a peer mentoring program, both in-person and virtually.

1.6 Limitations

The biggest limitation to this study is that the action stops at the knowledge-sharing stage and did not proceed to the point of implementation due to time restraints and other administrative priorities, especially during COVID-19. The data collection also focused only on the training and matching/initiating needs within peer mentorship rather than all six of its constructs (e.g., recruiting, screening, training, matching/initiating, monitoring/supporting, and closing; Garringer et al., 2015).

The instrument and mixed-method study are also limited in the sense that open-ended questions within the quantitative survey were used in place of in-depth interviews with participants. Due to the concerns of interviewing face-to-face with the COVID-19 pandemic and IRB restrictions for privacy on virtual platform interviews (i.e., Zoom), it was decided that open-ended questions within the survey instrument would be a safer way to collect meaningful responses from participants in an anonymized way. It is realized that the depth of detail and information gained from open-ended questions is limited when compared to interviews (LaDonna et al., 2018), but based on the number of participants that responded to this survey, it is assumed that adequate qualitative information was obtained to enhance and expound upon the quantitative results.

At large, it is known that "in the real world, there is never enough money to meet all needs [but it can serve] to help program planners identify and select the right job before doing the job right" (Office of Migrant Education, 2001, p. 2). While the mixed-methods instrument is critical in determining needs and prioritizing solutions or strategies, it may not be practical to identify all solutions and meet all student needs simultaneously. In addition, another limitation that arose within the instrument was that students "with different background and educational experiences (e.g., racial/ethnic group and first-generation status) may have somewhat different mentoring needs, perceptions, and experiences" (Crisp et al., 2017, p. 75). This brings in the difficulty of making decisions when deciding who to focus on, how to develop the program, and what resources may provide the most practical outcomes.

It is also realized that this study focused on one specific College of Engineering with a limited, convenient population (R. B. Johnson & Christensen, 2017). While the perceived student needs that result from this study may be different from other contexts and settings, the study process is easily transferable elsewhere because it allows readers and fellow researchers to transfer knowledge and tools from this study to their own situation (Maxwell & Chmiel, 2014).

Another limitation is the lack of a formal mentoring program, specifically peer mentoring, within the College of Engineering studied. Many students seemed generally unaware of what mentorship is, what mentorship looks like, and how they are supposed to be involved in mentorship. This may have skewed some of the perspectives shared by students. Lastly, it is recognized in this study that there was difficulty in determining the differences between students' perceived needs and wants. This is a common point of conflict, especially when determining priorities in the use of resources (McGregor et al., 2009). These limitations will be discussed in more detail in the Discussion (Chapter 6, Section 6.5).

1.7 Definitions of Key Terms

Academic Career Support: Career support as defined by the National Academies of Science Engineering, and Medicine (NASEM) is offered through career guidance, skill development, advisement, and sponsorship (NASEM, 2019). This can be applied within the realm of academia by offering these support functions in the context of academics, such as navigating university life, skill development, and promotion of opportunities.

Bracketing: Putting aside preconceptions or learned feelings with relation to a experiencing a phenomenon in order to truly determine its essence (R. B. Johnson & Christensen, 2017).

Content Validity: A subjective measure of whether an item is essential to the assessment within a given context (Taherdoost, 2016).

COVID-19: A worldwide pandemic declared in March 2020 by the World Health Organization (Avera Writers, n.d.).

Essence: The part of an experience that is unchanging across participants (R. B. Johnson & Christensen, 2017).

Face Validity: A subjective measure of the usefulness, reasonability, clarity, relevance, feasibility, readability, and consistency of a survey instrument (Taherdoost, 2016).

Insider: Someone within an organization or community where the research is to be conducted (Herr & Anderson, 2015). In the case of this study, this is defined as a someone within the College of Engineering, such as students, staff, faculty, or administrators, who has served as or interacted with pertinent stakeholders and are familiar with the context and environment.

Mentee: A person who is being mentored (Merriam-Webster, n.d.-a) in a dual relationship of trust with their mentor (W. B. Johnson, 2015).

Mentor: A person who serves as a long-term counselor (Merriam-Webster, n.d.-b) as part of a dual relationship of trust with a mentee (W. B. Johnson, 2015).

Mentorship: Two people work together to support one another in successfully growing and developing personally and professionally through career and psychosocial support (NASEM, 2019). Traditional mentors are thought of to be much farther ahead in age or expertise when compared with the mentee (Kram & Isabella, 1985), but they may have a similar age range and can be part of a dual relationship of trust with a mentee (W. B. Johnson, 2015).

Mixed-Methods: Emergent research methodology where quantitative and qualitative methods, approaches, or concepts are combined within the same study (R. B. Johnson & Christensen, 2017; Wisdom & Creswell, 2013).

Multi-Method: Any use of multiple methods of research, which could be multiple forms of qualitative or quantitative research (Fetters & Molina-Azorin, 2017).

Peer Mentorship: One is mentored by someone who is at approximately the same stage of career development, but has slightly more experience (Collier, 2015; Ensher et al., 2001; NASEM, 2019).

Perceived Need: A perceived gap or discrepancy between the current state and the desired future state (Office of Migrant Education, 2001).

Phenomenology: Research methodology commonly used in educational research aimed at determining the essence of a phenomenon based on individual's lived experiences (R. B. Johnson & Christensen, 2017; Larsson & Holmström, 2007; Shotton et al., 2007).

Phenomenon: An observable fact, experience, or event (Merriam-Webster, n.d.-c; Shotton et al., 2007)

Pragmatism: A problem-centered world view where the goal of the research is focused on practical or feasible outcomes, consequences, and real-world practice (Creswell & Plano Clark, 2018; Ormerod, 2006).

Psychosocial Support: Typical psychosocial support functions include supporting development of resilience in coping with stress, role modeling, and developing emotionally and psychologically (NASEM, 2019).

Stakeholder: People within an organization who may have an interest in the research topic of interest and may be affected by its outcomes (Vitae, 2021)

Validity: Explains whether an instrument collects the correct data and measures what it was designed to measure (Taherdoost, 2016).

CHAPTER II

LITERATURE REVIEW

In general, it is known that mentoring is an essential function within academia, but it receives much less formal attention and recognition than other aspects such as teaching and research. This may largely result from the lack of guidelines, certifications, or awards for documenting effective and inclusive mentorship in higher education (National Academies of Sciences, Engineering, and Medicine [NASEM], 2019; Allen et al., 2017). Lack of organization, structure, and support in conjunction with little monitoring of mentorship can also contribute to the lack of attention and recognition within academia (George & Peace, 1997). For instance, faculty report that mentoring undergraduates can provide valuable information about their teaching and results in a more meaningful professional role for them, but they recognize the amount of time, effort, and funding that mentorship requires and the few opportunities for recognition in their profession (Dolan & Johnson, 2010).

Unlike teaching and research, effective mentorship is rarely recognized with the same fanfare in academic environments, whether that is with a lack of mentor or mentee awards or when mentorship is not considered as a separate category to teaching in the promotion and tenure process (Allen et al., 2017; NASEM, 2019). This lack of recognition is in part because "advising" and "mentoring" are equated to "teaching" even though they are not the same. This literature review will provide an overview of the current state of mentorship programs in higher education with a specific emphasis on undergraduate engineering.

The review begins with synthesizing the importance of mentorship and defining mentorship and its functions. The focus then moves to compiling the many known and hypothesized benefits of effective mentorship, the steps to developing effective mentorship relationships, and an exposition of some negative experiences or barriers to effective mentorship. Formalized peer-mentorship programs are discussed in this chapter. Finally, an explanation of the goals of the work and intended outcomes for this dissertation is presented.

2.1 Importance of Mentorship

It should first be noted that the benefits of mentorship are difficult to support with empirical evidence since many studies on mentoring have methodological shortcomings or are filled with confounding factors (e.g., no comparison group, self-report bias, sampling bias, etc.; Dennehy & Dasgupta, 2017). Nonetheless, mentorship has been seen by many academic institutions as a plausible intervention to help students navigate transitions during their education (Dennehy & Dasgupta, 2017) and suggest its positive outcomes (Garringer et al., 2015). As the 2019 NASEM (NASEM, 2019) report suggests, mentorship has been deemed critical in helping individuals develop and cement their science, technology, mathematics, and medicine (STEMM) interest and involvement.

Mentorship is suggested to enhance productivity, confidence, career satisfaction, persistence, and research success (Eby et al., 2008; Pfund et al., 2016). Specifically, there is evidence that effective mentorship improves outcomes for career placement, development, and productivity (NASEM, 2019). Successful mentoring relationships can help students feel more comfortable academically and more motivated to succeed, resulting in a higher likelihood that students will continue their studies in a graduate setting or earning teaching credentials (Campbell & Campbell, 2007). Mentors also receive new knowledge, skills, and perspectives from their mentees while also reporting pleasure and enjoyment from their mentoring relationships (NASEM, 2019; Pfund et al., 2016).

2.1.1 Importance for Underrepresented Students

Underrepresented students are known to receive less mentorship than their well-represented peers within STEMM fields (NASEM, 2019; Gallup, 2019). As stated in the NASEM report on effective mentorship, “Talent is equally distributed across all sociocultural groups; access and opportunity are not” (NASEM, 2019, p. ix). As more access and opportunity are given to a full diversity of students, STEMM workplaces will increase in diversity, bringing an unprecedented increase in understanding, cultural competence, performance, and creative problem solving capabilities in ways previously not seen (Dennehy & Dasgupta, 2017; Foma, 2014; NASEM, 2019; U.S. Glass Ceiling Commission, 1995; Williams & Applyrs, 2015). This creativity and innovation are critical for “American competitiveness, quality of life, and national security” (Dennehy & Dasgupta, 2017, p. 5964). Mentorship can also enhance retention, confidence, motivation, access, equity, and inclusion of underrepresented students in STEMM fields, both within the academic sphere and the workplace (Dennehy & Dasgupta, 2017; Eby et al., 2013; NASEM, 2019).

Especially with underrepresented students (e.g., first-generation [first student in immediate family to attend college], racially, ethnically, or gender diverse, etc.), mentorship and other student support experiences are critical in building a science identity within a STEMM community and preparing them for the STEMM workplace (Atkins et al., 2020; Byars-Winston & Rogers, 2019; Chemers et al., 2011; NASEM, 2019). Science identity, in this case, is how the person sees themselves, receives recognition, gains knowledge and understanding, performs typical functions, makes meaning of experiences, and develops a professional identity within the realm of science (Byars-Winston & Rogers, 2019; Carlone & Johnson, 2007). Engineering identity has also been shown to be strengthened through mentoring relationships (Rodriguez et al., 2019; Ross et al., 2018). As STEMM fields attempt to create more inclusive cultures, effective mentorship must be accessible by all students, both represented and underrepresented, be culturally responsive, and be personalized to the mentee's needs (NASEM, 2019). This calls for research-informed and evidence-based practices being employed when creating and enhancing mentoring relationships since overall, the outcomes from mentorship, specifically effective mentorship, are positive (NASEM, 2019).

2.1.2 Negative Experiences and Barriers in Mentorship

While positive experiences are the goal of mentorship, negative experiences must be recognized and acknowledged (Eby et al., 2004; Limeri et al., 2019). This phenomenon happens when mentors are neglectful or not available, do not have the same values or personality as their mentees, are manipulative, lack needed expertise, have unachievable expectations, or are not clear in their guidance (Eby et al., 2010; NASEM, 2019). Mentees can also cause negative experiences, such as when they seem unwilling to learn, do not meet expectations, are overly submissive, or exhibit jealousy or competitiveness toward the mentor (Eby et al., 2010). Negative experiences can originate from both ill-intent (e.g., absenteeism, bullying, abuse of power, lack of support, exploitation, abuse, harassment, etc.) as well as good intentions (e.g., not giving suggestions of new activities or positions available because of fear of overwhelming the mentee; Limeri et al., 2019; NASEM, 2019). Power differences between mentors and mentees can be a cause of coerciveness or other issues in the mentoring relationship (Gelles et al., 2019; Limeri et al., 2019; NASEM, 2019). One important thing to remember also is that the absence of negative experiences does not necessarily mean the relationship was effective (Eby et al., 2010). Intentionality in the design and implementation of peer mentoring initiatives focused on student needs can likely lessen the negative effects within mentorship.

Along with negative experiences, there can be barriers to establishing effective mentoring relationships. Some of the barriers that prevent the implementation of effective mentorship include resources, lack of time, incentives, expertise, or confidence (NASEM, 2019). One barrier to improvement in mentorship programs is the valid assessment of the mentoring relationships. The problem is that assessment methods currently focus on programmatic goals and outcome variables instead of actually assessing whether the mentoring relationships are productive (NASEM, 2019). While there are positive effects of mentorship, since there is a lack of practical and experimental research on results and outcomes in mentorship, the causal effects are not well established within mentorship (Eby et al., 2008). As such, it is difficult to measure the impact of formal mentoring programs (Meyers et al., 2010). This limits the ability to fully implement and utilize mentoring relationships since there is a lack of understanding of the effects. One aspect to remember is also that satisfaction in mentorship relationships does not necessarily produce any different outcome results (Blake-Beard et al., 2011).

There are also personal barriers that individuals can face when attempting to establish mentoring relationships. A summary of these barriers is shown in Table 1. These barriers can range in scope. Some can be personal, intrinsic barriers such as lack of motivation or expectations, while others are more related to structural, extrinsic components of the program such as time commitment or lack of College of Engineering support (Leary et al., 2016; Pieterson & Ridgway, 2019; Sambunjak et al., 2010). It is important to know the types of barriers that are faced by students so that programmatic elements can be catered appropriately to support students in developing effective mentoring relationships. Recognizing and acknowledging these barriers may help the researcher to be attentive to the coding of qualitative responses in this study and serve to guide the priority steps/solutions recommended at the end of this study.

Table 1

Summary of Barriers to Mentorship

Barrier	Examples	References
Time commitment	• Meeting time • Preparation time	Leary et al., 2016; NASEM, 2019; Pieterson & Ridgway, 2019; Sambunjak et al., 2010
Lack of motivation	• Voluntary relationship • Lack of recognition • Benefits are not clear	Leary et al., 2016; NASEM, 2019 Sambunjak et al., 2010
Lack of College of Engineering support	• No help finding a peer mentor • No training in how to be a peer mentor/mentee	Pieterson & Ridgway, 2019; Sambunjak et al., 2010
Finding a peer mentor	• Lack of availability of peer mentors • Not sure how to find a peer mentor	Leary et al., 2016; Sambunjak et al., 2010
Expectations	• Mismatched between peer mentor and mentee • Lack of flexibility in relationship	NASEM, 2019; Pieterson & Ridgway, 2019; Sambunjak et al., 2010
Necessity	• Do not feel the need to have a peer mentor	NASEM, 2019

2.2 Defining Mentorship

One of the primary issues with defining mentorship is that many definitions exist (Collier, 2015, 2017; Crisp & Cruz, 2009; Haggard et al., 2011; Jacobi, 1991; NASEM, 2019). Variations in its definitions exist between different disciplines, such as business, psychology, and academia (Collier, 2015; Crisp & Cruz, 2009), where over 40 to 50 different definitions have been identified in reviews of this topic (Crisp & Cruz, 2009; Haggard et al., 2011). The following explanations attempt to address the overarching themes that exist in mentorship definitions to generate a 'working definition' for this dissertation.

The classical definition of mentoring is typically thought of as a unidirectional, apprentice-like relationship where a mentor, who is considered an expert, serves as an educator, guide, and purveyor of knowledge to a mentee (NASEM, 2019). Typical mentoring relationships have a hierarchical dimension where the mentor is the expert in guiding the relationship (Kram & Isabella, 1985). There is little emphasis within this definition on the mentee's role other than absorbing information and most of the work is focused on the mentor sharing information and teaching skills, with the power and authority belonging to the mentor (Gelles et al., 2019).

The definition of mentoring has evolved into the use of the term "mentorship" instead of "mentoring", alluding to the need to consider the duality and clarification of expectations for both parties in the mentoring relationship and the roles both mentors *and* mentees play in the relationship (Gelles et al., 2019; Limeri et al., 2019; NASEM, 2019, Palmer, 2019). Mentors and mentees work together in a collaborative alliance to provide the necessary support to each other in order to foster the "personal and professional growth, development, and success of the relational partner" (p. 37, NASEM, 2019). The mentee has agency and a role to play in the mentorship relationship whereas mentoring was focused on mentors taking over and leading the relationship (Gelles et al., 2019; NASEM, 2019; Palmer, 2019).

2.2.1 Defining Functions Within Mentorship

Within mentorship, it is important that both career and psychosocial support is involved in mentoring relationships in order to receive positive responses (Crisp & Cruz, 2009; Eby et al., 2013; NASEM, 2019). Career support is defined as career guidance, skill development, network growth, and sponsorship (NASEM, 2019), including tasks such as exploring interests, encouraging critical thinking, reflecting on progress, and providing advice (Crisp & Cruz, 2009; Jacobi, 1991). Psychosocial functions consist of emotional support and role modeling (NASEM, 2019), including tasks such as listening, providing encouragement and support, and establishing an effective two-way relationship (Crisp & Cruz, 2009). Throughout the relationship, though not formally included in the definition, mentoring may also include aspects of advising, guiding, challenging, training, clarifying, protecting, sponsoring, and helping to build a network (Jacobi, 1991; NASEM, 2019). While mentorship can have various functions (e.g., coaching, advising, role modeling, etc.), these functions differ based on who the mentee is and what stage of their career/profession they are in (Gershenfeld, 2014).

2.3 State of Undergraduate Mentorship

While many, especially within the STEMM community, know that mentorship is expected, beneficial, and necessary within the realm of academia, mentoring is sparsely formalized and has mostly been reliant upon spontaneous or unplanned initiatives (NASEM, 2019). This is despite findings that suggest that academic mentoring is strongly tied to positive outcomes for students, even more so than for youth or professional mentoring (Eby et al., 2008). Only 43% of recent graduates surveyed in the United States agree that they had a mentor who encouraged them to pursue their goals and dreams in their undergraduate education with 36% disagreeing (Gallup, 2018). Among those who had a mentor during their undergraduate careers, the most common source of mentorship came from a professor(s) (Gallup, 2018). Only 9% of those who had a mentor said they had a peer as a mentor (Gallup, 2018). Racial and ethnic minority graduates were 25% less likely than their White counterparts to have a professor as a mentor and relied more on informal mentors, such as friends, family, and college or university staff (Gallup, 2018). This evidences how critical it is to provide mentorship access to *all* students. It is the position of this researcher that by providing more accessible means for mentorship, such as peer mentoring, diverse groups of students can be better positioned to mutually benefit from this relationship as they navigate their engineering education degree.

Many formal mentors that students have access to (e.g., research advisor, faculty, dissertation or thesis committees, administrators) do not necessarily result in the formation of meaningful mentoring relationships, which are important to students’ development (NASEM, 2019). While considerations relating to the duties of these individuals (e.g. research, teaching, service) have to be taken into account, it is also likely that both parties may not be aware of the potential for the relationship, been formally trained or encouraged to develop these mentoring relationships, or do not have a motive or incentive to participate (Allen et al., 2017; Dolan & Johnson, 2010; George & Peace, 1997; Long et al., 2010). Training is critical in helping mentors and mentees guide their peer mentoring relationships, but it is rare to have any formalized training for either party (Pfund et al., 2016), let alone both. However, in conjunction with receiving training, appropriate matching and initiation of mentor and mentee relationships based on important elements (e.g., availability, motivation, interests, attributes, characteristics, goals, strengths, weaknesses, etc.) must take place in order for effective mentorship to happen (Garringer et al., 2015).

2.4 Elements of Effective Mentorship

As for research on mentorship, little progress has been made on the consensus for definitions, theory, strategies, and methods generally for effective mentorship even though it is becoming more common to have undergraduate mentoring programs (Crisp & Cruz, 2009; Gershenfeld, 2014; Jacobi, 1991; NASEM, 2019). In a review of twenty formal mentoring programs, there was a lack of specificity about program components and rigorous research designs in guiding evidence-based practices for mentoring (Gershenfeld, 2014). This section aims to synthesize current research on necessary elements for effective mentorship.

2.4.1 Mentorship Practices

Training, support, and incentives are necessary to gain, refine, improve, and implement mentorship skills (NASEM, 2019). The ability to be dynamic and adaptable in these relationships are important since skills and knowledge will change throughout a relationship (NASEM, 2019). Interaction frequency and relationship length both play into building a satisfying and beneficial mentoring relationship (Eby et al., 2013). Evidence-based practices are critical in supporting effective mentoring practices (e.g., curricula, tools, resources, professional development, feedback, etc.) to be responsive to the evolving needs of both mentors and mentees (NASEM, 2019). Valid measures both locally and from general research on mentorship should inform mentorship practices in order to further refine effectiveness (NASEM, 2019).

Though some people are naturally more competent in effective mentoring, it is important to remember that skills in mentorship can be learned as long as the participants are intentional with their personal development, practice, feedback, and self-reflection (Handelsman et al., 2005; NASEM, 2019). Mentorship relationships are more effective when they begin with “aligning expectations, building rapport, maintaining open communication, and facilitating mentee agency” (NASEM, 2019, p. 39). Mentees have more positive perceptions of the mentoring relationships when there is reciprocity in the relationship (Ensher et al., 2001).

Throughout the NASEM report on the science of effective mentorship, the three principles that were mentioned most were intentionality, trust, and shared responsibility (NASEM, 2019). Trust involves a level of vulnerability, where one is willing to take risks expecting the other party will act in a reciprocal way, regardless of the power differential (Mayer et al., 1995). Intentionality in mentorship involves an identification of strengths and weaknesses, improvement of those strengths and weaknesses, and implementation of skills (Broughton et al., 2019). Shared responsibility is manifested through reciprocity where the mentee is helping the mentor and vice versa, regardless of the expertise differential (Palmer, 2019). Effective mentorship also involves self-reflection and improvement throughout the working relationship (NASEM, 2019).

2.4.2 Structure and Types of Mentorship

When students are involved in a mentoring relationship within an academic institution, they report higher satisfaction with the institution and the social groups within those institutions (Eby et al., 2013; Ferrari, 2004; Meyers et al., 2010). There are many ways that mentoring relationships can be developed, structured, or administered, which are summarized in Table 2. Regardless of the type of mentorship, every mentoring relationship requires collaborative work where all participants are seeking psychosocial and professional support for each other.

Table 2

Forms of Mentoring Relationships as Adapted from NASEM, 2019

Development of Relationship *(how the relationship is formed)*	Structure of Relationship *(members in the relationship and their connection)*	Administration of Mentoring *(platform used for communication within the relationship)*
Formal:	Dyad:	Online Synchronous:
Develops as part of an organized program	*Relationship between one mentor and one mentee*	*Live online mentoring via video chatting (e.g., Zoom, FaceTime, WhatsApp, Skype, WebEx, etc.)*
Informal:	Triad:	Online Asynchronous:
Develops spontaneously based on interest and interpersonal comfort	*Relationship involving either one mentor and two mentees or two mentors and one mentee*	*Asynchronous online mentoring (e.g., discussion boards, email, chatroom, LinkedIn, etc.)*
	Collective or Group:	Face-to-Face:
	Relationship involving multiple mentors and/or mentees working all together with bidirectional engagement	*In-person mentoring (e.g., weekly/monthly meetings, lunch conversations, etc.)*
	Network:	Blended:
	A mentee develops relationships with multiple mentors, groups, or resources	*Combination of face-to-face and online mentoring*

2.5 Benefits of Peer Mentorship

While many of the previously cited studies were focused on traditional mentoring where the mentor is much more experienced and farther ahead in their career (i.e., faculty to student, experienced employee to new employee, etc.), there is a space for peer mentoring, meaning a mentorship relationship with someone at the same level or close to the same level (i.e., near-peer or step-ahead mentoring), to support and fill in the gaps of traditional mentorship (Kram & Isabella, 1985). It would appear that opening access to student mentoring via a peer mentoring program, or co-mentoring as it is also described in Allen et al. (2017), may present a suitable alternative to faculty mentorship to meet the needs of students while still providing them with the psychosocial and academic support they may need (Ensher et al., 2001; NASEM, 2019), as these near-peers have recently overcome the challenges that these peer mentees are about to face in their engineering education. It is through a level of mutuality in peer mentoring that is not found in other mentoring relationships that both a mentor and mentee can be givers and receivers of information and support (Kram & Isabella, 1985).

Peer mentorship is referred to as near-peer or step-ahead mentorship when one is mentored by someone who is at approximately the same stage of career development, but has slightly more experience (Collier, 2015, 2017; Ensher et al., 2001; NASEM, 2019). Even though a peer mentor is at a similar experience level, they do have some sort of expertise to be able to offer that their mentee may not possess (NOVA SHRM & Dulles SHRM, 2012). Traditional mentors are usually significantly farther ahead in age or expertise, but in peer mentoring, at least one of those attributes is similar (Kram & Isabella, 1985). The power differentials that are usually apparent in traditional mentorship are less likely to appear and be an issue in peer mentorship (Allen et al., 2017). Mentees are typically more satisfied in a step-ahead peer mentoring (i.e., slightly higher level) relationship than simply a peer mentoring (i.e., exact same level) relationship (Ensher et al., 2001), although both are valued. These types of relationships provide the added benefit of an increased credibility in the relationship and an establishment of trust in the relationship (Collier, 2017).

In a study from Elegbe (2015), it was suggested that students are primarily gaining their emotional competency (e.g., teamwork, communications, trust, dependability, influence) from unstructured and informal learning environments with other peer students. Students claim that peer mentors are able to support, build friendship, encourage involvement and connection to campus, help out, and uplift mentees through one-on-one attention (Colvin & Ashman, 2010). Peer mentors can also increase the level of interpersonal comfort within mentoring relationships (Allen et al., 2017; Haggard et al., 2011; Meyers et al., 2010). Students can feel less isolated and more confident when involved with a peer-mentor (NASEM, 2019). Their identity as a college students is further developed because the students have balanced roles and expectations within the peer mentoring relationship (Collier, 2017). It has also been found that retention efforts can be mutually beneficial to both peer mentors and mentees because of the involvement, relationships, and resources available through a formalized peer mentorship program (Kiyama & Luca, 2014). Mentors have many of the same benefits that mentees receive from mentorship, such as career satisfaction, performance, and commitment (Ghosh & Reio, 2013)

When 20,771 full-time STEM faculty mentors from 143 four-year colleges and universities were surveyed, only 21.1% said that they strongly agreed that they played a role in students' emotional development, 29.6% said they strongly agreed they helped students develop personal values, and 35.8% said they strongly agreed that they played a role in developing students' moral character (Stolzenberg et al., 2019). These are lower than all percentages reported for non-STEM faculty, where 29.1% said that they strongly agreed that they played a role in students' emotional development, students' personal development of values (40.1%), and students' development of moral character (41.6%; Stolzenberg et al., 2019).

The aforementioned percentages relating to faculty roles in emotional development are in stark contrast to the statements relating to academic career support functions where more than approximately 60 to 80 percent of STEM faculty strongly agreed that they have a role in preparing students for graduate or advanced education, preparing students for employment after college, and promoting students' ability to write effectively (Stolzenberg et al., 2019). STEM faculty are substantially higher on both preparing students for graduate or advanced education and preparing students for employment after college (Stolzenberg et al., 2019). While these professional development functions are all essential and meaningful, there appears to be a lack of intentional student emotional support and development from faculty mentors (Crabtree, 2019; Elegbe, 2015). Emotional support and development fall under the category of psychosocial support in mentorship, which is a critical function that should not be overlooked in mentoring effectiveness (NASEM, 2019).

In a recent study of over 32,000 undergraduates at 43 randomly selected universities in the U.S, only 23% of surveyed student alumni in science and engineering strongly agreed that their professors cared for them as a person (Crabtree, 2019). It is possible that the faculty's demands for time and their responsibilities in higher education such as research, teaching, service, may impact their availability to students outside of the classroom (Allen et al., 2017).While faculty may have the organizational power to help students progress in their careers (Haggard et al., 2011), they may not be assisting students with personal adaptation and positivity in the same way a peer could.

One additional element to consider as to why peer mentoring could be beneficial is cost. A formal peer-mentorship program can be less expensive than mentorship involving faculty or staff due to the lower compensation needs of peer mentors (Collier, 2015, 2017; Kram & Isabella, 1985) and it may be easier to recruit peers compared to traditional mentors due to scheduling and availability. To summarize, peer mentoring programs can serve to provide inclusiveness, sustainability, and attentiveness to addressing students' needs that may not be provided through other types of mentoring programs. Some of these points are summarized in Table 3.

Table 3

Peer Mentoring Program Rubric as Designed by Collier (2015)

Inclusiveness[a]	Duration[b]	Approach to Addressing Students' Needs[c]
Universal:	Short term:	Targeted:
Open to all students	*One semester or less*	*Addresses student needs at one point in time*
Tailored:	Long Term:	Developmental:
Designed for a specific audience	*More than one semester*	*Responds to student needs as they evolve over time*

[a]Inclusiveness is the audience to which the peer mentoring is designed and available.

[b]Duration is how long the mentoring will be provided for students.

[c]Approach to addressing students' needs is how the program will respond to helping with student needs.

2.5.1 Student Peer Mentor Descriptors

Terrion & Leonard (2007) performed a literature review of 54 scholarly studies and summarized student peer mentor descriptors found throughout peer mentoring research in a list of 15 descriptors according to the mentoring function served. They divided the descriptors into the three categories (a) prerequisites for the student peer mentor; (b) characteristics of the student peer mentor serving the career-related function; and (c) characteristics of the student peer mentor serving the psychosocial function (Terrion & Leonard, 2007). These descriptors suggested that certain types of expertise, characteristics, and experiences are needed for a flexible, understanding, and supportive mentoring relationship.

While some of the descriptors are based upon student's previous characteristics, attributes, and experiences (e.g., university experience, academic achievement, program of study, gender and race, and personality; Terrion & Leonard, 2007), it should be recognized that many of the descriptors are attributes, characteristics, and abilities that can be learned in order to be an effective mentor (e.g., flexibility, empathy, supportiveness, communication skills, enthusiasm, trustworthiness, and attitude; Handelsman et al., 2005; Terrion & Leonard, 2007). The results are compiled in Table 4 with the categories, descriptors, and importance. The importance listed shares the probable outcomes that may result from the given descriptor when present in a peer mentoring relationship.

Table 4

Summary of the Student Peer Mentor Descriptors (Terrion & Leonard, 2007)

Category	Descriptor	Importance[a]
Prerequisites for the student peer mentor	Ability and willingness to commit time	Accessibility and availability influences relationship satisfaction
	Gender and race	May influence satisfaction levels depending on the context
	University experience	Experience and expertise navigating the university environment may contribute value to the mentee
	Academic achievement	Establish credibility as an insider
	Prior mentoring experience	Not necessarily important for screening since effective mentorship can still happen, but being mentee may influence becoming a mentor
Characteristics of the student peer mentor serving the career-related function	Program of study	Same program of study increases satisfaction and dependability because of a similar expertise
	Personal development motivation	Mentors with strong advancement aspirations provide valuable career support to mentee

Category	Descriptor	Importance[a]
Characteristics of the student peer mentor serving the psychosocial function	Communication skills	Ability to listen, understand others (verbal and non-verbal), give advice, counsel, provide feedback, and express self can help in becoming ideal mentor
	Supportiveness	Support (e.g., empowerment, encouragement, endorsement, care, acceptance, nurture, etc.) can reduce stress and anxiety
	Trustworthiness	Having someone who it is safe to give personal information to, who is reliable, responsible, dependable, etc. can bring consistency to mentoring relationships
	Interdependent attitude	Mentors who are focused on being continuous learners can bring connectedness since both mentor and mentee are growing
	Empathy	Can be important in developing intimacy and trust in a mentoring relationship
	Personality Match	Personality can affect development and maintenance of a relationship
	Enthusiasm	Mentor enthusiasm is critical to mentees perseverance during difficulties
	Flexibility	Tolerance and acceptance of the values, limitations, and failures of others can lead to successful mentorship

[a] Importance shares the probable outcomes that may result from the given descriptor when present in a mentoring relationship

2.5.2 Engineering Peer Mentorship

To gauge the general prominence of engineering peer mentoring programs, a non-scholarly Google search for “College of Engineering Peer Mentoring Programs” was conducted. A non-scholarly approach was implemented due to a lack of formalized research publications on these topics. The most prominent are summarized in Table 5 but there were many more that appeared in the search. While peer mentoring programs in general tout positive outcomes for mentors and mentees, there was a lack of consistency and transparency for the peer mentoring programmatic characteristics, such as to the matching process of a mentor or mentee, the length of the program, and the types of mentorship. Information about how many of these programs were informed by formalized research activities was not found.

Table 5

Summary of Non-Scholarly Google Search for College of Engineering Peer Mentoring Programs

Institution	Type of Mentorship	Length	Mentor Selection	Mentee Inclusion
University of Utah - Mechanical Engineering (N. Brown et al., n.d.)	One mentor to 6 to 12 mentees	One academic year	Application and interview	Volunteer - Transfer student or freshman in first year of program
University of Colorado Boulder - College of Engineering and Applied Sciences (*CEAS Peer Mentor*, n.d.)	Teaching Assistant type role – lead a small group	One academic semester	Job application	Student in first-year symposium class
University of Colorado Boulder - Chemical and Biological Engineering (*Peer Mentor Program*, n.d.)	One-on-one	One academic year	Voluntary application	Voluntary application
California State University Long Beach – College of Engineering (*Peer Mentoring*, n.d.)	Ambassador program (tutoring & mentoring)	One academic year	Job application	Not specified
University of Michigan – College of Engineering (*Peer Mentoring CoE Peer Mentoring Program*, 2020)	One-on-one	One academic term	Voluntary application	Voluntary application
University of Southern Indiana – College of Science, Engineering, and Education (Pott College Student Campus Community, 2020)	One-on-one	One academic year	Voluntary application	Voluntary application

To determine the current state of scholarly research within engineering peer mentorship programs, a systematic literature review was conducted using EBSCOhost Academic Search Ultimate and Google Scholar. The primary key words used were “undergraduate”, “engineering”, “peer mentoring”, “peer mentorship”, and “program”. It was desired to have studies that were relatively current (i.e., published in the 2010s) to ensure up-to-date applicability to the given context. An exception was given for a study published in 2000 with relation to minority mentorship benefits. The paper had to include a formal mentorship program since this dissertation is focused on giving recommendations to a College of Engineering for developing formal peer mentorship program efforts.

While exploring research on peer-mentoring programs, it was found that there was a lot of variation in the programmatic elements depending on college circumstances. From approximately 35 papers identified, six papers were further examined. These six studies were chosen based on the focus, structure, and outcomes of their program to show the diversity of peer mentoring programs. The studies chosen had to be in the realm of engineering and at an institution of higher education. Six examples of either peer-mentoring programs that have been established long-term for the given College of Engineering or that have been developed for research purposes are summarized in Table 6. While this glimpse is far from comprehensive, it gives an idea of the variety of current happenings in peer mentorship in engineering. One of the programs was required in conjunction with a course (Budny et al., 2010) and the rest were volunteer based (Dennehy & Dasgupta, 2017; Gattis et al., 2007; Good et al., 2000; Holland et al., 2012; Meyers et al., 2010). While overall positive outcomes were found, since peer mentorship looked so different in all the programs, it was difficult to gain consensus on what the student experience, needs, and benefits of their peer mentorship programs were. Papers were also sparse or vague on details of the recruitment, training, matching, and monitoring of programs, so many would be very difficult to replicate or transfer. There also seemed to be a lot of peer-mentorship programs available, but the research literature was sparse in the long-term development, maintenance, and success of these programs. All studies were devoid of supporting evidence of the examination of student needs for the development of such a program. This dissertation aimed to begin filling this gap in knowledge.

Table 6

Summary of Peer Mentoring Program Findings from the Literature Review

Study	Recruitment	Type	Matching	Outcomes
University of Pittsburgh (Budny et al., 2010)	Required (in conjunction with lecture)	Group	Non-Academic theme interest for mentoring group (e.g., billiards, football, different cultures)	Freshman performance: • Increased first semester honors • Lowered first semester probation • Increased overall GPA • Increased retention Helpful in: • Selecting major • Managing the workload • Transitioning to college life • Sharing personal experiences • Assessing needs
University of Notre Dame (Meyers et al., 2010)	Volunteer	N/S	N/S	• No statistically significant improvements in adjusting to engineering or comfort with the choice of engineering • Showed promise for supporting new students since they showed a preference for approaching upperclassmen about adjustment skills and personal issues in an engineering context

Study	Recruitment	Type	Matching	Outcomes
Gender Matching (Dennehy & Dasgupta, 2017)	Volunteer	One-on-One	Randomized Assignment	Women: • Felt more similar and closer to women mentors • Decreased in belonging, aspirations to pursue advanced degrees in engineering, and self-efficacy in the first year when have a man as a mentor or no mentor • Felt threatened more than challenged in the first year with a man as a mentor or no mentor • Had less thinking about switching majors with any mentor • 100% retention of mentees with a woman as a mentor after year one whereas only 82% with a man as a mentor and 89% of those with no mentor • Outcomes more significant with a woman as mentor than with no mentor or a man as a mentor except with relation to engineering GPA
Minority Mentor Benefits (Good et al., 2000)	Volunteer	One-on-One	Matched based on similar courses of study	Mentors: • Grew academically (e.g., study skills, critical thinking, problem solving, understanding core engineering concepts, better GPA, higher retention) • Developed communication and leadership skills • Increased in confidence and identity • Experienced less isolation

Study	Recruitment	Type	Matching	Outcomes
Capitalization and Mentoring in STEM Education (Holland et al., 2012)	Volunteer	N/S	N/S	Increased: • Capitalization • Security in major • Confidence in ability to succeed
University of Arkansas (Gattis et al., 2007)	Volunteer	One-on-One	Meshing personality based on Peer Mentoring Program Questionnaire	• Increased retention rates and GPAs over non-mentored students • Mentees reported gaining recognition, confidence, self-esteem, encouragement, and support • Mentors learned more about services offered on campus, improved interpersonal skills, and increased commitment to engineering

2.5.2.1 Summary of Engineering Peer Mentorship

The examples of engineering peer mentorship summarized in Table 6 generally showed positive outcomes (e.g., academic growth, major security, increased retention, confidence gains, etc.) coming from peer mentorship programs, regardless of who they were targeted at and the scope of the peer mentorship program. The clear gap between each of these studies is consistency in determining the why and how of the mentorship program. Though they address the efficacy of mentorship programs, they do not necessarily assess the need students specifically perceived as being essential for peer mentorship. The studies generally lacked details on what the student specific needs were and how the peer mentorship program was designed to meet those needs. The students may have filled out surveys for matching purposes or for analyzing the benefits, but none featured a needs assessment *before* the formation of a program. The studies were primarily focused on the outcomes of the peer mentoring program instead of on the foundational design of the program. This dissertation aimed at filling this gap, which was done by thoroughly exploring commonalities in student needs for peer mentorship within a College of Engineering *before* a generalized and accessible peer mentorship program is developed.

2.5.2.2 Support Functions in Peer Mentoring

Table 7 and Table 8 contain a summary of the psychosocial support and academic career functions, respectively, as well as the example function outcomes addressed under the overall function. These support functions and outcomes of peer mentoring originated from the aforementioned literature review on engineering peer mentorship (Budny et al., 2010; Dennehy & Dasgupta, 2017; L. T. de T. Eby et al., 2008; Gattis et al., 2007; Good et al., 2000; Higgins & Kram, 2001; Holland et al., 2012; Meyers et al., 2010; Pfund et al., 2016; von der Borch et al., 2011). Each of the functions were related specifically to an engineering peer mentorship context to assess needs in the survey instrument, which will be discussed further in Chapter 3. For each function, the table gives the example outcomes, the relation to engineering peer mentorship, and applicable references. These outcomes can be directly related to the needs that students have within the realm of peer mentorship and give the priorities for developing a peer mentoring program. For example, if a student identified the navigating transitions outcome as a need they had with regards to peer mentorship, a training module could be developed within the peer mentorship program for mentors to know how to share advice and assist in coping with the transition. This will be discussed further in the integrated data analysis portion of Chapters 4 and 5.

Table 7

Summary Table of the Psychosocial Support Function and Examples

Function Outcome	Relation to Engineering Peer Mentorship	References
Navigating transitions	Navigating the transition as someone is admitted into college (e.g., homesickness, stress management, independence, conflicts with roommates, time management, etc.)	Budny et al., 2010; Dennehy & Dasgupta, 2017; Meyers et al., 2010
Capitalization	Taking advantage of opportunities and circumstances (i.e., getting involved in research, applying to jobs or scholarships, volunteering, etc.)	Holland et al., 2012
Gaining confidence	Gaining confidence in being able to succeed in engineering	Dennehy & Dasgupta, 2017; Eby et al., 2008; Gattis et al., 2007; Good et al., 2000; NASEM, 2019; Pfund et al., 2016
Belonging	Belonging (e.g., building friendships in engineering; feeling valued and respected within the College of Engineering, engineering classes, engineering clubs, etc.)	Dennehy & Dasgupta, 2017; Gattis et al., 2007; Good et al., 2000; Haggard et al., 2011; Holland et al., 2012; Meyers et al., 2010
Extracurricular involvement	Getting involved in campus life (e.g., engineering clubs, College of Engineering events and socials, etc.)	Budny et al., 2010; Gattis et al., 2007; Holland et al., 2012; Meyers et al., 2010
Developing identity	Developing engineering identity (i.e., what you refer to when defining yourself within engineering such as who you are, how you think about yourself, what your goals are, how you are viewed by the world, and what traits you possess)	Good et al., 2000; Holland et al., 2012; NASEM, 2019

Table 8

Summary Table of the Academic Career Support Function and Examples

Function Outcome	Relation to Engineering Peer Mentorship	References
Study tips	Engineering studying tips (e.g., forming study groups, taking notes, checking homework, using tutoring, etc.)	Budny et al., 2010
Choosing a major	Choosing an engineering major	Budny et al., 2010; Dennehy & Dasgupta, 2017; Holland et al., 2012; Meyers et al., 2010
Persistence and retention	Staying in an engineering major	Dennehy & Dasgupta, 2017; Eby et al., 2008, 2013; Gattis et al., 2007; Holland et al., 2012; NASEM, 2019; Pfund et al., 2016
Developing teamwork skills	Working on a team (e.g., group project for class, research team, club, etc.)	Budny et al., 2010
Referrals to appropriate resources	Referrals to appropriate campus resources (e.g., formal tutoring services, counseling services, career services, advising, etc.)	Budny et al., 2010; Gattis et al., 2007
Tutoring (e.g., problem solving, critical thinking	Tutoring (e.g., peer mentor personally helping with homework and studying)	Good et al., 2000
Developing communication skills	Developing professional communication skills (e.g., conflict management, oral presentations, writing skills, etc.)	Good et al., 2000

Function Outcome	Relation to Engineering Peer Mentorship	References
Network growth	Network growth (i.e., gaining valuable relationships with other professors, students, working professionals, etc.)	Higgins & Kram, 2001; NASEM, 2019; von der Borch et al., 2011
Promotion of opportunities	Sharing and encouraging pursuing opportunities that may be a good fit	Gattis et al., 2007
Gaining recognition	Gaining recognition (e.g., praise for success, awards, etc.)	Gattis et al., 2007
Sponsorship	Sponsorship (i.e., serving as a reference for a job)	NASEM, 2019

2.6 Assessing Mentorship Needs

Studies focused on assessing mentorship needs were found by searching on Google Scholar and EBSCOhost Academic Search Ultimate with keywords such as "mentoring needs assessment", "peer mentoring needs assessment", and "engineering mentoring needs assessment". "Mentorship" was also used in exchange for "mentoring" to make sure studies were not missed. Nine studies were identified for further review. All studies were within the 2000s, with all but one being from after 2010 to assure recent and applicable information was obtained. Seven of the studies were within the realm of medical education and training (Binkley & Brod, 2013; Breakey et al., 2018; Riley et al., 2014; Sawatzky & Enns, 2009; Sinclair et al., 2015; von der Borch et al., 2011), one was for counselor training (Allen et al., 2017), and one was in engineering education (Jones & Waggenspack, 2017).

Needs can be both theoretically and practically important when determining solutions to problems (Sallis & Henggeler, 1980). While it is important to continually assess mentor and mentee needs and expectations throughout a mentoring relationship (NASEM, 2019), literature reveals few evidences of studies being used to explore these needs *before* the development of any type of mentorship program (Allen et al., 2017; Binkley & Brod, 2013; Breakey et al., 2018; Riley et al., 2014; Sawatzky & Enns, 2009; Sinclair et al., 2015; Tran et al., 2012; von der Borch et al., 2011) with only *one* evidence found of an assessment of needs for undergraduate engineering peer mentorship (Jones & Waggenspack, 2017) that was used in conjunction with an evaluation survey for the previously developed program. The assessment of needs was given to *reflectively* assess hurdles students faced as well as hurdles they expect to face (Jones & Waggenspack, 2017). All of the questions for assessing needs were qualitative, so they were lacking quantitative integration and evidence to support the findings (Jones & Waggenspack, 2017). As emphasized by Crisp & Cruz (2009) and found throughout this part of the literature review, the current literature on assessments used within mentorship neglect providing a full copy or description of the actual assessment instrument that is used even though many of the assessments are created by the researchers themselves. A summary of the nine aforementioned examples that were found for assessment of needs for mentorship programs are summarized in Table 9.

Table 9

Summary of Mentorship Needs Assessment Findings from Literature Review

Study	Context	Purpose	Population	Assessment Structure	Validity and Reliability
Nursing Faculty Mentorship Needs Assessment (Sawatzky & Enns, 2009)	Nursing Education	Assess mentoring needs to establish foundation for formal mentorship program	29 full-time nursing faculty	• Six Likert-scale item questionnaire assessing: ○ Characteristics of good mentorship ○ Possible roles and responsibilities of mentors ○ Benefits of being a mentor ○ Stressors for faculty ○ Barriers to mentorship • Open-ended questions for qualitative comments at the end of the quantitative questions • Open-ended questions for those who had been in mentoring relationships to discuss benefits and drawbacks of mentorship	Pre-tested by three faculty members

Study	Context	Purpose	Population	Assessment Structure	Validity and Reliability
Medical Student Mentorship Needs Analysis (von der Borch et al., 2011)	Medical Education	Determine goals and expectations for the future mentorship program	All medical students (4,109) with a 14.1% return rate for quantitative (n = 578) 24 students and 22 faculty for focus groups	• Seven Likert-scale items and one open-ended question assessing: ○ Student desire for increased individual support ○ Current quality of medical education • Focus groups aimed at determining: ○ Demand for mentoring ○ Attitudes toward mentoring ○ Introduction of a possible mentoring program	Not discussed
Faculty Mentorship in Family medicine Needs Assessment (Riley et al., 2014)	Family Medicine Education	Analyze current mentorship program and examine relationships between given factors	62 faculty (83% return rate)	○ Quantitative survey inquiring about: ○ Perceptions of importance of mentorship ○ Current mentorship practices ○ Mentorship satisfaction ○ Job satisfaction ○ Academic productivity	Not discussed

Study	Context	Purpose	Population	Assessment Structure	Validity and Reliability
Faculty Mentorship in College of Medicine Needs Assessment (Binkley & Brod, 2013)	Medical Education	Determine current mentorship practices and explore how mentors are identified	All 576 faculty members with 50% return rate (n = 289)	○ Self-developed survey to assess: ○ Amount of faculty with a mentor ○ How mentors are identified ○ Frequency of mentorship	Not discussed
Surgical Training Mentorship Needs Assessment (Sinclair et al., 2015)	Surgical Education	Determine the current and future needs for mentoring within surgical training	565 surgical trainees	○ Self-developed 47-item questionnaire (free-text, binomial, and 5-point Likert scale) that distinguished those who had a mentor and those that did not to examine: ○ Current mentorship ○ Desire for mentorship ○ Ideal mentoring program ○ Mentor practices	Content and face validity

Study	Context	Purpose	Population	Assessment Structure	Validity and Reliability
Peer Mentoring Program for Counselors in Training (Allen et al., 2017)	Counselor Education	Described theoretical importance of needs assessment for developing peer mentorship program	Not applicable	○ Provided an example needs assessment for the development of a peer mentorship program to determine: ○ Student interest in peer mentoring relationship ○ Topics for mentorship ○ Expectations or requests for mentorship	Faculty acceptance of proposal
Online Hemophilia Peer-to-Peer Mentoring Needs Assessment (Breakey et al., 2018)	Medical Patient Care	Determine the needs and wants of hemophilia patients	23 participants between the ages of 12 and 25	○ Semi-structured interviews to explore: ○ Experiences dealing with hemophilia ○ Interest levels in building friendships or mentoring relationships with other hemophilic youth	Interview format developed based on literature review and clinical experience
Inflammatory Arthritis Peer Mentorship (Tran et al., 2012)	Medical Patient Care	Determine the support that could possibly be offered through a peer mentorship program	15 individuals with inflammatory virus, 6 family members or friends, and 9 health care professionals	○ Semi-structured interview to determine: ○ Determine perspectives on patient needs ○ Give perspective of multiple stakeholders involved with patient	Interview developed based on previous research explored

Study	Context	Purpose	Population	Assessment Structure	Validity and Reliability
Pathway Scholarship Project Assessment (Jones & Waggenspack, 2017)	Engineering Education	Provide information about students and their experiences relating to mentorship	36 pathway scholarship students	○ Open-ended questions about: ○ Expected and actually experienced hurdles ○ Engineering identity ○ Belonging in program	Not discussed

2.6.1 Summary of Mentorship Needs Assessments

It was interesting that three of the studies were focused on inter-faculty mentorship in academic contexts (Binkley & Brod, 2013; Riley et al., 2014; Sawatzky & Enns, 2009), but these studies had no mention of mentoring students. The focus of some of the examples simply examined the *current* mentorship practices within the various contexts rather than examining the *perceived* need gaps where mentorship may be useful. Five of the studies examined student or participant needs (Breakey et al., 2018; Jones & Waggenspack, 2017; Sinclair et al., 2015; Tran et al., 2012; von der Borch et al., 2011), but only one was involved in an engineering context (Jones & Waggenspack, 2017). One example was simply explaining the theoretical importance of performing a needs assessment (Allen et al., 2017). Details about the development of these assessments as well as the reasoning to when or to who it was given were not explained thoroughly, thus severely limiting the validity and transferability of the surveys. These examples emphasized the lack of empirical studies to explore the needs for mentorship, especially within the context of peer mentorship in engineering.

2.7 Designing a Mentorship Program

When designing a formal mentorship program and the accompanying evaluation systems, Garringer et al. (2015) have developed six core standards of practice that must be considered, which are (a) recruiting; (b) screening; (c) training; (d) matching and initiating; (e) monitoring and supporting; and (f) closing.

In recruitment, it is critical to realistically give the benefits and challenges in mentorship, both for the mentors and mentees, as well as build positivity about the mentorship (L. T. Eby et al., 2010; Garringer et al., 2015). It is important as well to make sure appropriate mentors are recruited by advertising and that they know what is expected and required of mentors (Garringer et al., 2015). Screening is critical in knowing which mentees and mentors to accept or disqualify, whether that comes through interviewing or reference and background checking (Garringer et al., 2015). The better that the screening and recruitment are, the more effective the later steps of matching and initiation will be. Matching can be completed considering both surface-level and deep-level characteristics (Garringer et al., 2015; NASEM, 2019). Initial meetings should be arranged and all parties should give written commitment to all obligations and policies required by the program (Garringer et al., 2015).

Training is critical to help both mentors and mentees understand the program goals and requirements, their obligations and opportunities, safety and confidentiality regulations, and resources available for support (Garringer et al., 2015; Eby et al., 2010). Overseers of the program should make sure to keep consistent contact with the mentors and mentees, thoroughly document progress, and offer support or feedback as needed (Garringer et al., 2015). It is important that there is structural support in place to helping deal with challenges that arise within mentoring relationships (Eby et al., 2010). An important but sometimes overlooked step of the mentoring relationship is closure, whether the ending of the relationship is anticipated or unanticipated (Eby et al., 2010; Garringer et al., 2015). The steps of monitoring and closure are also critical times to evaluate the mentorship program. Assessment methods should be planned before the program is developed (Postlethwaite & Schaffer, 2019).

Two of these standards of practice were chosen to serve as the constructs for this dissertation: training and matching/initiating. Based on a review of current peer mentoring programs, the training and matching/initiating standards of practice are the critical programmatic elements that could be implemented according to student needs. Recruiting, screening, monitoring, supporting, and closing practices are generally well-established and have a set of best-practices to accompany them (Garringer et al., 2015) whereas training and matching/initiating needs and preferences are highly reliant on the population of interest and their needs (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017; Eby et al., 2013; NASEM, 2019). This choice will be discussed in greater detail in Chapter 4.

2.8 Summary of Literature Review

In this literature review, it has been found that there is a multiplicity of definitions of what mentorship entails as well as a variety of approaches to the methodology of mentorship. Overall, there are positive outcomes in mentoring relationships assuming all parties have good intentions and set out to establish a mutually beneficial relationship. But, as mentioned previously, the details are sparse on the development, maintenance, and success of these programs, especially with relation to peer mentoring relationships in an academic engineering program.

As stated by Meyers et al. (2010), there is a “lack of scholarly work in mentoring programs” (p. 176). There are overall, general guidelines on how to establish effective mentorship programs, but specific details on addressing specific needs within those standards of practice on a program-by-program basis are not available. One aspect that was not found in literature was an empirical exploration of peer mentoring needs or the involvement of students in the development of a mentorship program. With undergraduate mentorship programs focused on addressing student needs such as identity development, belonging, involvement, choosing a major, retention, and developing skills (Budny et al., 2010; Dennehy & Dasgupta, 2017; L. T. de T. Eby et al., 2008; Gattis et al., 2007; Good et al., 2000; Haggard et al., 2011; Holland et al., 2012; Meyers et al., 2010; NASEM, 2019; Pfund et al., 2016), ironically, no studies have examined student perspectives of their needs when designing a mentorship program to meet their determined needs.

CHAPTER III

PILOT STUDY: DEVELOPMENT AND VALIDATION OF A MIXED-METHODS INSTRUMENT TO EXPLORE STUDENT PERCEIVED NEEDS IN PEER MENTORING

Because of the critical and extensive nature of the validation of a research survey instrument before interpreting results, this chapter was dedicated to exploring and explaining the methodology and results from the validation of the survey items created. This instrument was created as part of a pilot study aimed at answering the three research questions to form a foundation for studying student perceived needs in peer mentoring. This approach was used since no satisfactory research instrument to assess perceived student needs in engineering regarding peer mentorship exists.

An assessment is considered valid when it is actually measuring what it was designed to measure (ACAPS, 2016). A reliable assessment produces the same answers under the same circumstances when repeatedly administered (ACAPS, 2016). Similar to Sinclair et al. (2015), one particular focus for the validity of an assessment is face and content validity, especially when considering the inclusion of both qualitative and quantitative questions on the instrument. The instrument's reliability is also tied to its validity since the instrument can exhibit both quality and rigor (Golfashani, 2003) through quantitative calculation and qualitative feedback from expert reviewers. Validity and reliability were central to the development stages of the instrument and guided subsequent methodologies described in Chapter 4.

After performing face and content validity, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to explore and validate the relationships between constructs and items (Yong & Pearce, 2013) that were newly created. Reliability by means of internal consistency of the quantitative questions was determined through the Cronbach's Alpha coefficient, which is commonly used when analyzing ordinal data, such as Likert scales (Taherdoost, 2016). Cronbach's Alpha assesses the interrelation between items or factors to make sure the answers are consistent (R. B. Johnson & Christensen, 2017). Also, Cronbach's Alpha was used to explore the reliability of each construct, informed by CFA, as well as the instrument as a whole (Taherdoost, 2016).

3.1 Creating a Mixed-Methods Survey Instrument for Peer Mentoring Needs

Within peer mentorship, instruments exploring needs are typically used to identify what gaps exist in peer mentoring relationships (Pieterson & Ridgway, 2019). A perceived need is defined as a "measurable gap between two conditions – what currently is and what should be" (Altschuld & Watkins, 2014, p. 6) and is not focused on what currently exists or what the desired state is, but rather it is the gap in between the two (Office of Migrant Education, 2001).

Two different data strategies that can be used to explore needs are (a) hard data (i.e., quantitative); or (b) impressionistic (i.e., qualitative) data (Sallis & Henggeler, 1980). Hard data focuses on quantitatively relating participant characteristics to outcomes (Sallis & Henggeler, 1980) such as relating gender to engineering retention rate. Impressionistic approaches focus on subjective assessment of experiences and needs (Sallis & Henggeler, 1980). In mixed-methods survey instruments, problem areas, issues, or difficulties can help point to what will be needed in the future (Altschuld & Watkins, 2014). This was the main reason for incorporating quantitative and qualitative data. The quantitative portions helped determine perceptions, while the qualitative portion elucidated experiences. Since perceived need is the gap between what should be addressed in the future by the peer mentorship program and students' experiences rather than institutional goals and objectives (Sallis & Henggeler, 1980), a mixed-methods instrument was deemed appropriate.

Instruments focused on needs rely more on planning and anticipating rather than evaluating, though the results can directly contribute to designing applicable evaluation of a program after design and implementation (Altschuld & Watkins, 2014). As was seen in the literature review, the formalized assessments of needs found in the realm of mentorship were focused primarily on *evaluating* the current state of mentorship instead of focusing on *planning and anticipating* a future program. Empirical assessments based on needs are often neglected because funding is often tied to predetermined, quick solutions (Allen et al., 2017; Altschuld & Watkins, 2014). Designing and implementing a new program can be time consuming and demanding, which is why a pilot study is an ideal way to attend to these early, pre-planning type of assessments.

Studying perceived needs, even if only implemented for training and matching/initiating, has the advantage of obtaining information that is specific to a given population's context, even if the population is demographically similar to other studies (Witkin & Altschuld, 1995). The survey instrument developed for this dissertation was able shed light on priorities needed for establishing formal peer mentoring programs within the College of Engineering (Altschuld & Watkins, 2014; Witkin & Altschuld, 1995). Through the mixed-methods survey instrument and pilot study, a rigorous study design (Chapters 4 to 6) was developed for this dissertation. The use of mixed-methods also increases the visibility and credibility of the findings that would support evidence-based programmatic formations in the future (Sallis & Henggeler, 1980).

3.1.1 General Comments on Validity and Reliability Standards

Overall, the pilot study followed validity and reliability standards for qualitative and quantitative measures through measures of quality, transferability, consistency, goodness, credibility, or trustworthiness (Golfashani, 2003; Heron, 1996). Validity and reliability as a whole are summarized as the compilation of rigor, quality, and trustworthiness of the study (Golfashani, 2003; R. B. Johnson & Christensen, 2017). Internal validity, generated from research techniques, indicates credibility and objectivity (Heron, 1996). External validity, derived from collected data and its approaches, marks transferability, reliability, and dependability (Heron, 1996). Reliability was primarily considered as the quality of the study and its ability to generate understanding instead of simply explaining data (Golfashani, 2003). Aspects of validity and reliability are discussed further with regards to each part of the dissertation study that followed this survey development throughout the next two chapters.

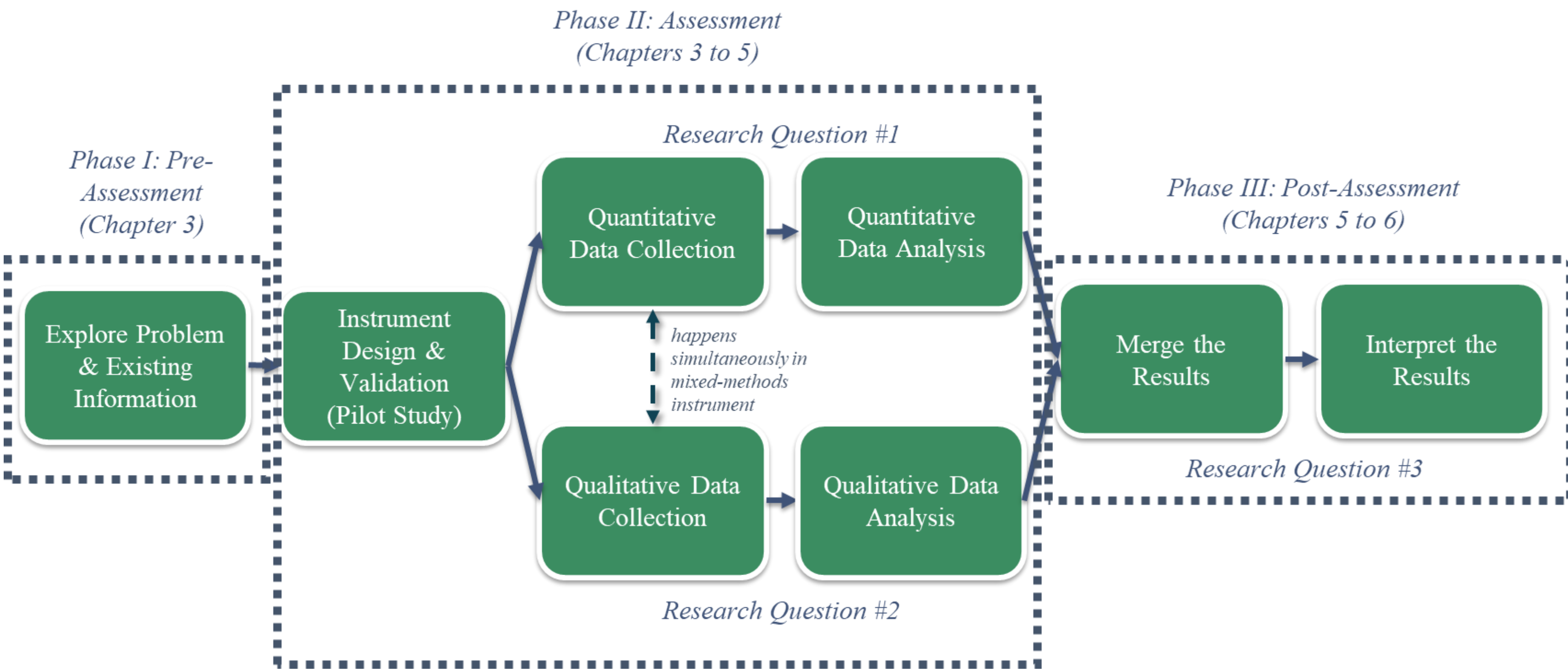
3.1.2 Process to Develop an Assessment of Needs Survey Instrument

In this parallel convergent mixed-methods study, the three overall phases in the process of assessment of needs were followed (ACAPS, 2016; Altschuld & Kumar, 2010; Office of Migrant Education, 2001) consisting of a pre-assessment (Phase I), assessment (Phase II), and post-assessment (Phase III), as shown in Figure 3. The three phases provide an overview of the entire research study, which included this pilot study as well as the dissertation study focus.

Phase I was the exploration phase consisting of examining current practices in mentorship, especially in the given College of Engineering, by way of literature review and informal methods, both in a practical sense and from a researcher perspective. Phase II was the creation and validation of the instrument based on findings from Phase I as well as the distribution, collection, and analysis of formal survey information from involved stakeholders. Phase III was the integrating and reporting portion of the study where the needs of students were summarized based on the results of Phases I and II with regards to a peer-mentorship program. The pilot study included Phases I and II while the remainder of the dissertation expanded the work from Phase II to a follow-up analysis in Phase III. Results and suggestions for the design of a peer mentorship program based on the data analysis were compiled and presented to the appropriate parties within the College of Engineering.

Figure 3

Adapted Overview of the Dissertation Study as Refined and Described from Altschuld & Kumar (2010), Creswell & Plano Clark, (2018), and Office of Migrant Education (2001)



3.1.3 Structure and Content of the Mixed-Methods Survey Instrument

All survey questions and data collection procedures were approved through the appropriate Internal Review Board (IRB) Office at Utah State University. The full text of the mixed-methods instrument and IRB Approval are shown in Appendix A. A convergent mixed-methods (Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017) instrument was designed, meaning there were both quantitative and qualitative questions (R. B. Johnson & Christensen, 2017). The quantitative and qualitative questions used together complemented each other to concurrently collect data from participants (Zohrabi, 2013). One important consideration was the focus on the “need-to-haves” not the “nice-to-haves” in the survey items in order to not burden the person taking the mixed-methods instrument with unnecessary questions (ACAPS, 2016; Savitzky, n.d.).

The quantitative questions were close-ended because they were easier to compare across respondents and easier to analyze compared to open-ended questions (ACAPS, 2016). At the same time, close-ended questions, such as those on a five-point Likert scale or a multiple choice question, can be restraining and do not allow for the subjective expression of perceptions and ideas, which may have valuable feedback, like open-ended questions do (ACAPS, 2016). For this pilot study, the primary goal was to validate the survey instrument for use in the dissertation; thus, most items were close-ended and quantitative. However, a small number of open-ended questions were added to the survey instrument to allow participants to use their own language (R. B. Johnson & Christensen, 2017), clarify complexities (Driscoll et al., 2007), and use participant quotes to enhance, embellish, and validate quantitative findings (Creswell & Plano Clark, 2018). Together, the mixed-methods instrument, whose validation and reliability were assessed in this pilot study, served to increase the rigor, value, and depth (Harland & Holey, 2011) of the dissertation findings in Chapters 5 and 6.

3.1.3.1 Mixed-Method Design for Survey Development

Mixed-methods research is an emergent methodology where the research combines both quantitative and qualitative methods, approaches, or concepts within the same study (R. B. Johnson & Christensen, 2017; Wisdom & Creswell, 2013). A more complete, rich breadth of understanding can be obtained from mixed-methods studies rather than those studies that only use one method (Schoonenboom & Johnson, 2017; Wisdom & Creswell, 2013). Wisdom & Creswell (2013) recommend that there are five core characteristics of a well-designed mixed-methods study:

1. Collect and analyze both qualitative and quantitative data.
2. Use rigorous procedures in collecting and analyzing data appropriate to each method's tradition (i.e., sample size).
3. Integrate data during collection, analysis, or discussion.
4. Use procedures that implement qualitative or quantitative components concurrently or sequentially with same or different samples.
5. Frame the procedures within the appropriate philosophical or theoretical models of research.

This pilot used a parallel convergent design with both the qualitative and quantitative portions of the data collection happening at the same time and whose results were integrated (Chapters 4 to 6) for overall interpretation and comparison (Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017). The parallel convergent design was chosen to provide synergistic comparisons of the qualitative and quantitative data since the same participants completed all parts of the survey at the same time (Driscoll et al., 2007).

Mixed-methods can assist in strengthening and expanding findings in a research study and provide validation between data sources to develop a foundation for future decisions made from the results of the research (Schoonenboom & Johnson, 2017; Wisdom & Creswell, 2013). Parallel convergent design allows for a more complete and comprehensive understanding of research results by intertwining both qualitative and quantitative data (Creswell & Plano Clark, 2018). Complementarity is the main purpose for mixing methods in this study because the qualitative question elaborated upon, enhanced, increased credibility, illustrated, provided contextual understanding, and clarified the results from the quantitative results (Harland & Holey, 2011; Schoonenboom & Johnson, 2017). With the combination of both quantitative and qualitative inquiry, additional insight can be obtained when both methods are used instead of just one (R. B. Johnson & Christensen, 2017).

The quantitative portion was a substantial part of the research instrument with the qualitative portion existing to enhance, expand, and supplement (Schoonenboom & Johnson, 2017). This means that the core component, which in this case of the quantitative portion of the study, could be implemented on its own (Schoonenboom & Johnson, 2017), if needed. Both quantitative and qualitative approaches were used in order to get a broader understanding of the issue at hand (R. B. Johnson & Christensen, 2017). Quantitative and qualitative findings together can add meaning to one another and increase the understanding gained from the results (R. B. Johnson & Christensen, 2017). While the dissertation study did not fully mix its methods and results, strategic partial mixing was done to narrow down important, priority areas in the results and discussion sections (Chapters 5 and 6).

While an overview of the entire research study process (pilot + dissertation) was presented in Figure 3, an overview of the research instrument design with regards to the research questions, question categories, question type, and applicable constructs are shown in Figure 4. The breadth of question categories and items were designed to allow for thorough answers to each of the research questions. This research instrument design was conducted as part of the pilot study within Phase II based on findings from Phase I (Figure 3). Specific item topics and sub-topics relating to the question categories in Figure 4 are shown in Table 10. Decisions of why these items were chosen will be further discussed in the subsequent sections in this chapter. The analysis performed to answer the research questions will be discussed in more length in Chapter 4.

Figure 4

Summary of Overall Research Survey Instrument Design by Research Question, Question Category, Question Type, and Applicable Constructs

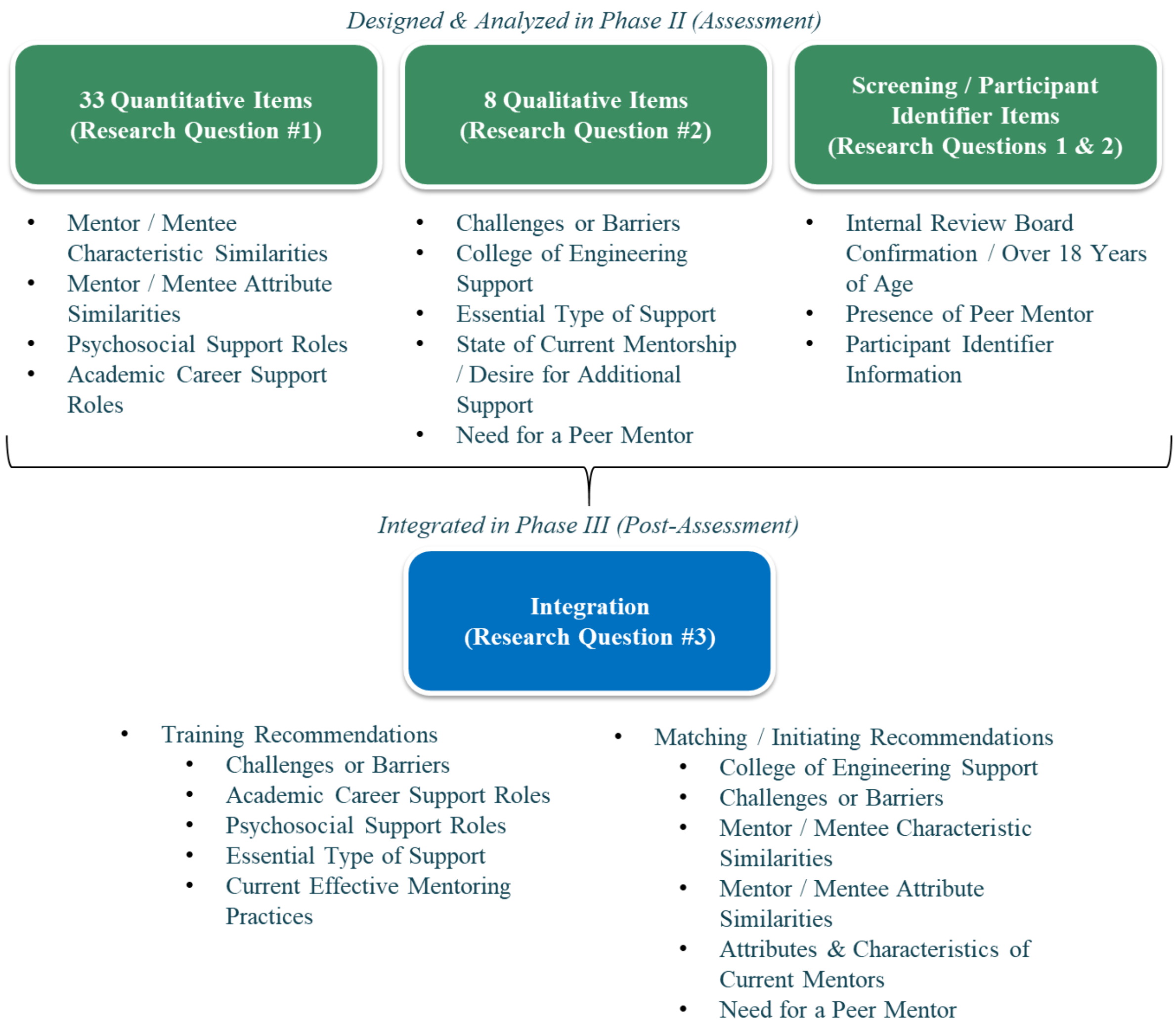


Table 10

Summary of Instrument Item Topics by Question Category (Figure 4)

Question Category	Instrument Item Topics	Instrument Item Sub-Topics (as applicable)	Citations
Participant Identifier Information	○ Ethnicity/Race ○ GPA ○ Year in School ○ Gender ○ First-Generation Status ○ Major		Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017; L. T. de T. Eby et al., 2013; Fernandez et al., 2016; Hughes et al., 2016; NASEM, 2019; Pawley, 2017
Mentor/Mentee (Theoretical) Characteristic Similarities	○ Commitment ○ Interests ○ Effort	○ Major ○ Specialty Areas ○ Career ○ Hobbies	L. T. de T. Eby et al., 2013; NASEM, 2019; Terrion & Leonard, 2007
Mentor/Mentee (Theoretical) Attribute Information	○ Ethnicity/Race ○ Gender Identity ○ First-Generation Status		Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017

Question Category	Instrument Item Topics	Instrument Item Sub-Topics (as applicable)	Citations
Yes, I currently have a peer mentor	○ Essential Type of Support ○ Attributes ○ Characteristics ○ Effective Mentoring ○ Additional Support Desired		NASEM, 2019
No, I do not currently have a peer mentor	○ Essential Type of Support ○ Need for a Peer Mentor		NASEM, 2019
Psychosocial (Theoretical) Support Roles	○ Emotional Support ○ Personal Development	○ Work/Life Balance ○ Living Situation ○ Persistence ○ Identity ○ Major Choice ○ Set Goals ○ Build Friendships ○ Events & Socials ○ Research Involvement ○ Study Groups ○ Network Growth	Budny et al., 2010; Dennehy & Dasgupta, 2017; L. T. de T. Eby et al., 2008; Gattis et al., 2007; Good et al., 2000; Haggard et al., 2011; Holland et al., 2012; Meyers et al., 2010; NASEM, 2019, Pfund et al., 2016

Question Category	Instrument Item Topics	Instrument Item Sub-Topics (as applicable)	Citations
Academic (Theoretical) Career Support Roles	○ Skills ○ Resource Referral	○ Note Taking ○ Communication ○ Time Management ○ Group Projects ○ Tutoring Services ○ Advising Services ○ Campus Resources ○ Jobs & Scholarships	Budny et al., 2010; Dennehy & Dasgupta, 2017; L. T. de T. Eby et al., 2008, 2013; Gattis et al., 2007; Good et al., 2000; Holland et al., 2012; Meyers et al., 2010; NASEM, 2019; Pfund et al., 2016
Challenges or Barriers	○ Peer Mentoring Challenges or Barriers		Leary et al., 2016; NASEM, 2019; Pieterson & Ridgway, 2019; Sambunjak et al., 2010
College of Engineering Support	○ Support Needed from College to Support Peer Mentorship		NASEM, 2019

3.2 Face and Content Validity of the Survey Instrument

Face validity is a subjective judgement of the relevance, feasibility, clarity, consistency, and readability of the assessment (Taherdoost, 2016). Face validity was established through an iterative process of review by the research team, construct experts, pertinent involved stakeholders, and like-population participants (Lewinski et al., 2017). Although face validity may be the weakest form of validity (Taherdoost, 2016), for a newly created mixed-method research instrument, it is an appropriate form of validity. Throughout the face validation process, the research questions were kept in mind to make sure the instrument did not deviate from the original goal of the original research questions (Figure 4), which was continually verified throughout the validation process (further explained below). All commentary discussed among reviewers and researchers was implemented iteratively until a final version of the survey was created (Vrbnjak et al., 2017).

Content validity is a subjective measure of whether an item is essential to the assessment within a given context, commonly described by relevance and representativeness (Taherdoost, 2016). This means that the content domain is well defined and the assessment adequately samples that domain (Lawshe, 1975). This is based upon thorough literature reviews and then evaluation by subject matter expert reviewers who determine whether each item is essential or not (Lawshe, 1975; Taherdoost, 2016). Content validation occurred through many revisions to ensure proper content and clear wording of items. A summary of all participants involved in the face and content validation are shown in Table 11.

Table 11

Summary of Participants Involved in Face and Content Validation

Category	Participants
Dissertation Committee	• Three Associate Professors in Engineering Education • One Full Professor in Engineering Education • One Associate Dean in College of Engineering
Construct Expert	• One Assistant Professor in Engineering Education with experience in instrument design & validation

First Round Like-Participants	• One recent (within one year) Engineering Education Ph.D. graduate
	• One recent (within one year) alumni in Engineering Industry
	• Two Engineering Education Ph.D. students
	    o One English second language (ESL) learner
	• Three undergraduate Engineering students
	    o One English second language (ESL) learner
	    o Two Seniors
	    o One Freshman

Second Round Like-Participants	• Four undergraduate Engineering Students
	    o Two Juniors
	    o Two Seniors
	• Three Engineering Education Ph.D. students
	    o One English second language (ESL) learner

Stakeholders	• Two Staff & Support Member
	    o One expert in student recruitment
	    o One expert in student recruitment, retention, & involvement

The original refinement happened in seven rounds with the primary researcher and her advisor. The version resulting from this process was then provided to the dissertation committee for feedback. Based on provided feedback for content and clarity, the survey questions were categorized, ordered, and adjusted to consistently fit the overall constructs. Throughout this process, it was also decided that, instead of screening for participants who had or had not engaged with a peer mentor, screening for both categories would help gather an overall scope of needs. This was especially important when considering the lack of a formalized and broadly available peer mentoring program in the College of Engineering of interest for this dissertation.

Feedback was again obtained from the dissertation committee and an additional construct expert and further refinement was made with more careful attention paid to the validation. The research questions were revisited, the instrument was condensed and revised, and the wording was changed as appropriate. After the content was deemed appropriate by the research team, the wording then underwent four additional rounds of revision, again with the research team and a construct development expert.

For validation with external (i.e., external to the research group and dissertation committee) reviewers, it was suggested that multiple sets of reviewers should be recruited to determine the face and content validity (Polit et al., 2007). For the first round, seven like-participants were recruited to take the survey then provide item-by-item feedback on interpretation and clarity. This was done virtually on Zoom. A like-participant is considered someone who currently or very recently fit into the category of participants desired for the study, which is the preferred population for a pilot study to ensure adequate validation (Moore et al., 2011). These participants ranged from undergraduates to recent doctoral graduates, all in engineering. This allowed for a diverse set of perspectives to be considered for validation. Also, English second language (ESL) learners were intentionally included in this process as well to ensure the instrument was understandable to a breadth of participants. From this validation, it was determined that "peer mentorship" required definitions and explanations. There were also many changes in the wording and order to increase clarity of the survey instrument items.

The next validation round included a new set of eight like-participants, both undergraduate and graduate students in engineering, as well as a stakeholder who is a staff and support member in the College of Engineering focused on student recruitment. This round of validation was conducted through written item-by-item responses. The changes that resulted were primarily wording changes for clarity, but some items were deleted, and small clarifications were made where needed.

The final round of face and content validity was conducted with the dissertation committee, a content expert, and a new staff stakeholder who has an expert background in the needs of students with regards to retention, involvement, and recruitment. This resulted in further changes in wording and small content changes to make sure the research questions were being answered adequately and thoroughly. Overall, it was agreed that the instrument was well thought out and prepared and covered the necessary aspects of peer mentorship when considering the creation of a new survey instrument. Thirty-three total Likert scale items were developed because of this validation in conjunction with eight qualitative questions and eight participant identifier questions. The content of these questions is described in more detail in the following sections. As a reminder, only two of the qualitative questions were analyzed for the purpose of this dissertation (Chapter 5). Additional analysis of the remaining questions is recommended for the future (Chapter 7, Section 7.1).

3.2.1 Face and Content Validated Survey Instrument

The following sections describe the content of the face and content validated survey instrument.

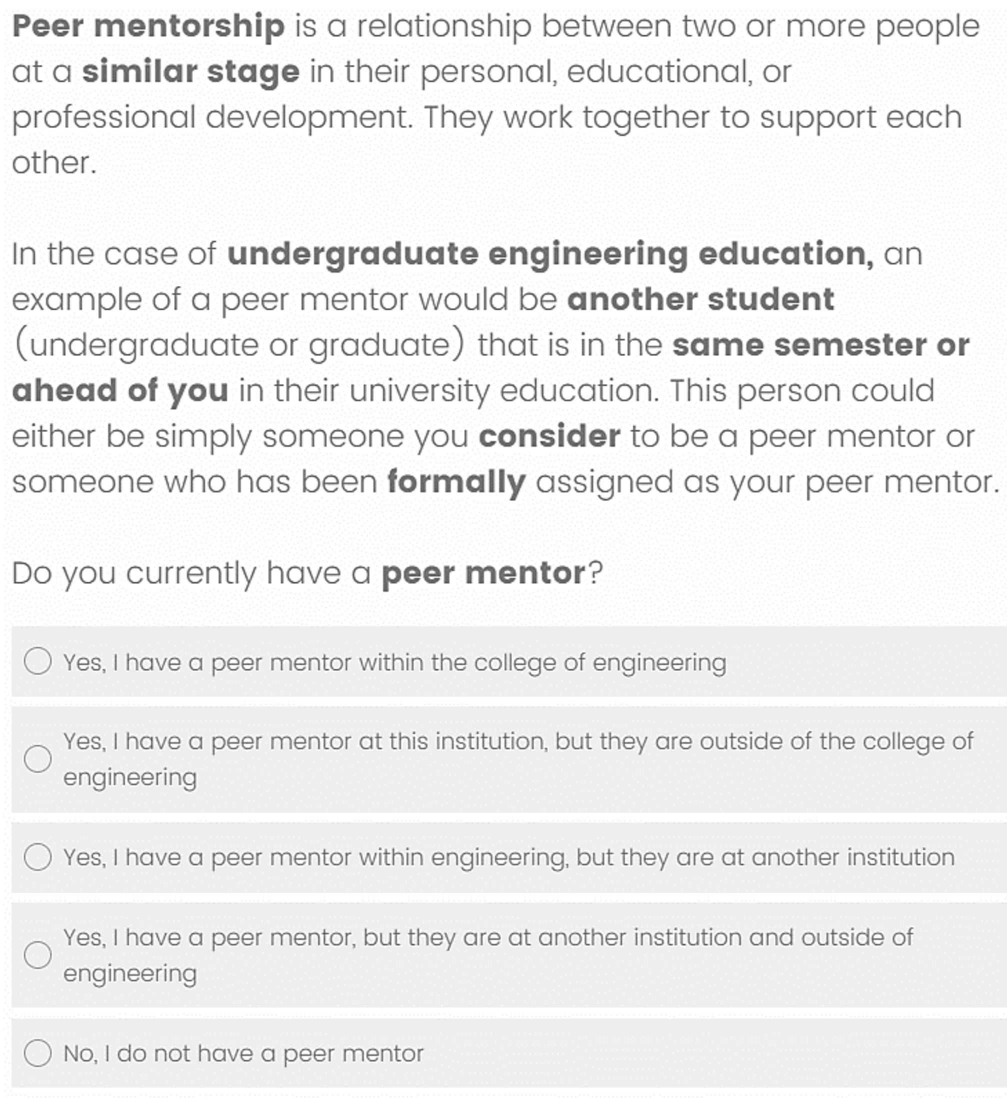
3.2.1.1 Screening Questions in Survey Instrument

The only screening question of concern in allowing participation in the mixed-methods instrument was whether the participant was 18 years of age and agreed to the informed consent (Q1, Appendix A). If the participant answered “no” to this question, the participant was sent to the end of the survey without answering any further questions. The participants also needed to be a student within the College of Engineering since the questions were aimed at determining the specific needs of undergraduate engineering students, which may differ from the needs of the general population of students. Students did indicate their major, including if it was not engineering (Q18, Appendix A), so that was considered in analysis. There were a small number of computer science students included in the survey population because they were in an engineering course.

After providing a simple definition and example of peer mentorship (Chapter 1, Section 1.7), students taking the survey were asked whether they considered themselves to currently have a peer mentor either within or outside the university, either inside or outside the College of Engineering (Figure 5; Q2, Appendix A). This question served to gauge what level of peer mentorship was occurring for students within the College of Engineering, if any, at the time of the study. Asking this simple, relatable, multiple choice question first also aimed at encouraging survey completion versus asking an open-ended question to begin with (Savitzky, n.d.). When surveys begin with a simple, multiple choice question, an 89% completion rate is averaged versus an 83% completion rate when an open-ended question is the first question in a survey (Savitzky, n.d.).

Figure 5

Question Related Peer Mentorship Experience (Q2, Appendix A)



Peer mentorship is a relationship between two or more people at a **similar stage** in their personal, educational, or professional development. They work together to support each other.

In the case of **undergraduate engineering education,** an example of a peer mentor would be **another student** (undergraduate or graduate) that is in the **same semester or ahead of you** in their university education. This person could either be simply someone you **consider** to be a peer mentor or someone who has been **formally** assigned as your peer mentor.

Do you currently have a **peer mentor**?

- Yes, I have a peer mentor within the college of engineering
- Yes, I have a peer mentor at this institution, but they are outside of the college of engineering
- Yes, I have a peer mentor within engineering, but they are at another institution
- Yes, I have a peer mentor, but they are at another institution and outside of engineering
- No, I do not have a peer mentor

After the quantitative portion of the instrument, which is discussed in the next section, students were shown a block of questions based on their experience with peer mentorship. These questions were not analyzed for this dissertation, but they will be considered in future studies. These questions aimed to allow students the opportunity to reflect on their experiences with peer mentorship, both positive, negative, and desired.

If they indicated they had no peer mentor, they were asked in a multiple-choice question whether the personal, professional, or educational support related to peer mentorship was the most essential to them. The multiple-choice options gave an opportunity for students to explain their answer if they were willing. Since the students indicated they do not have a peer mentor, they were given the definition of a need and asked if they felt they needed a peer mentor. Again, with this question, they were given an opportunity to explain their answer, if they desired.

If the students indicated they did have a peer mentor, regardless of whether that mentor was inside or outside the institution or engineering, they were given the same question about the essentiality of the personal, professional, or educational support related to peer mentorship. Next, they were guided through a series of short, open-ended questions to describe the attributes and characteristics of their peer mentor, what makes their peer mentor effective, and what additional support they wished the peer mentor could provide.

3.2.1.2 Quantitative Questions: Perceptions of Needs for Training and Matching/Initiating

This section explains the quantitative questions within the mixed-methods instrument that focused on the importance of mentor characteristics, attributes, and roles within a theoretical mentoring relationship.

3.2.1.2.1 Participant Characteristic and Attribute Matching.

While it is easy to match participants based on surface level similarities (e.g., race, ethnicity, gender, age, etc.), it may be even more important to match on deep-level similarities (e.g., attitudes, goals, priorities, interests, values, etc.; NASEM, 2019). It has been found that mentees gave the most positive perceptions of their mentoring relationship when attitudes, values, beliefs, and personality were aligned (Eby et al., 2013).

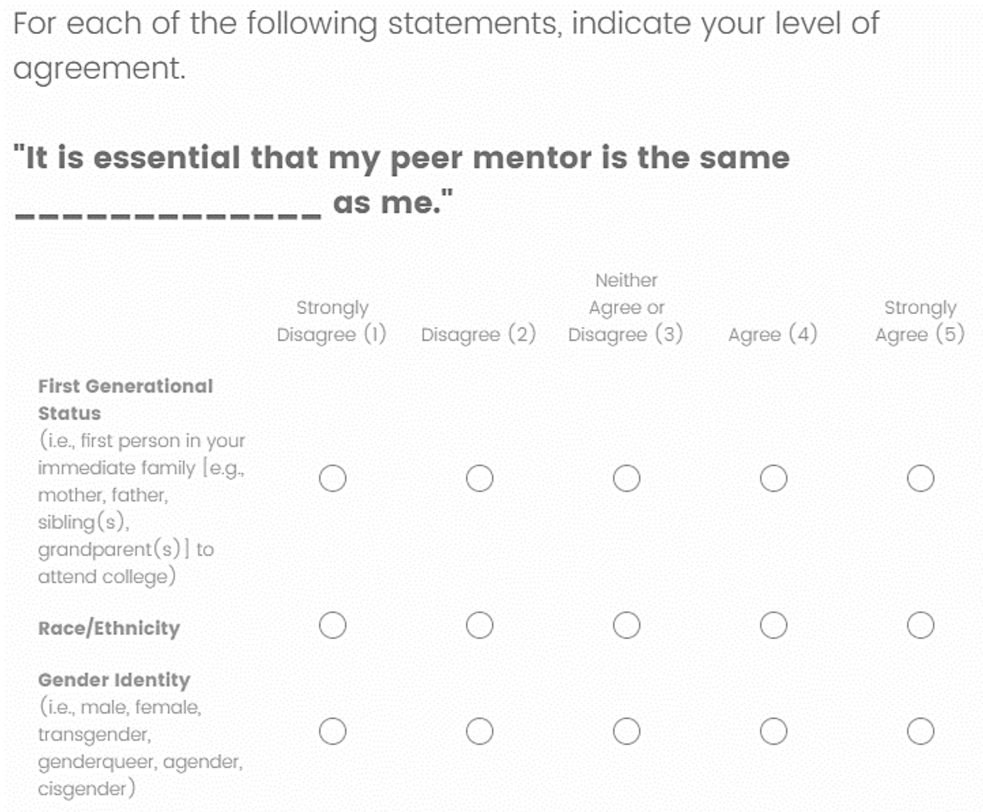
In STEM, women and students of color have expressed the importance of having a mentor that is of the same gender or race, and those students who did have a mentor of their same gender or race say they received more help (Blake-Beard et al., 2011). There is evidence that, at least in engineering, matched mentoring may be effective for long-term benefits of increased belonging, confidence, motivation, and retention of women in engineering (Dennehy & Dasgupta, 2017). It is important to note that these same trends may not hold at different time points, such as in the workplace since it has been found that mentors who are men may be equally, if not more, beneficial (Dennehy & Dasgupta, 2017). In another study, race and gender matching did not cause a difference in academic outcomes, regardless of whether the students preferred to be gender/race matched or not (Blake-Beard et al., 2011). This suggests that gender or race matching may bring a level of interpersonal comfort in the relationship but may not influence academic outcomes.

Even when there are surface or deep-level differences between mentors and mentees, if they are willing to acknowledge the difference and validate its importance, the relationship can be mutually beneficial (NASEM, 2019). When mentors as well as mentees are clear about their strengths and weaknesses, including a willingness and effort to learn how to improve upon their weaknesses, mentorship relations are more positive (Ensher et al., 2001), which can be a part of the training, matching, and initiating of a peer mentoring relationship.

Considering these findings, two sets of five-point Likert-scale items questions (Q3 & Q4, Appendix A) on the mixed-method instrument directly addressed participant matching. A five-point Likert-scale was chosen because it has been found that scales below five or above seven can produce less accurate data (Johns, 2010). The five-point scale allows for enough differentiation between points to allow participants to indicate their attitude accurately while not overwhelming them with too many options (Johns, 2010). The first question (Figure 6; Q3, Appendix A) related to having similar *attributes* between the mentor and mentee, specifically race/ethnicity, gender identity, and first-generation status. These were chosen because mentees will likely know these attributes about their mentors (Blake-Beard et al., 2011), though there may be some assumption biases since these attributes may not be clearly known. The participants ranked the essentiality that the peer mentor had the same attribute as them on a five-point Likert scale. It should be noted that in each question block, one screening question item was included to ask participants to choose a certain response to make sure they were actually reading and paying attention to their responses (Gummer et al., 2021). How this was used is further explained in the Data Cleaning section (Section 3.4).

Figure 6

Question Related to Similar Attributes Between the Mentor and Mentee (Q3, Appendix A)


For each of the following statements, indicate your level of agreement.

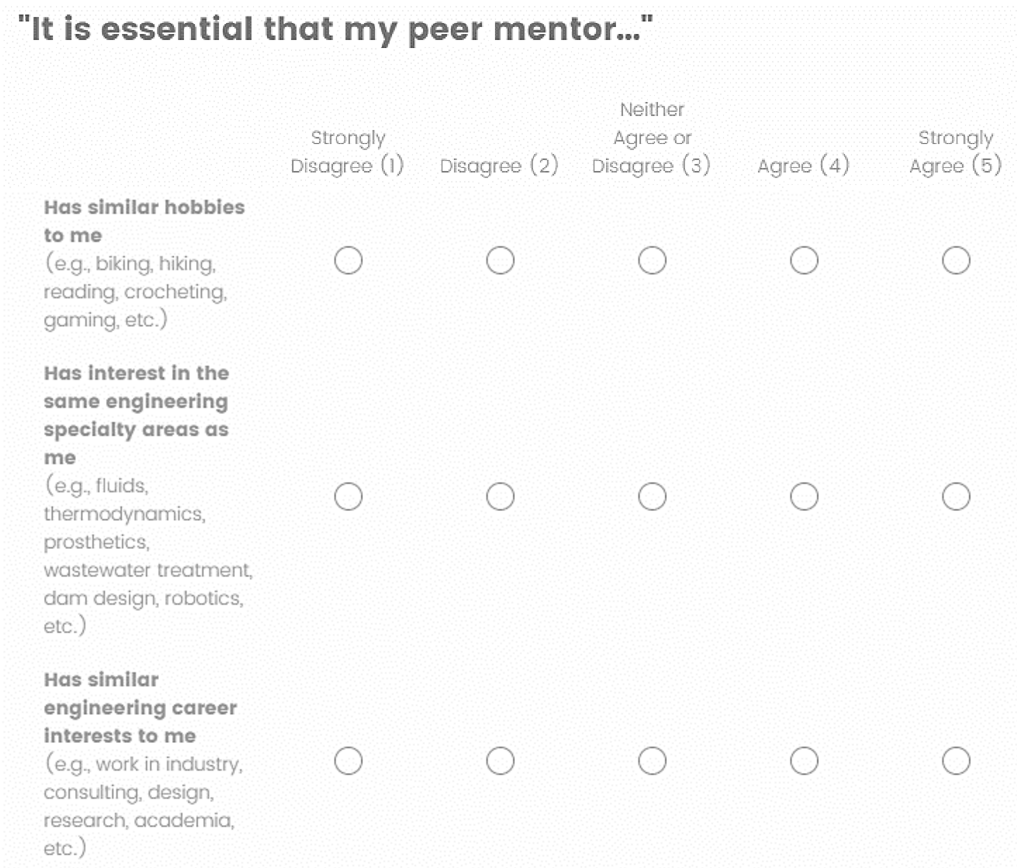
"It is essential that my peer mentor is the same ______________ as me."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
First Generational Status (i.e., first person in your immediate family [e.g., mother, father, sibling(s), grandparent(s)] to attend college)	○	○	○	○	○
Race/Ethnicity	○	○	○	○	○
Gender Identity (i.e., male, female, transgender, genderqueer, agender, cisgender)	○	○	○	○	○

The second question (Figure 7; Q4, Appendix A) related to having similar *characteristics* between mentor and mentee, such as commitment, interests (e.g., major, specialty areas, career, hobbies), and effort. The order of the attributes and characteristics were randomized within each question to remove order bias (Zong, n.d.). These attributes and characteristics were largely inspired and narrowed from the taxonomy of characteristics of student peer mentors by Terrion and Leonard (2007) as shown in Table 4 (Chapter 2, Section 2.5.1).

Figure 7

Snapshot of Question Related to Similar Characteristics Between the Mentor and Mentee (Q4, Appendix A)


"It is essential that my peer mentor..."

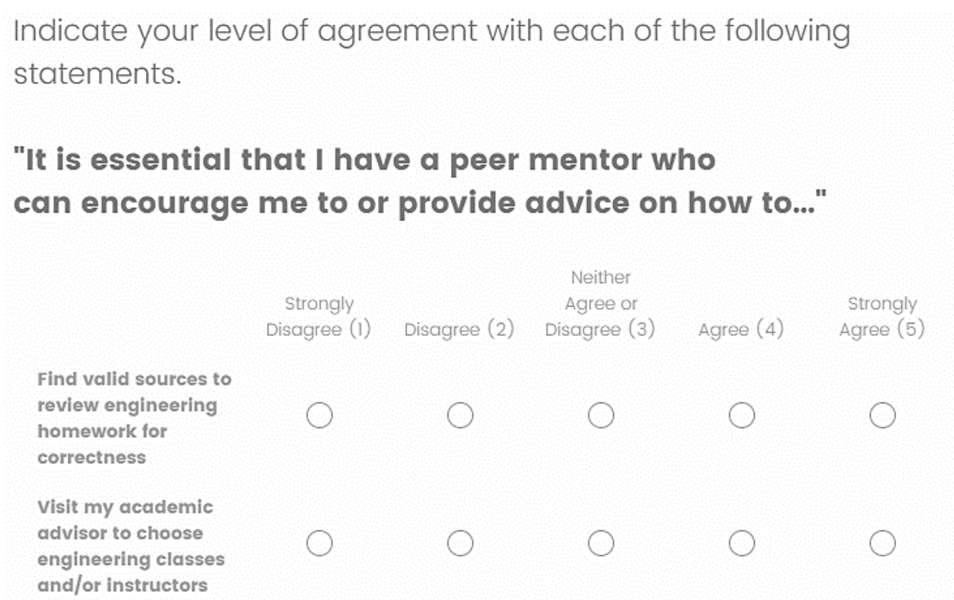
	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Has similar hobbies to me (e.g., biking, hiking, reading, crocheting, gaming, etc.)	○	○	○	○	○
Has interest in the same engineering specialty areas as me (e.g., fluids, thermodynamics, prosthetics, wastewater treatment, dam design, robotics, etc.)	○	○	○	○	○
Has similar engineering career interests to me (e.g., work in industry, consulting, design, research, academia, etc.)	○	○	○	○	○

3.2.1.2.2 Psychosocial and Academic Career Support Peer Mentoring Roles.

This section considered the possible roles within peer mentoring that were deemed very important based on the literature review (NASEM, 2019) and is where a large amount of the quantitative data for this survey came from. The questions asked about what roles and resources peer mentors needed to be knowledgeable to support their mentee. Based on the literature review, the possible needs addressed by peer mentorship fell within the two typical functions of traditional mentorship, which are psychosocial and career support (NASEM, 2019). The focus in “career support” for students is considered specifically “academic career support” for the purpose of this study. Four blocks within the survey (Q5 to Q8, Appendix A, example in Figure 8) focused on the possible psychosocial and academic career support roles within peer mentorship. The roles and applicable outcomes are shown in Table 7 and Table 8 (Chapter 2, Section 2.5.2.2), respectively. To assess these roles within the survey, students were asked to rate the importance of a peer mentor providing encouragement or advice in specific realms. All roles within these sets of questions were randomized to remove order bias (Zong, n.d.).

Figure 8

Snapshot of Question Related to Academic Career Support Roles (Q6)


Indicate your level of agreement with each of the following statements.

"It is essential that I have a peer mentor who can encourage me to or provide advice on how to..."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Find valid sources to review engineering homework for correctness	○	○	○	○	○
Visit my academic advisor to choose engineering classes and/or instructors	○	○	○	○	○

3.2.1.3 Qualitative Questions: Student Perceived Needs around Training and Matching/Initiating as a Common Essence of Experience

The overall idea for the qualitative questions employed in this survey was to identify an “authentic and comprehensive description” (Lin, 2014, p. 82) of the current experiences and needs of engineering students with regards to peer mentoring. As Jewell (2007) has stated, a phenomenological approach allows for meaningful exploration of human decisions and interactions rather than attempting to quantify the experiences. Past research on peer mentoring featuring phenomenological approaches has primarily focused on evaluating the effectiveness of previously established peer mentoring programs (Lim et al., 2017; Lin, 2014; Shotton et al., 2007) rather than attempting to establish the need for a peer mentoring program *before* its inception, as is the case with this research study.

Phenomenology is a reflective exploration of the meaning, structure, and overall essence of people’s lived experiences of, not reflections on, a given phenomenon (Adams & van Manen, 2012; R. B. Johnson & Christensen, 2017; Larsson & Holmström, 2007). Phenomenology aims to look at both the what and how of lived experiences (Neubauer et al., 2019). Phenomenology aims to determine the commonalities between all individuals of the perceived reality of lived experiences of a phenomenon, which are referred to as the essence of the phenomenon (Creswell, 2007; R. B. Johnson & Christensen, 2017; Starks & Trinidad, 2007). Phenomenology offers a way that researchers can learn from others’ experiences (Neubauer et al., 2019). In this study, the researcher posits that perceived needs for peer mentorship are a common lived reality of undergraduate students, specifically in engineering (Budny et al., 2010; Gattis et al., 2007; Holland et al., 2012; NASEM, 2019). As such, an in-depth exploration of peer mentorship was a merited consideration for analysis and design of the qualitative questions of the survey instrument.

3.2.1.3.1 Barriers to Peer Mentorship.

The first of two qualitative questions on the survey that were analyzed for this dissertation dealt with determining the barriers that currently exist for these students in establishing peer mentoring relationships. This question is a qualitative tie to the first research question, which was quantitatively focused on determining relationships that exist in mentor/mentee alignment and perceived needs. The wording of this question was informed by literature on the common barriers that were found in other studies (Table 1, Chapter 2, Section 2.1.2). The barriers and challenges identified may support the relationships found among demographics and attributes, characteristics, or roles found from statistical analysis of the quantitative portions of the study. While asking a phenomenological question within an instrument is limited in the sense that the researcher cannot probe a participant for more details about the event, asking a question specifically about experiences gives a better idea of the experiences and perspectives have around peer mentoring that cannot be found from quantitative data.

3.2.1.3.2 College of Engineering Support.

To fully understand the gap that peer mentoring can fill, it was deemed important to determine the ways students perceived that their College of Engineering could support them in establishing peer mentoring relationships (Q10, Appendix A). This open-ended question helped identify contextual information on the primary areas where students seek formalized peer mentoring support. This qualitative question was targeted to attend to the second research question, which aimed to explore the common experiences and needs with regards to having a peer mentor. This question also had a phenomenological wording to allow for an introspection from participant on their overall perceived needs for peer mentoring, as communicated by their written experience and desires.

3.2.1.4 Participant Identifier Questions

The last section of survey questions was the participant identifier question section. These were placed at the end of the survey to lessen the risk of stereotype threat among participants (Fernandez et al., 2016). These questions were chosen and worded according to standards established in literature for surveys (Hughes et al., 2016) in order to determine correlations or interactions of the participant identifiers with other quantitative findings throughout the survey (Fernandez et al., 2016). This information can also help in exploring the diversity and lack thereof of the sample set (Pawley, 2017) and possible influences or intersections those identities have on student experiences and perceptions (Fernandez et al., 2016). The participant identifying questions were worded in such a way as to let participants express their complex identities within the survey (Fernandez et al., 2016; Hughes et al., 2016). It has also been found that mentoring may have different effects on moderating variables (e.g., gender, underrepresented populations, etc.; Blake-Beard et al., 2011; Dennehy &

Dasgupta, 2017; Eby et al., 2013; NASEM, 2019), so it was deemed important to obtain such participant identifiers. This section included questions on the following:

- Approximate year in undergraduate engineering education
- Declared major
- Estimated college GPA
- First-generation student status [i.e., first person in their immediate family (e.g., mother, father, sibling[s], grandparent[s]) to attend college]
- Race/Ethnicity
- Gender identity

3.3 Recruitment Procedures

All recruitment procedures for the study were approved through the Utah State University Institutional Review Board (IRB) office. Based on circumstances within the College of Engineering of interest during the current COVID-19 pandemic, all recruitment and administration for surveys occurred virtually. Following the face and content validation of the mixed-methods survey instrument, recruitment was accomplished through the following methods:

1. College-wide emails and learning management system (LMS) announcements distributed from the advising office

2. Online LMS announcements with a flyer, written communication, and video introduction within courses and major-specific pages (11 faculty – all courses and sections)

3. Live recruitment on Zoom at the beginning of class, followed by an LMS announcement by the professor with flyer, written communication, and video reminder (5 faculty – all courses and sections)

4. Communication to club representatives or leadership to distribute the flyer, written communication, and video introduction (5 different engineering student organizations)

The survey was created to be mobile friendly, so the flyer included a Quick Response (QR) code for easy access. The survey was also directly linked on each form of communication. The first page of the survey included all pertinent IRB information, and the first question required the participant to agree to the consent. Upon initial recruitment, key large classes in engineering for each age and major of students were targeted, such as Statics, Thermodynamics, Strength of Materials, and Senior Design. Since recruitment in these courses did not return sufficient numbers and not all faculty responded to my request for recruitment, more classes were invited. Club representatives and leadership were also contacted to recruit participants. Faculty had the choice whether they would prefer live recruitment on Zoom if they were teaching class live or agreed to post the announcement, flyer, and video communication in their course learning management system.

The survey instrument itself was completely anonymous, but the participants could choose to fill out a separate form to enter a randomized drawing for thirty, $10 gift cards. These gift cards were disseminated, and all participant identifiers were destroyed. It was also up to the discretion of an instructor to provide participation points for completing the survey. Any points given for participation were completely handled by the instructor because the survey was anonymous. In communication with the instructors, they were informed that if they decided to provide any participations points, they should provide an equivalent means of participation for those that chose not to complete the survey per IRB guidelines.

3.3.1 Recruited Participants

The respondents to this mixed-methods instrument were current undergraduate engineering students within the College of Engineering for the study. Undergraduate engineering students were recruited to show potential similarities between the priorities in peer mentoring relationships dependent upon various participant identifiers. For the Fall 2020 academic semester, there were 2,132 students enrolled in the College of Engineering, and this included graduate students (Office of Analysis Assessment and Accreditation, 2020a). In Fall 2020, there were 246 graduate students (M. Snow, personal communication, September 25, 2020). This provided a total of 1,886 undergraduate students enrolled within the College of Engineering.

For validation and reliability purposes, eigenvalues (from Exploratory Factor Analysis [EFA]) were used, thus it was desired to have between five and ten participants per quantitative item (Gorusch, 1983; Nunnally, 1978). The original research survey instrument contained 33 quantitative items. This put the desired minimum number of participants between 165 and 330 based on recommendations for

EFA. Ultimately, 320 responses were obtained, but after cleaning the data, which will be further explained later in this chapter, 223 complete responses were kept.

According to typical survey response rates, emailed and web-based surveys receive between 25% to 30% response rates (Lindemann, 2019; People Pulse, 2018). These response rates would give a margin of error below 5% based on Equation 1, which is the equation for minimum sample size (Qualtrics, 2019).

$$SS = \frac{z^2 \times \sigma(1-\sigma)}{E^2} \tag{1}$$

Where SS is the sample size, z is the z-score based on confidence level, σ is the standard deviation, and E is the margin of error (Qualtrics, 2019). The margin of error below 5% is assuming a z-score of 1.96 (95% confidence) and standard deviation of 0.5. While this would have been ideal, the number of participants was limited due to the lack of access to students because of the current COVID-19 pandemic. While it was attempted to reach every student in the College of Engineering, because of the lack of in-person or live classes as well as the number of students physically on campus, it was unknown what percentage of the total enrollment were invited to participate. This was also limited by the number of professors willing to allow recruitment in their courses. Thus, 223 complete responses to the survey were considered adequate for this study since this gave an approximately 6% margin of error according to Equation 1 assuming 95% confidence. Social science margin of errors typically range from 3 to 7% (National Institutes of Health, n.d.).

3.4 Data Cleaning

After obtaining the validation data and the survey responses were collected, the data were cleaned. All responses that were primarily blank as well as those that were missing participant identifier question responses were removed. The responses were then screened to make sure participants were engineering or computer science majors and were undergraduates. The next cleaning step was to make sure that participants were actually reading and paying attention to their responses rather than randomly choosing responses. This was done by including screening questions in each of the aforementioned blocks of Likert-scale questions that asked the participant to choose a certain response (Gummer et al., 2021).

By this step, 241 responses were left that provided complete responses to all Likert-scale item. Descriptive statistics were then performed on the Likert scale items for measures of central tendency, kurtosis, skewness, and frequencies (R. B. Johnson & Christensen, 2017). Questions with large skewness and kurtosis levels (i.e., ±2; Kim, 2013) were flagged as outliers because these values can affect normality of the data. Skewness and kurtosis z-scores were then used on these questions to flag which participants should be removed (i.e., ±3.29; Kim, 2013). This flagged 18 participants, which were then removed. As a result, 223 total participant responses for the study remained. The descriptive statistics were then calculated again, and the skewness and kurtosis levels were all within acceptable levels (i.e., ±2; Kim, 2013).

Multicollinearity and singularity were both examined by looking at the Pearson correlation coefficients for independent variable correlations and did not return any concerns ($r < .90$), which was especially important for linear regression and EFA (Abrams, 2007). Correlations between the Likert-scale survey instrument items were not higher than .80, meaning there were not very strong correlations. For those values between .50 and .80, the content of the two questions were revisited by the researcher and compared to the constructs from instrument design (Figure 4 and Table 10, Chapter 3,) to determine if the questions appropriately fell under a similar construct. All the higher correlations ($.50 < r < .80$) were between items under the same constructs, so no concerns arose from this analysis.

3.4.1 Participant Identifiers

After data cleaning, there were 223 participant responses that were included in the EFA, CFA, and quantitative and qualitative data analysis for this dissertation (Chapters 4 to 6). No Likert scale questions were blank, and a minimal number of qualitative questions were left blank (4% on Q9, 4.3% on Q10). Demographic questions were also answered fully by participants, though some opted to "prefer not to answer". The breakdown of major, year in undergraduate engineering education, gender, and first-generation status of the participants is shown graphically in Figure 9.

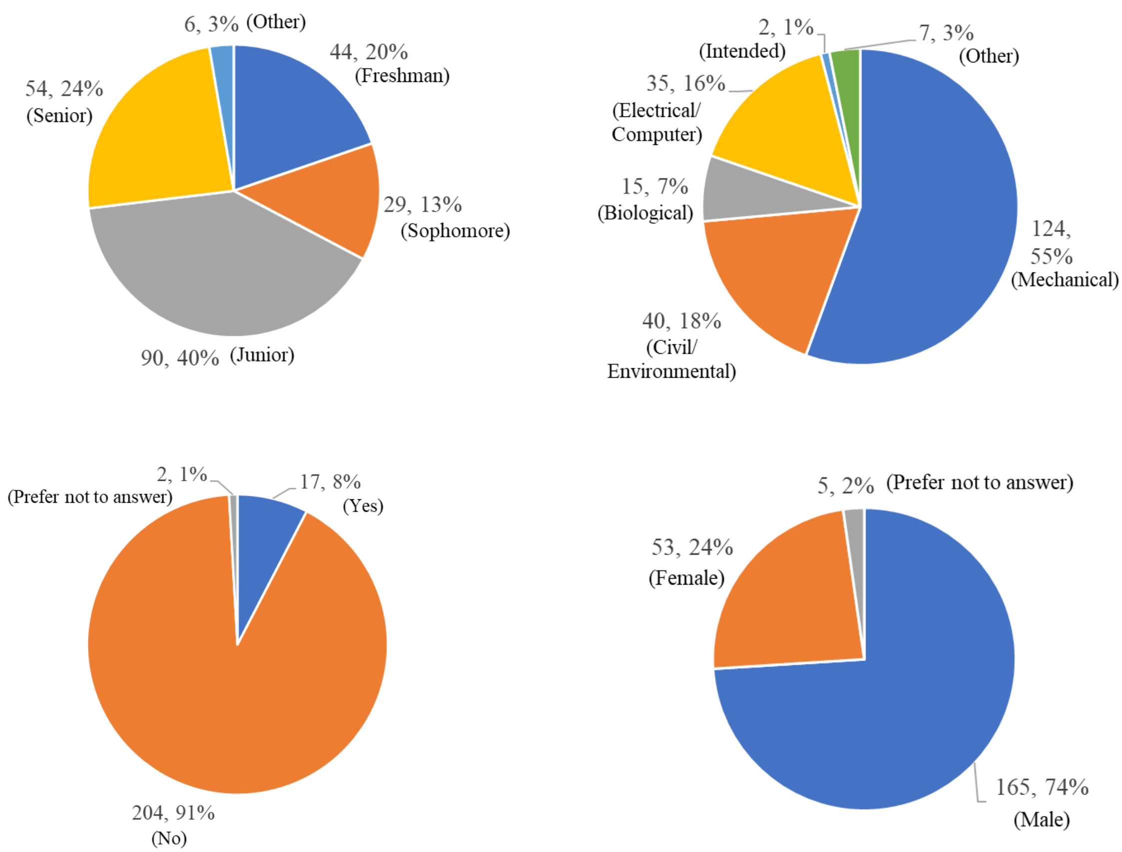
Of the 223 participants, 55.6% were Mechanical Engineering majors, 17.9% were Civil or Environmental Engineering, 6.7% were Biological Engineering, and 15.7% were Electrical or Computer Engineering. All others had either not declared their major in engineering, but they intended on declaring engineering as their major and were currently in an engineering course, or had an "other" major, such as computer science, but were enrolled in an engineering course. The sample obtained is considered representative of the College of Engineering major breakdown since at the institution (Fall 2020), about 40% of engineering students were in Mechanical Engineering, 18.5% were Civil or Environmental Engineering, 9.6% were Biological Engineering, and 17.3% were Electrical or Computer Engineering (Office of Analysis Assessment and Accreditation, 2020a).

When it came to the approximate year of participants in undergraduate engineering education, 19.7% were freshman (i.e., first year), 13% were sophomores (i.e., second year), 40.4% were juniors (i.e., third year), and 24.2% were seniors (i.e., fourth year). All other respondents answered “other” and clarified what year they were, usually just indicating what year they were in engineering versus college overall. Only 7.6% of participants were first-generation students (e.g., mother, father, sibling(s), grandparent(s) did not attend college) whereas 91.5% of students were not first-generation students and the rest of the participants preferred not to answer. Institutional data on these factors were not available, but they are assumed to be adequately representative of the College of Engineering during the year this dissertation took place.

Of the participants, 23.8% identified as women and 74% identified as men, with the rest preferring to not answer. While the sample obtained had a slightly higher representation of women than are enrolled in the College of Engineering (15% women; Office of Analysis Assessment and Accreditation, 2020a), it was assumed to be representative. This was also in line with numbers in North America where in 2019, 23.9% of undergraduates in engineering were women (American Society for Engineering Education, 2020).

Figure 9

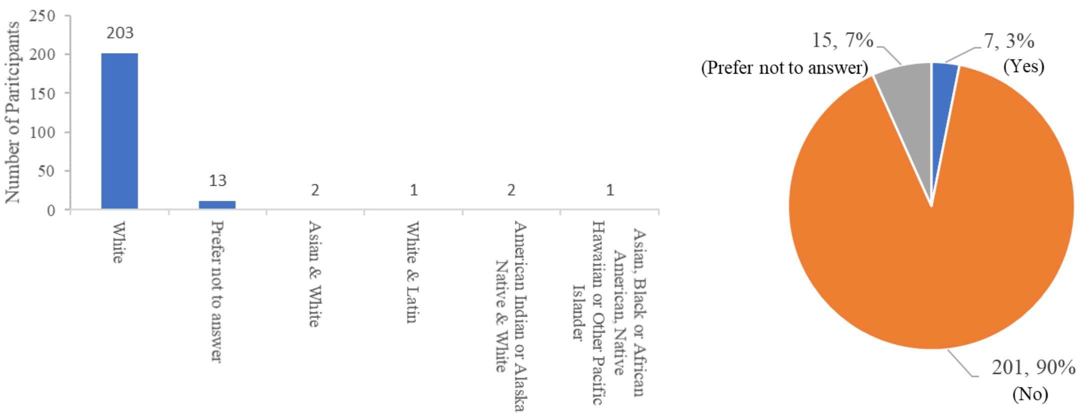
Year in Undergraduate Engineering Education (top left), Major (top right), First-generation Status (bottom left), and Gender of Participants (bottom right)



Demographic information pertaining to race and ethnicity of participants is shown in Figure 10. For race, 91% of participants identified as solely White while all others identified with multiple races or preferred not to identify. Compared to institutional data (83% White; Office of Analysis Assessment and Accreditation, 2020b), this was considered a representative sample. Of the survey participants, 3% of the participants were of Hispanic, Latinx, or Spanish Origin and the rest were either not of Hispanic, Latinx, or Spanish Origin or preferred not to answer. This was also representative of the institution (5.5% of students Hispanics of any race; Office of Analysis Assessment and Accreditation, 2020a, p. 1) at the time of this dissertation study.

Figure 10

Race (left) and Ethnicity (of Hispanic, Latinx, or Spanish Origin - right) Demographic Information of Participants



One question that was considered a demographic question for this study was whether the participant identified that they currently had a peer mentor or not. The original question (Q2, Appendix A) had the participant identify whether their peer mentor was in engineering or not, if they were at the same institution or not, or if they did not have a peer mentor (Figure 11). Because some of the “yes” categories had so few participants, all of them were grouped together for analysis (Figure 12).

Figure 11

Proportion of Participants with a Current Peer Mentor

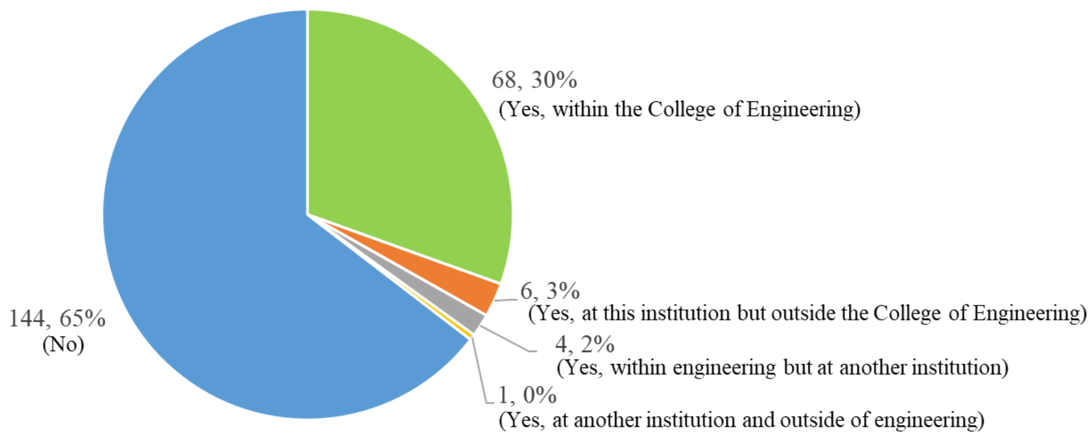
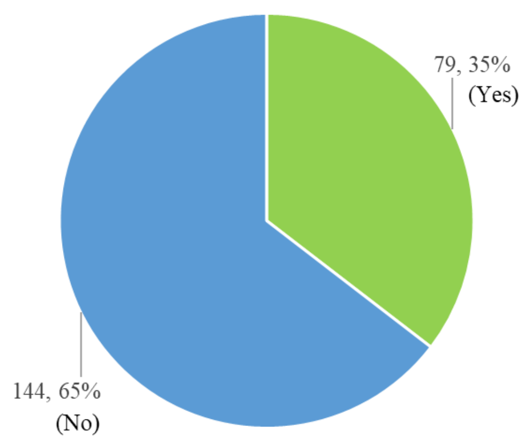


Figure 12

Proportion of Participants with a Current Peer Mentor



3.5 Exploratory Factor Analysis (EFA)

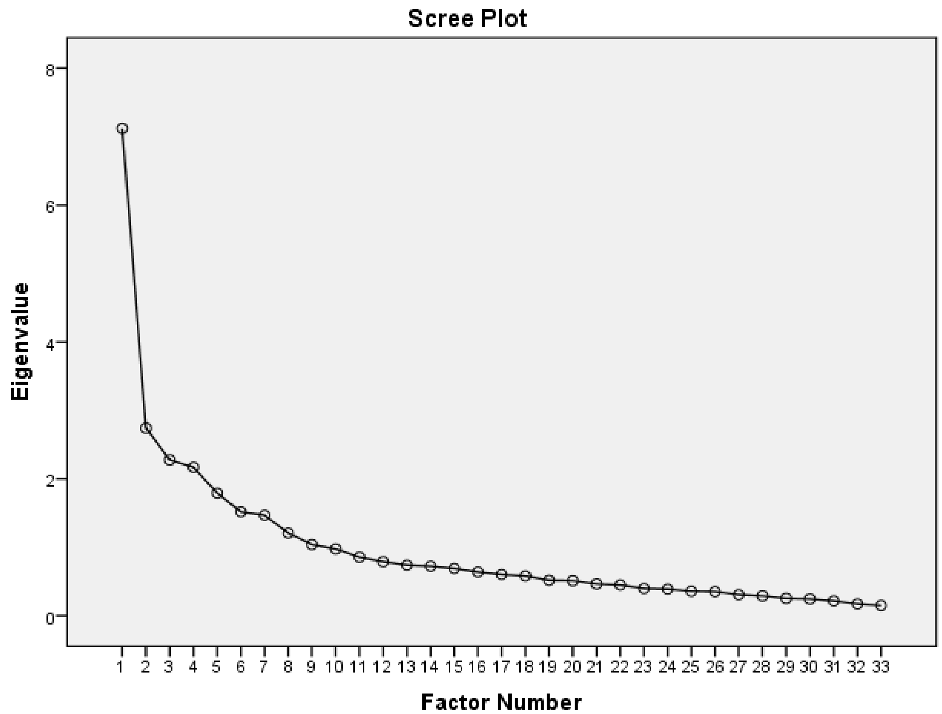
After data cleaning, EFA was employed to analyze the potential relationships between the variables and constructs to assist in mapping and interpreting the categories the variables fit into (Yong & Pearce, 2013). The goal of EFA was to find out how many factors existed between the items and which items fit under each factor (Orcan, 2018). EFA was run using Principal Axis Factoring (PAF) with Direct Oblimin rotation using SPSS (IBM, 2021). PAF was chosen since it is a conceptual approach aimed at trying to understand shared variance based on communality (Warner, 2012). The solution was also rotated in order to attempt making the factor loadings clear since this was a pilot, exploratory study (J. D. Brown, 2009). Direct Oblimin rotation, which is an oblique rotation method, assumes that the factors are correlated (J. D. Brown, 2009). When a factor correlation matrix was obtained from the EFA, there were correlation values greater than .32, which indicates it is a good idea to perform an oblique rotation to give a simpler structure (J. D. Brown, 2009; Tabachnick & Fidell, 2007).

The first two statistics checked within EFA were the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, which showed the proportion of variance that could be accounted for in underlying constructs, and Bartlett's test of sphericity, which tests whether the correlation matrix is an identity matrix since in order to detect structure, the variables needed to be related (IBM, n.d.-c). Values closer to one for KMO indicated that the factor analysis may be useful and values less than .500 are not likely to return good results (IBM, n.d.-c), so the result of .793 is considered meritorious. The anti-image correlation matrix also returned values greater than .500 for the KMO measure between each of the variables on the diagonal, thus indicating factor analysis may be useful (IBM, n.d.-c). The off-diagonal elements were also very small, which may indicate a good factor model (IBM, n.d.-b). Bartlett's test of sphericity returned a value of $p < .001$, indicating that overall analysis may be useful since the null hypothesis of the correlation matrix being an identity matrix was rejected.

Since this was a pilot study, factors with an eigenvalue larger than 1 were retained since they are considered very strong (Yong & Pearce, 2013). The overall visualization of the eigenvalues for the factors are shown in Figure 13. As seen in the figure, around Factor 9, the slope of the line begins to level off. This indicates that the factors after Factor 9 are accounting for much less of the variance, evidenced by the eigenvalue being less than 1. Under this standard, the 9 factors with an eigenvalue larger than 1 were extracted from the 33 instrument items. These 9 factors explained 64.6% of the variance. Each factor was then examined item by item to determine which items should be retained for each factor. For a parsimonious model, the rule of at least three items was used (MacCallum et al., 1999; O'Rourke & Hatcher, 2013) for each factor to be retained. On an item-by-item basis, two parameters for making decisions about the retention of each items were focused on: communalities and factor loadings from the pattern matrix. Initial communalities were used, which was considered the proportion of variance for each item that is accounted for by the remaining items (IBM, n.d.-a).

Figure 13

Scree Plot Showing Eigenvalues for Factor Extraction



All communalities for items retained were above .300, which may be considered low or poor on many scales (Comrey & Lee, 1992; MacCallum et al., 1999), but is accepted with minimal significance in this pilot validation process since the participant numbers were greater than 150 and at least three items were retained per factor (Habing, 2003; MacCallum et al., 1999; O'Rourke & Hatcher, 2013). For factor loadings, it was desired that the item only loaded on one factor at a loading of at least .300. If the item did load on more than one factor, it needed to have at least one more strongly loaded factor (i.e., factor loading greater than .300) and the other was weakly loaded (i.e., factor loading less than .300) on a factor that was not retained. This analysis resulted in six retained factors (i.e., factors 1 to 4 and 8 to 9 from original factor extraction) containing a total of 21 items, accounting for around 50% of the variance. These factors were named based on the original constructs and categories of questions (O'Rourke & Hatcher, 2013) organized for the instrument development (Figure 4, Chapter 3, Section 3.1.3.1) and are shown in Table 12 with the communality and factor loading listed for each item from most strong factor loading to least strong factor loading. The CFA labeling was also included with each question in addition to the instrument numbering (Appendix A), which were labeled in ascending question number order.

Table 12

Retained Named Factors with Items

Factor Number	Factor Name	Questions Included with CFA Labeling (communality, factor loading)	Question Summary (see Appendix A for full context and wording of the question)
1	Psychosocial Support Roles (PSR)	• Q6_2, PSR4 (.432, .613) • Q5_3, PSR1 (.477, .501) • Q5_4, PSR2 (.490, .452) • Q6_1, PSR3 (.395, .414)	• Feel sure of major choice • Set goals for future • Persistence despite failure • Time management
2	Mentor/Mentee Characteristic Similarities (CS)	• Q4_5, CS3 (.583, .855) • Q4_4, CS2 (.560, .748) • Q4_6, CS4 (.443, .583) • Q4_3, CS1 (.439, .577)	• Similar career interests outside of engineering • Similar engineering career interests • Similar hobbies • Same engineering specialty
3	Mentor/Mentee Attribute Similarities (MA)	• Q3_1, MA1 (.621, .910) • Q3_3, MA3 (.527, .734) • Q3_2, MA2 (.422, .627)	• Mentor race/ethnicity • Mentor first-generation status • Mentor gender identity
4	Engineering Involvement (EI)	• Q6_3, EI1 (.592, .834) • Q6_4, EI2 (.603, .828) • Q6_5, EI3 (.476, .431) • Q7_5, EI4 (.461, .326)	• Involved in clubs & organizations • Informed & involved in events and socials • Involved in research opportunities • Build an engineering network

Factor Number	Factor Name	Questions Included with CFA Labeling (communality, factor loading)	Question Summary (see Appendix A for full context and wording of the question)
5	Skill Development (SD)	• Q7_3, SD2 (.518, .765) • Q7_4, SD3 (.531, .544) • Q7_2, SD1 (.468, .401)	• Group project skills • Communication skills • Take appropriate notes
6	Formal Support Opportunities (FS)	• Q8_3, FS3 (.454, .768) • Q8_2, FS2 (.481, .422) • Q8_1, FS1 (.309, .350)	• Campus resources • Tutoring services • Valid sources to review homework

Note. Factor loadings and communalities for the retained items were greater than .300 and each item could only load strongly on one factor (Comrey & Lee, 1992; MacCallum et al., 1999; O'Rourke & Hatcher, 2013)

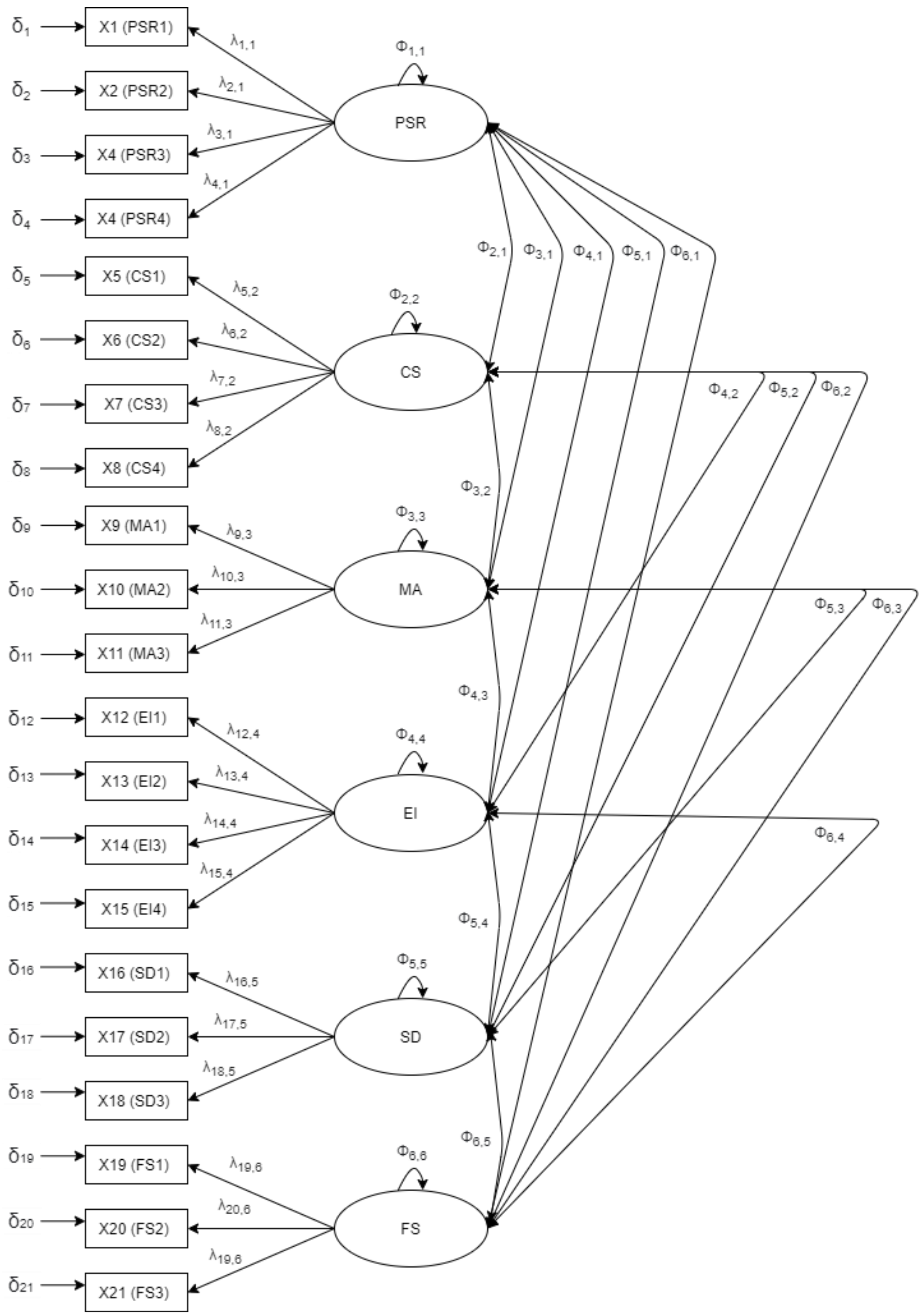
3.6 Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was then used to validate the findings from the EFA since the model generated from EFA was promising (Orcan, 2018). While it is disputed whether EFA and CFA should be performed successively, with an exploratory study where a new scale is being developed, this is considered acceptable (Orcan, 2018). CFA is based upon theory, so the relationships between the variables were pre-planned from EFA and tested to create a hypothetical model (Orcan, 2018; Schreiber et al., 2006). For this dissertation, the same data were used from the EFA for CFA due to data collection procedures during the COVID-19 pandemic and the scope of this dissertation, though it is recognized that an additional set of data in the future would further validate the instrument and confirm the actual factor structure (Orcan, 2018). The CFA was performed using LISREL (Scientific Software International, 2021) and multiple goodness-of-fit indices were considered.

The first step for running CFA was to develop the diagram of the relationship between all factors and items, shown in Figure 14. Within the diagram, λ (Lambda) indicates the factor loading matrix on latent variables (i.e., constructs or factors), δ (Theta-delta) is an error variance matrix indicating the measurement residual variances of items, and ϕ (Phi) is the covariance of latent variables. All 21 items were considered in one group, six factors, and 223 cleaned participant responses were included. A correlational matrix between the items served as the data input for the CFA. For adequate measurement, the first factor loading of each factor was fixed to a value of 1. For the output and modification, the solution path diagram (PD) and the output were observed using options of suppressing the computation of internal starting values (NS), completely standardized solution (SC), and model modification indices (MI).

Figure 14

Confirmatory Factor Analysis (CFA) Diagram



Note. λ is the factor loading, δ is an error variance matrix, and ϕ is variance and covariance of latent variables.

The first round of CFA was run, and all factor loadings were significant while part of the error variances and covariances were not. All items were loading on only one factor and while some items had communalities below .300, overall, the items loaded well on factors, so all items were retained (Table 13). The items that had communalities below .300 (CS4, EI1, EI2, EI4, and FS1) were flagged to be explored further and possibly revised in future iterations of the survey, if desired.

Table 13

Communality Values for all Items in the CFA Analysis

Item	Communality	Item	Communality
PSR1	.501	EI1	.293
PSR2	.495	EI2	.254
PSR3	.416	EI3	.624
PSR4	.300	EI4	.280
CS1	.388	SD1	.451
CS2	.696	SD2	.450
CS3	.555	SD3	.381
CS4	.185	FS1	.174
MA1	.973	FS2	.392
MA2	.344	FS3	.442
MA3	.474		

Note. Communalities for items are acceptable when they are above .300 (Comrey & Lee, 1992; MacCallum et al., 1999; O'Rourke & Hatcher, 2013)

The goodness of fit parameters of interest were Chi-Square, Comparative Fit Index (CFI), Incremental Fit Index (IFI), Non-Normed Fit Index (NNFI), Goodness of Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). The Chi-Square ratio measures the significance of the difference between the proposed model and the given data using maximum likelihood method, giving an overall view of the goodness of fit (Alavi et al., 2020; Hu & Bentler, 1999). There are significant limitations with the Chi-Square model dealing with sample size, distribution, and complexity of the data (Alavi et al., 2020). Because of these limitations, other fit indices were considered and relied upon for goodness of fit considerations.

Alongside Chi-Square, GFI, RMSEA, and SRMR are all absolute fit indices to determine how well a theoretical model can reproduce observed sample data (Alavi et al., 2020; Hu & Bentler, 1999). IFI and NNFI are incremental fit indices, which compared the designed theoretical model with a base-line model that contains no relationships between variables (Alavi et al., 2020; Hu & Bentler, 1999). These absolute and incremental fit indices are designed in order to help with problems originating from sample size and distributional complications with the Chi-Square statistic (Hu & Bentler, 1999). The ideal cutoff values to reduce error rates for these indices are shown in Table 14 along with the goodness of fit parameter results from CFA. While some of the values obtained will only be close to the cutoff value, the combination of the fit indices employed led to a more robust and thorough conclusion, allowing for confidence in the fit of the model (Hu & Bentler, 1999).

Looking at the goodness of fit parameters in Table 14 with relation to the first round of CFA, the CFI, IFI, NNFI, and GFI parameters were below the desired value of at least .90, so suggested modifications were justified for an additional round of CFA analysis to improve the goodness of fit parameters by estimating additional error variances. The model was revised by estimating three error variances. Modifications were done on the error variance matrix (Theta-delta) since those are least likely to cause cross loading on factors. This was done by finding the maximum modification index, which in this case, was the most impactful change by estimating the error variance between items EI1 and EI2, which were both within the same factor. After this estimation was included in the CFA, all factor loadings were again significant and only loading on one factor. The CFI, NNFI, and IFI were all now above .90, which was an improvement, but there was still room for improvement on both these and the RMSEA and SRMR, so additional modifications were explored in the modification indices under δ.

This additional modification resulted in an estimation of Theta-delta (δ) being included between CS3 and CS4, again, both under the same factor. In this case, CFI, IFI, NNFI, and GFI were all above the threshold of .90, which was good, but one more modification was performed to attempt to get RMSEA and SRMR as close to .05 as possible. The final modification chosen was to estimate δ between SD3 and EI4, this time from different factors. The goodness of fit parameters for this final solution are also shown in Table 14. The CFI, IFI, NNFI, and GFI parameters were all above the threshold of .90 though still below the excellent standard of .95. RMSEA was below

.05, which is considered excellent. SRMR was below .08, which is also considered excellent. Overall, this was considered a sufficient and acceptable solution of fit indices for this pilot, exploratory survey.

Table 14

Goodness of Fit Parameter Results for CFA

	Initial Solution	δ (EI1, EI2)	δ (CS3, CS4)	δ (SD3, EI4)	Ideal Cutoff Values[a]
Degrees of Freedom	174	173	172	171	-----
Maximum Likelihood Ratio Chi-Square	325.772 (p < .0001)	284.981 (p < .0001)	268.72 (p < .0001)	247.034 (p = .0001)	-----
Comparative Fit Index (CFI)	.890	.919	.930	.945	Ideally greater than .95, but no less than .90
Incremental Fit Index (IFI)	.893	.921	.932	.946	Ideally greater than .95, but no less than .90
Non-Normed Fit Index (NNFI)	.867	.901	.914	.932	Ideally greater than .95, but no less than .90
Goodness of Fit Index (GFI)	.880	.895	.901	.909	Ideally greater than .95, but no less than .90
Root Mean Square Error of Approximation (RMSEA)	.0625	.0539	.0502	.0447	Less than .06
Standardized Root Mean Square Residual (SRMR)	.0769	.0675	.0665	.0638	Less than .08

[a] Browne & Cudeck, 1992; Hu & Bentler, 1999; Schreiber et al., 2006

The completely standardized final solution is shown as a path diagram in Figure 15. As was mentioned previously, the factor loadings given by the Lambda matrix were all above .300 and only loaded on one factor (O'Rourke & Hatcher, 2013). These factor loadings (λ) along with all covariances (ϕ) and error variance (δ) values are shown in Figure 15. Labeling for these values are all available in Figure 14. The factor loadings (λ) and covariances (ϕ) are also summarized for ease of reference in Table 15 and Table 16, respectively. As a reminder, all factor loadings (Table 15) should be greater than .300 and each item should only load on one factor (Comrey & Lee, 1992; MacCallum et al., 1999; O'Rourke & Hatcher, 2013). Covariances described the magnitude and direction of how the two constructs vary together (Table 16).

Figure 15

CFA Final Solution (Standardized Solution Path Diagram)

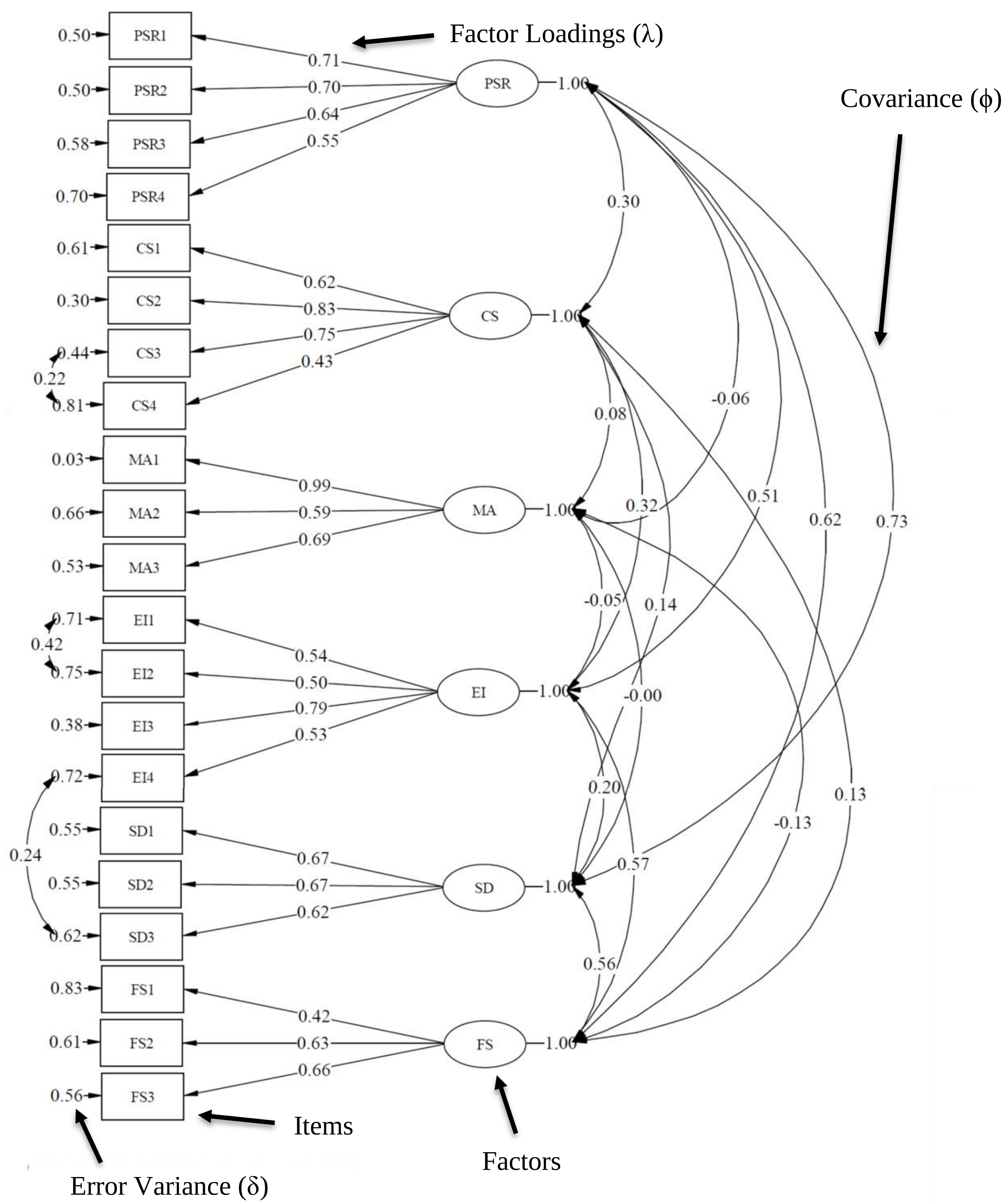


Table 15

Factor Loadings (λ) of CFA Completely Standardized Final Solution

Item Abbreviation	Question Summary (see Appendix A for full text)	Psychosocial Support Roles (PSR)	Characteristic Similarities (CS)	Attribute Similarities (MA)	Engineering Involvement (EI)	Skill Development (SD)	Formal Support Opportunities (FS)
PSR1	Feel sure of major choice	.707	----	----	----	----	----
PSR2	Set goals for future	.704	----	----	----	----	----
PSR3	Persistence despite failure	.645	----	----	----	----	----
PSR4	Time management	.547	----	----	----	----	----
CS1	Similar career interests outside of engineering	----	.623	----	----	----	----
CS2	Similar engineering career interests	----	.834	----	----	----	----
CS3	Similar hobbies	----	.745	----	----	----	----

Item Abbreviation	Question Summary (see Appendix A for full text)	Psychosocial Support Roles (PSR)	Characteristic Similarities (CS)	Attribute Similarities (MA)	Engineering Involvement (EI)	Skill Development (SD)	Formal Support Opportunities (FS)
CS4	Same engineering specialty	----	.430	----	----	----	----
MA1	Mentor race/ ethnicity	----	----	.987	----	----	----
MA2	Mentor first-generation status	----	----	.586	----	----	----
MA3	Mentor gender identity	----	----	.688	----	----	----
EI1	Involved in clubs & organizations	----	----	----	.541	----	----
EI2	Informed & involved in events and socials	----	----	----	.504	----	----
EI3	Involved in research opportunities	----	----	----	.790	----	----

Item Abbreviation	Question Summary (see Appendix A for full text)	Psychosocial Support Roles (PSR)	Characteristic Similarities (CS)	Attribute Similarities (MA)	Engineering Involvement (EI)	Skill Development (SD)	Formal Support Opportunities (FS)
EI4	Build an engineering network	----	----	----	.529	----	----
SD1	Group project skills	----	----	----	----	.672	----
SD2	Communication skills	----	----	----	----	.670	----
SD3	Take appropriate notes	----	----	----	----	.618	----
FS1	Campus resources	----	----	----	----	----	.417
FS2	Tutoring services	----	----	----	----	----	.626
FS3	Valid sources to review homework	----	----	----	----	----	.665

Note. All items only loaded on one factor and all loadings were greater than .300, which is acceptable (Comrey & Lee, 1992; MacCallum et al., 1999; O'Rourke & Hatcher, 2013).

Table 16

Construct Covariances (ϕ) of CFA Completely Standardized Final Solution

Construct	PSR	CS	MA	EI	SD	FS
Psychosocial Support Roles (PSR)	1.000	----	----	----	----	----
Mentor / Mentee Characteristic Similarities (CS)	.298	1.000	----	----	----	----
Mentor / Mentee Attribute Similarities (MA)	-.058	.078	1.000	----	----	----
Engineering Involvement (EI)	.513	.316	-.050	1.000	----	----
Skill Development (SD)	.732	.144	-.004	.204	1.000	----
Formal Support Opportunities (FS)	.621	.129	-.128	.574	.564	1.000

Note. Covariances describe the magnitude and direction of how the two constructs vary together.

3.7 Internal Reliability

Cronbach's Alpha was used to formally determine internal reliability by assessing the interrelation between the items to make sure the answers are consistent (R. B. Johnson & Christensen, 2017). This was performed on both the overall 21 items retained by CFA as well as the individual constructs formed by each of the 6 factors designated also by EFA and CFA. Since this is for research purposes, coefficient alpha should be greater than .70 (R. B. Johnson & Christensen, 2017), though .50 to .70 can be considered moderate reliability for an exploratory study (Taherdoost, 2016). The results are shown in Table 17. All of the values except for Factor 6 were above .70, which is considered sufficient for research purposes (R. B. Johnson & Christensen, 2017; Taherdoost, 2016). For Factor 6, though .572 is considered to be low, .50 to .70 can be considered moderate reliability for an exploratory study (Taherdoost, 2016).

Table 17

Cronbach's Alpha for CFA Validated Instrument and Scales

Factor Number	Scale	Cronbach's Alpha	Number of Items Included
-----	All Items	.783	21
1	Psychosocial Support Roles (PSR)	.735	4
2	Mentor / Mentee Characteristic Similarities (CS)	.774	4
3	Mentor / Mentee Attribute Similarities (MA)	.764	3
4	Engineering Involvement (EI)	.744	4
5	Skill Development (SD)	.705	3
6	Formal Support Opportunities (FS)	.572	3

3.8 Discussion of Instrument Validation

As was further expanded upon in the literature review, very few needs assessments exist in the realm of mentorship, let alone in engineering peer mentorship. This pilot study allowed for the development and validation of a research instrument to bridge the gap of knowing what students' perceived needs are in peer mentorship, specifically in engineering. The responses to this validated instrument allowed for a beginning exploration, via a dissertation study, of student needs in a realm where peer mentorship is a topic has not been broadly accessed or implemented. An adequate and acceptable level of validity and reliability was achieved for this instrument, which is a solid, foundational starting point for future program development, both in this College of Engineering and others.

After examining the student results, it was determined that overall, the concerns mentioned in the Limitations (Chapter 1, Section 1.6; Chapter 6, Section 6.5) with regards to the ability to measure wants versus needs is something to further explore with the wording and focus of future instruments. When making decisions relating to formal programming that will require many resources, it will be important to discern and balance the differences to make sure the prioritization is not skewed just toward needs or wants (McGregor et al., 2009). Since the quantitative questions were derived from an extensive literature review about the critical elements of mentorship, participants may have found it easy to answer all questions in a favorable or agreeable context, such as answering all the questions of psychosocial and academic career support roles as "essential" but being matched with someone the same gender as you as “not essential” because of the implications of answering otherwise. This may be attributed as a residual of the Hawthorne Effect, specifically demand characteristic biases, which implies that students may answer questions differently or favorably because of their knowledge of being a part of a study (McCambridge et al., 2012, 2014).

The overall conclusion from the instrument validation is having students reflect on what they truly needed versus what they wanted in a quantitative survey context can be difficult, which creates challenges in ascertaining specific or contextual findings (R. B. Johnson & Christensen, 2017). In this case, the mixed-methods instrument that included qualitative questions was critical in providing a more contextualized perspective on the barriers and support needed in peer mentorship. In turn, the qualitative questions helped emphasize and describe the emerging priorities that were important to participants that may not have been evident in the quantitative data alone (R. B. Johnson & Christensen, 2017), as will be discussed in Chapter 6.

CHAPTER IV

METHODOLOGY

To fully establish a solid foundation for peer mentorship within the College of Engineering, a rigorous methodology involving development, validation, and analysis of both qualitative and quantitative aspects was used. The development and validation stages, which served as the pilot study, were presented and discussed in Chapter 3. This entire process ensured a thorough investigation of the perceived needs of students by directly involving and surveying students to increase personal accountability and involvement. This chapter will thoroughly discuss the research methodology of the qualitative, quantitative, and integrated analysis portion of this dissertation including positionality, validity, and reliability. A valid and reliable analysis of these data were only possible because of the thorough validation of the instrument as discussed in Chapter 3.

4.1 Research Questions

As mentioned in the Introduction (Chapter 1), this dissertation was guided by three fundamental research questions. Each directly related to a portion of the questions designed and validated for the survey instrument in the pilot study (Chapter 3, Figure 4), which were the driving influences in the overall design of this dissertation study (Chapters 4 to 6). These research questions were focused on a mixed-methods discovery and in no way were trying to determine a causation of outcomes or experiences within peer mentoring (Moustakas, 2011a). Together, they aimed to understand the perceived needs of students within the College of Engineering for a peer mentorship program, specifically with a focus toward the training and matching/initiating stages of the program.

The first research question related to the quantitative portion while the second question involved the qualitative inquiry within the validated instrument. The third research question considered the integration of the quantitative and qualitative results from the first two research questions. The research questions are as follows:

RQ1. (Quantitative) What relationships, if any, exist between participant identifiers around perceptions of needs for training and matching/initiating constructs within the scope of peer mentorship in engineering?

RQ2. (Qualitative) What common needs relating to training and matching/initiating constructs are expressed amongst undergraduate students within a College of Engineering?

RQ3. (Integrated) What are the priority student communicated needs with relation to training and matching/initiating constructs in peer mentoring?

Within each of these research questions, two of the six programmatic standards of practice mentioned previously (Garringer et al., 2015) served as the constructs. The six programmatic standards of practice from Garringer et al. (2015) were (a) recruiting; (b) screening; (c) training; (d) matching and initiating; (e) monitoring and supporting; and (f) closing.

The two standards of practice that served as the constructs for this dissertation were training and matching/initiating. After reviewing many existing mentorship programs and needs assessments within peer mentorship, it was decided that the training and matching/initiating standards of practice are the most plausible programmatic elements that could be implemented from the explored student needs. Recruiting, screening, monitoring, supporting, and closing practices generally have a set of best-practices to accompany them (Garringer et al., 2015) whereas training and matching/initiating needs and preferences are highly reliant on the population of interest and their needs (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017; Eby et al., 2013; NASEM, 2019) as discussed in the next two paragraphs.

Training was chosen because it considered how to manage expectations for the relationship, work out differences (e.g., culture, gender, race, religion, socioeconomic status, etc.), fulfill obligations and roles, develop and maintain the relationship, increase awareness and take advantage of resources, and initiate mentoring relationships (Garringer et al., 2015). The needed training in these aspects are influenced by student perceptions, expectations, and experiences (Garringer et al., 2015).

Matching was chosen because a peer mentorship program must consider the characteristics and attributes of both the mentor and mentee in a relationship *before* encouraging or initiating matches (Garringer et al., 2015). The principles of deep and surface level matching state that similarities and differences between a mentor and mentee may be a critical dimension of forming a mentoring relationship (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017; Eby et al., 2013; NASEM, 2019), which can differ depending on the needs, perceptions, expectations, and experiences of students.

4.2 Researcher Positionality

Researcher positionality is especially important to consider in this study since the researcher has a relationship to the context and possibly some of the participants of this dissertation (Herr & Anderson, 2015). As the researcher, I had a practical interest in this study, meaning I wanted to explore the perceived needs of students with regards to peer mentorship, with an emancipatory desire to increase human potential and opportunity (Herr & Anderson, 2015) within a community I have been engaged with for many years. I have done both undergraduate and graduate degrees at this institution all within their College of Engineering. I know from my experience as a student at this College of Engineering that peers make all the difference in navigating undergraduate and graduate engineering education. I have felt the lack of structured mentorship within the College of Engineering and am excited about the prospect of initiating discussions towards change regarding mentorship in the College, specifically around peer mentorship.

As both an undergraduate and graduate student, I have been highly involved in undergraduate student outreach and retention as a student leader, mentor, and as an instructor. I have a connection with this institution and have built credibility with a wide scope of students, staff, and faculty, which has ignited my passion and commitment to encourage change (Boden et al., 2015). This positioned me as an insider in collaboration with other insiders, though positionality is never a static characteristic and researchers have to be consistently reflective on where they fall within the context and participation (Herr & Anderson, 2015; Thomson & Gunter, 2011). I was the researcher who was familiar with the organizational demands and politics within (Coghlan & Shani, 2015) the given College of Engineering. I was mindful of my positionality as an insider throughout the data collection and analysis.

Positionality can be a fluid title depending on the relationship that is currently imminent and the development of that relationship (Thomson & Gunter, 2011). It should be recognized that there are benefits to both being an insider and outsider since outsiders can be critical with their new perspectives but may lack context whereas insiders know the ins and outs of the situation but may lack distance (Coghlan & Shani, 2015; Thomson & Gunter, 2011). In general, an insider in collaboration with other insiders gives a way to increase impact within a research situation (Herr & Anderson, 2015) and engender trust amongst its participants (Staples, 2001; Taylor, 2011). While the focus of this study was not on the entire logistical development or implementation of a peer mentoring program, this study aimed to generate knowledge that is mainly practice-driven (Herr & Anderson, 2015) but informed by existing literature (e.g., Garringer et al., 2015) and from my positionality.

4.2.1 Ethical Validity

Ethical validation was a consideration throughout the study design, analysis, and dissemination instead of simply reviewing ethical considerations at the beginning of a research process (Sochacka et al., 2018). Considering ethics throughout the research process leads to higher quality research findings (Sochacka et al., 2018). This called for an exploration of the intersection of motivations and intentions of the researcher within the study, which included a thorough and active effort to treat the participants, co-researchers, and stakeholders with equity and impartiality (Sochacka et al., 2018). Researcher positionality and its impacts were considered throughout the dissertation, determining what assumptions, agendas, or impacts were involved (Sochacka et al., 2018).

4.3 Participants

The participants for this portion of the study were the same as the participants for the Pilot Study, whose identifiers are fully described in Chapter 3 (Section 3.3.1). As a reminder, all respondents were current undergraduate engineering students within the College of Engineering for the study. There were a total of 1,886 undergraduate students enrolled within the College of Engineering in Fall 2020 (Office of Analysis Assessment and Accreditation, 2020a, 2020b). Of these students, 320 responses were gathered and after data cleaning, 223 responses remained. The sample was considered representative in terms of major, year in the program, first-generation status, gender identity, race, and ethnicity when compared to the overall student population in the College of Engineering.

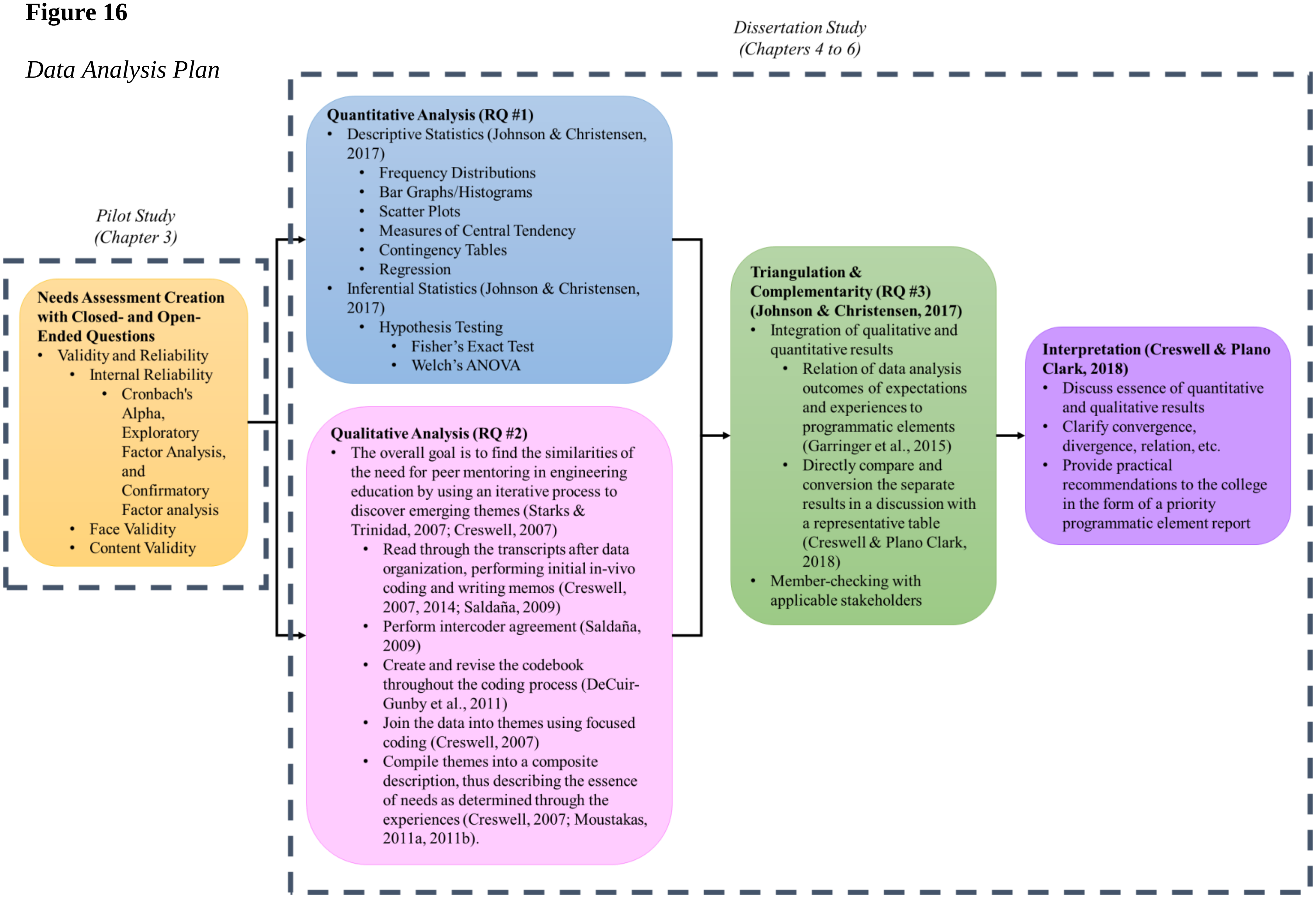
4.4 Data Analysis

The analysis and integration of qualitative and quantitative data within mixed-methods research are complex and can be challenging (Wisdom & Creswell, 2013).

Results were analyzed using a multi-data, multi-analysis approach, which means both the qualitative and quantitative data were analyzed separately and integrated in the interpretation of results (R. B. Johnson & Christensen, 2017). A summarized overview of the data analysis plans and procedures, which will be discussed in depth in the upcoming sections is presented in Figure 16. The data analysis plan features both the analysis done from the pilot study (Chapter 3) and the analysis performed on the qualitative and quantitative data to answer the three research questions (Chapters 4 to 6). The focus of this chapter is on the methodology for the dissertation study analysis.

Figure 16

Data Analysis Plan



4.4.1 Quantitative Data Analysis

As described previously, the quantitative portion of the survey resulted in 21 Likert-scale questions after validation of the instrument. The full set of quantitative questions can be viewed within the survey text in Appendix A. Descriptive statistics were used to analyze the results from the survey as suggested by Lewinski et al. (2017) and Johnson & Christensen (2017). Methods showing frequencies and proportions were used. Frequency distributions were used to depict the overall results of the survey by showing the frequency of those who chose each option in a question (R. B. Johnson & Christensen, 2017; Lodico et al., 2006). Frequency counts were also converted into percentages (Lodico et al., 2006) to show the proportion of each option chosen by percent of participants. Histograms, bar graphs, and scatter plots were used to display data (R. B. Johnson & Christensen, 2017; Lodico et al., 2006) to show potential relationships amongst the participant responses and identifiers.

The data were also examined with relation to various participant identifiers of interest such as year in their undergraduate engineering education, major, peer mentor status and gender identity to determine similarities and differences of priorities based on these demographic factors. These relationships were examined using both inferential and descriptive statistics, such as linear regression and hypothesis testing (R. B. Johnson & Christensen, 2017). The specific test assumptions and techniques employed will be justified and described more thoroughly in the Chapter 5 with the accompanying results.

4.4.2 Qualitative Data Analysis

Primarily, the qualitative data were used to more deeply illustrate the complexity of choices from the quantitative results (Schoonenboom & Johnson, 2017) and served to highlight emerging needs based on the essence discovered through a phenomenological-type of analysis (Moustakas, 2011a, 2011b). Though phenomenology commonly employs interviewing, the open-ended questions in this study aimed at determining the participant's experience of peer mentoring in the College of Engineering as described by the participant (Starks & Trinidad, 2007). As such, no transcription was necessary as the written responses were analyzed directly.

Typically, phenomenological analysis requires what is called bracketing by the researcher, which means putting aside any preconceptions about the phenomenon to fully learn about the phenomenon's essence without subjective bias (R. B. Johnson & Christensen, 2017; Larsson & Holmström, 2007). Because of the researcher's positionality within the College of Engineering, hermeneutic phenomenological techniques were used, which assumes the researcher is not bias-free and is an insider within the context (Neubauer et al., 2019). This allowed the researcher to consider the background influences that may be affecting a participant's experience, allowing for interpretation of experiences and not just description (Adams & van Manen, 2012; Neubauer et al., 2019). This also included allowing the researcher to consider and reflect upon their own experiences to determine how their subjective bias may influence the qualitative analysis (Neubauer et al., 2019). The researcher used her experience as an insider to guide the interpretation of where the participants perspectives were coming from, including the recognition of preconceptions about what was needed that may not have been true (Neubauer et al., 2019). This was a reflective process for the researcher, both in reflecting upon personal experience as well as reflecting upon theories and ideas found in the literature review in preparation for this study (Neubauer et al., 2019).

This was especially important since the researcher has been an undergraduate student with preconceptions about the student experience at this College of Engineering. The researcher was “honest and vigilant about her own perspective, preexisting thoughts and beliefs, and developing hypotheses” (Starks & Trinidad, 2007, p. 1376). This was done by recording and reviewing memos while coding about the thought process happening to preserve the thought process trail (Starks & Trinidad, 2007). The bias review process was similar to what was conducted by Youmans (2020) during coding. This included being reflexive of her positionality and by consistently creating memos while coding (Creswell, 2007; Saldaña, 2009) as well as performing intercoder agreement (Saldaña, 2009) with a researcher external to this study and topic.

The open-ended responses were analyzed by means of in-vivo and focused coding (Saldaña, 2009), described more fully in the next section, so as not to lose the depth and insight provided in the response, which may have been lost if only analyzed by quantitizing (Driscoll et al., 2007). Context, personal meaning, and detail are lost if the qualitative data are simply “counted” (Driscoll et al., 2007; Wisdom & Creswell, 2013). So, in order to increase validity, qualitative data was analyzed using typical rigorous procedures through qualitative coding (Harland & Holey, 2011; LaDonna et al., 2018) while also keeping in mind themes that could be integrated with quantitative results.

4.4.2.1 Qualitative Coding Procedures

The overall process for qualitative phenomenological-type analysis was guided by Moustakas (2011a), who advises that methods in human research are flexible and open-ended and not made of definitive requirements. Thus, methods within this methodology were adapted as appropriate during the process. The overall goal of this qualitative analysis was to find the common perceptions shared in student responses by using an iterative and emerging coding process (Creswell, 2007; Starks & Trinidad, 2007). Thus, it aimed to describe the essence of the lived experiences and not analyze the experience itself (Creswell, 2007).

All qualitative data coding of participants' written responses was performed using MAXQDA (VERBI GmbH, 2021). The first round of coding was performed alongside another graduate student researcher to determine intercoder agreement. To do this, the primary researcher coded 25% of the data set for the two qualitative questions of interest using in-vivo coding methods and created a list of codes with definitions. This was an iterative process where the data were separated and deconstructed by looking at each response on a participant-by-participant basis, then reconstructed and recontextualized by compiling the findings (Starks & Trinidad, 2007). This included writing memos and highlighting significant phrases, ideas, or statements that seemed to give an idea of the experience of the participant (Creswell, 2007, 2014; Saldaña, 2009). All statements were given equal value meaning each statement applicable to the topic was given consideration, regardless of its frequency (Moustakas, 2011b). The codes were data driven, emerging from the raw data (DeCuir-Gunby et al., 2011). In-vivo coding allowed for preservation of the participant's voice within the analysis (Saldaña, 2009). These in-vivo codes were then focus coded into larger code categories to give an overall essence and categorization of participant responses. A codebook was developed and revised throughout the coding process (DeCuir-Gunby et al., 2011). The codebook includes a label, definition, and examples (DeCuir-Gunby et al., 2011) and the final codebook is shown in Appendix B.

The external researcher coded the same 25% of the data according to the list of code categories. The coding was reviewed, and the researchers met together virtually to reach consensus upon a full set of codes for each of the two questions. The primary researcher then re-coded the 25% of the data set according to the codes and the external researcher reviewed the coding. Over 90% intercoder agreement was reached on a participant-by-participant basis for the data set, which is considered adequate (Saldaña, 2009). Results were also reviewed with stakeholders in order to member-check (i.e., discuss the results of the study with those associated with the study) the analysis (R. B. Johnson & Christensen, 2017) and share priority elements. This was done with those who were involved in the study, either with the validation (i.e., staff, students, researchers) or as participants in the study (i.e., students). These practices helped to maintain checks and balances of appropriate ways to analyze participant voices.

After the first, initial round of coding with intercoder agreement, the entire data set was then focus coded using the formalized code book. This allowed for the determination of the frequent and significant codes (Creswell, 2007). These focused codes gave a way for the researcher to write a description of the participants' experience of the phenomenon by examining the code categories created by focused coding as well as adjoining those focused codes into pertinent themes that were appropriate for the integrated analysis (Creswell, 2007). This also included the researcher's experience in the form of memos and personal description and interpretation of experiences (Creswell, 2007), which is a function of hermeneutic phenomenology, allowing for flexibility in the subjective interpretations of the researcher (Neubauer et al., 2019). These descriptions were compiled into a complete description of student experiences and perceptions of peer mentorship, which makes up the essence of the phenomenon (Creswell, 2007). These findings are presented in Chapter 5.

4.4.2.2 Qualitative Validity Checks During Analysis

During coding procedures, both theoretical, ethical, and interpretative validity were considered to make sure the analysis considered both the research questions and what the participants found to be of interest (Chioncel et al., 2003; Sochacka et al., 2018). This was done through an iterative process of revisiting the analysis and research questions consistently throughout the process (Chioncel et al., 2003). One other researcher, in addition to the primary researcher, coded the transcripts to cross-check and determine intercoder agreement (Creswell, 2014). Over 90% intercoder agreement was achieved. After themes emerged and the essence of peer mentorship in the College of Engineering was established, the results were also member-checked (i.e., debriefed) with applicable parties, such as administrators, students, or staff who supported peer mentorship, as peer review to discussed and verified the accuracy of data analysis and for further insight, verification, and clarification (Creswell, 2014; R. B. Johnson & Christensen, 2017). The researcher also employed reflexivity throughout the research process, continually reflecting on her biases, preconceptions, intentions, motivations, and actions and how the research was being affected (R. B. Johnson & Christensen, 2017; Sochacka et al., 2018).

4.4.3 Integrated Data Analysis

After analyzing both the quantitative and qualitative data separately, a merge of the two sets of results occurred to allow for triangulation and complementarity (R. B. Johnson & Christensen, 2017). The purpose of integration was to provide both results and interpretations of the data to more fully understand, comprehend, validate, and confirm the findings to the mixed-methods research question (Creswell & Plano Clark, 2018). The approach in this section was to directly compare the results from each of the separate analyses in a discussion (Creswell & Plano Clark, 2018) and determine the priority needs that emerged from both analyses. The results from both qualitative and quantitative sections were compared by means of looking at the essence of emerging programmatic elements in relation to training and mentoring/initiating that were emphasized in both the analyses to determine the overall commonalities of the needs with regards to training and matching/initiation. The results were compiled into a joint display table summarizing the quantitative results and its statistical analyses, alongside concurrent qualitative findings (Creswell & Plano Clark, 2018). Text summaries were also used to represent the results (Creswell & Plano Clark, 2018). As mentioned, these fit into the two constructs of training and matching/initiating. These findings are discussed in depth in Chapter 5.

A discussion of the essence of the qualitative and quantitative results as well as a summary of the overall integrated results (Creswell & Plano Clark, 2018) is presented in Chapter 6. The results and discussion also were compiled in the form of an infographic and presentation that was provided to the college that discussed recommendations of the priority steps/solutions that should be implemented in a peer mentorship initiative. As mentioned previously, it is never plausible to implement all recommendations because of staffing and financial limitations, but this compilation should provide a baseline of priorities that students perceived are needs for peer mentorship within the given College of Engineering.

4.4.3.1 Legitimation of Integration

During the integration of qualitative and quantitative results, it was the desire of the researcher to make sure that the interpretation and inferences were valid, confirmable, credible, and trustworthy (Onwuegbuzie et al., 2011; Onwuegbuzie & Johnson, 2006). To do this, the researcher was mindful of her own perspective as an insider since she was previously an undergraduate student in the same program and her position interpreting insiders' responses (Onwuegbuzie et al., 2011; Onwuegbuzie & Johnson, 2006). The qualitative and quantitative findings were used together to minimize the weaknesses from each approach by garnering the strength of the other approach (Onwuegbuzie et al., 2011; Onwuegbuzie & Johnson, 2006). The mindfulness of validity in both the individual quantitative and qualitative analysis stages included many expert reviewers, stakeholders, and like-populations, which contributed to better inferences developed in integration (Onwuegbuzie et al., 2011; Onwuegbuzie & Johnson, 2006).

CHAPTER V

RESULTS

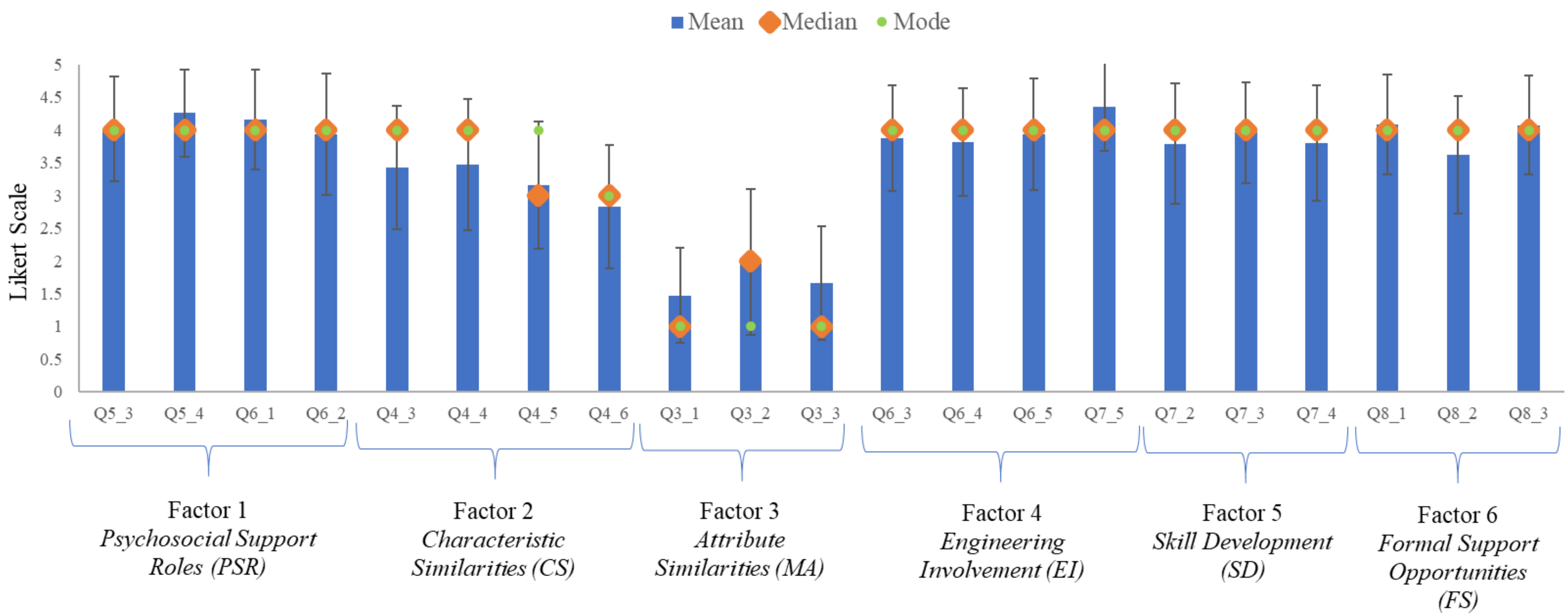
This chapter will present the results from the quantitative, qualitative, and integrated analysis.

5.1 Quantitative Analysis

The overall goal of the quantitative analysis was to determine if there were any relationships between the demographic characteristics of participants and the way they answered the questions relating to training and matching/initiating (Research Question 1). For the quantitative analysis, only the 21 Likert scale items that were validated by the EFA, CFA, and Cronbach's Alpha, as discussed in Chapter 3, were included. The 21 questions and what factor they are under are shown in Table 12 and the full text of the questions can be found in Appendix A. A summary of the mean, median, mode, and standard deviations for each of the 21 questions are shown in Figure 17. To statistically compare these questions, they were grouped by factor, which is also shown in Figure 17.

Figure 17

Summary of Descriptive Statistics of the 21 Validated Likert Scale Items



Note. Error bars indicate ±1 SD. All 223 participant responses are included in this summary.

5.1.1 Factor Mean Comparison

To determine which factors were stated to be of most importance for students, the mean values for each factor were compared using statistical techniques. The descriptive statistics for the factors are featured in both Figure 18 and Table 18 for ease of reference. For analysis of variance (ANOVA), the data must meet the assumptions of normality, homogeneity of variance, and independence (Navarro, 2021). In order to assess normality, a Shapiro-Wilk test was performed using R Studio (RStudio Team, 2020; Navarro, 2021), which returned significant result, indicating a lack of normality in the data, $W = .87$, $p = < .001$. Levene's Test was employed to determine the homogeneity of variance since Bartlett's test is more sensitive to non-normal data (NIST/SEMATECH, 2013). Levene's Test returned a significant result, indicating that the variances could not be assumed to be approximately equal, $F(5, 4677) = 33.72$, $p < .001$. The assumption of independence was met because each participant individually answered each question, so there should be no relationship between each observation (Navarro, 2021).

Figure 18

Box Plot of Six Factors for Mean Comparison

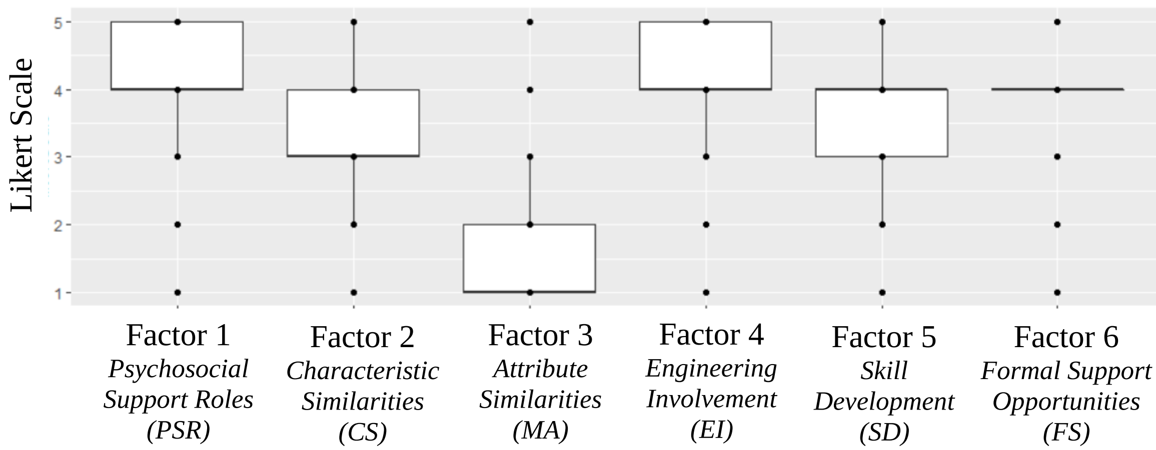


Table 18

Descriptive Statistic Summary of Six Factors for Mean Comparison

	Factor 1 (PSR)	Factor 2 (CS)	Factor 3 (MA)	Factor 4 (EI)	Factor 5 (SD)	Factor 6 (FS)
Mean	4.09	3.22	1.71	3.99	3.85	3.93
Median	4	3	1	4	4	4
Mode	4	3	1	4	4	4
St. Dev.	0.80	1.00	0.94	0.82	0.86	0.84

Because of the violations of the assumptions, especially concerning the unequal variances, Welch's ANOVA was employed to determine if there were differences between the means even with unequal variances (Frost, n.d.). For Welch's one-way analysis of means not assuming equal variances, there was a statistically significant difference found among the factors, $F(5, 2114) = 714.04$, $p < .001$. To find which factors were different, post-hoc analysis was used. Games-Howell allows for multiple comparisons and is most comparable to the Tukey post-hoc method for normal one-way ANOVA (Frost, n.d.). The Games-Howell also does not require equal variances (Frost, n.d.). The results are shown in Table 19.

Table 19

p-values for Mean Factor Comparison Following Welch's ANOVA

Factor Number	Factor Number	Adjusted p-value
1	2	< .001
1	3	< .001
1	4	.097
1	5	< .001
1	6	< .001
2	3	< .001
2	4	< .001
2	5	< .001
2	6	< .001
3	4	< .001
3	5	< .001
3	6	< .001
4	5	.010
4	6	.578
5	6	.571

Based on these results, many of the factors were significantly different from one another. For the sake of simplicity, it is easier to focus on those factors that are not significantly different from one another at the 95% confidence level: Factor 1 is not significantly different from Factor 4, Factor 4 is not significantly different from Factor 6, and Factor 5 is not significantly different from Factor 6. When looking at what these factors are labeled as, Factors 1, 4, 5, and 6 are focused on psychosocial (Factor 1) and academic career support (Factors 4, 5, and 6) roles while Factors 2 and 3 are focused on mentor/mentee similarities. In looking at Table 18, the median and mode are the same for Factors 1, 4, 5, and 6 and the means are similar, all of which are significantly higher than Factors 2 and 3. This indicates that students are not as concerned about what their mentor "looks like" (i.e., characteristic and attribute similarities; Factors 2 and 3), but are instead in need of peer mentors who can support them academically and psychosocially. Factor 1 (psychosocial support) is considered the most critical priority since it was statistically significantly different from all other factors (at the 90% confidence level) and had the highest mean ($M = 4.09$) but lowest standard deviation ($SD = 0.8$).

Factor 1 included the psychosocial support roles in providing support or advice to feel sure about engineering major choice, set goals for future in engineering, gain strategies to persist in engineering even in the face of failure, and develop time-management skills to meet engineering course demands. Factors 4, 5, and 6 were focused on engineering involvement (e.g., clubs, events, socials, research opportunities, network building), skill development (e.g., group projects, communication, appropriate note taking), and formal support opportunities (e.g., utilizing campus resources, tutoring services, and sources to review homework). These three factors fell under the realm of academic career support. These findings indicate that when determining how to match participants and what to train them on, a primary focus should be on providing information, resources, awareness, and skills with relation to psychosocial and academic career support. Participants were less concerned about the attributes and characteristics of their mentor and more concerned that the mentor can provide advice, guidance, and encouragement.

5.1.2 Participant Identifier Relationships

The next part of quantitative analysis explored if there were any significant relationships between the participant identifiers and the participant responses for the quantitative questions. Since the demographic indicators and Likert questions could be considered as nominal, the non-parametric Fisher's Exact Test was used (McDonald, 2014). This was chosen instead of a Chi-square test as well because there were many cells in the contingency tables that were less than five, with multiple being zero, which is not compatible with a Chi-square test (McHugh, 2013). To further alleviate this concern and allow for better distinguishing between Likert answers, "Agree" and "Strongly Agree" were combined into a single code. The same was done for "Disagree" and "Strongly Agree". This essentially converted the five-point Likert Scale to a three-point Likert Scale. The sample size of 223 is considered a relatively small sample size (less than 1000, McDonald, 2014), which is better for Fisher's Exact Test as well (Kim, 2017). The null-hypothesis for the Fisher's Exact Test is that the proportions at one variable are the same at other values of the separate variable (McDonald, 2014). If the statistic returns significant, it shows the proportions are different somewhere within the contingency table.

Four reported demographic characteristics were used for this analysis:

- Presence of Peer Mentor (Q2, Appendix A)
- Year in Undergraduate Engineering Education (Q17, Appendix A)
- Undergraduate Engineering Major (Q18, Appendix A)
- Gender Identity (Q23, Appendix A)

Other demographic characteristics were not considered in this analysis because there were not sufficient numbers in each of the categories to distinguish statistically significant differences, such as race, ethnicity, and first-generation status (Figure 9 and Figure 10). After the initial contingency tables with frequency counts were analyzed using Fisher's Exact Test and a significant result was obtained (Table 20) using RStudio (RStudio Team, 2020), a post-hoc analysis was performed using pairwise comparisons to determine where the statistically significant difference was found. In order to control for the inflation of the false positive rate, the post-hoc analysis was performed using the False Discovery Rate (FDR), a powerful adjustment method by Benjamini and Hochberg (Benjamini & Hochberg, 1995; Jafari & Ansari-Pour, 2019). With this adjustment, though there were many significant relationships as shown in Table 20, only two relationships returned statistically significant categorical differences, which were the relationships between Q2 (presence of peer mentor) and Q6_2 (importance of encouragement/advice needed to feel sure about major choice) as well as Q23 (gender identity) and Q3_3 (importance that peer mentor is same first-generation status). These will be discussed further in the upcoming paragraphs and figures.

Table 20

Fisher's Exact Test p-value Results

Item	Q2 (Presence of Peer Mentor)	Q17 (Year in Undergraduate Education)	Q18 (Major)	Q23 (Gender Identity)
Q2 (mentor)	-----	.514	.170	.912
Q3_1 (MA1)	.065*	.578	.420	.220
Q3_2 (MA2)	.313	.633	.373	.549
Q3_3 (MA3)	.178	.767	.105	.004**
Q4_3 (CS1)	.374	.125	.813	.681
Q4_4 (CS2)	.101	.890	.947	.141
Q4_5 (CS3)	.326	.360	.847	.895
Q4_6 (CS4)	.269	.283	.606	.857
Q5_3 (PSR1)	.311	.609	.077*	.099*
Q5_4 (PSR2)	.248	.220	.040**	.089*
Q6_1 (PSR3)	.100	.094*	.076*	.132
Q6_2 (PSR4)	.011**	.127	.576	.040**
Q6_3 (EI1)	.129	.745	.026**	.666
Q6_4 (EI2)	.282	.204	.042**	.141
Q6_5 (EI3)	.870	.212	.665	.455
Q7_2 (SD1)	.840	.166	.242	.140
Q7_3 (SD2)	.268	.455	.030**	.312
Q7_4 (SD3)	.479	.809	.403	.016**
Q7_5 (EI4)	.903	.432	.462	.031**
Q8_1 (FS1)	.251	.152	.604	.366
Q8_2 (FS2)	.692	.574	.789	.326
Q8_3 (FS3)	.665	.256	.244	.038**
Q17 (year)	.514	-----	-----	.082*
Q18 (major)	.170	-----	-----	.048**
Q23 (gender identity)	.912	.082*	.048**	-----

Note. * $.10 \leq p < .05$ and ** $p < .05$

One of the relationships to return statistically significant categorical differences after applying the p-value correction was participants indicating whether they had a peer mentor or not (Q2, Appendix A) and the degree to which participants agreed that it is essential that they have a peer mentor who can encourage them to or provide advice on how to feel sure about their choice of an engineering major (Q6_2, Appendix A). Fisher's Exact Test returned that a statistically significant difference somewhere in the contingency table existed (Table 21; $p = .011$).

Table 21

Contingency Table for Importance of Encouragement/Advice Needed to be Sure of Major Choice Grouped by Having a Peer Mentor

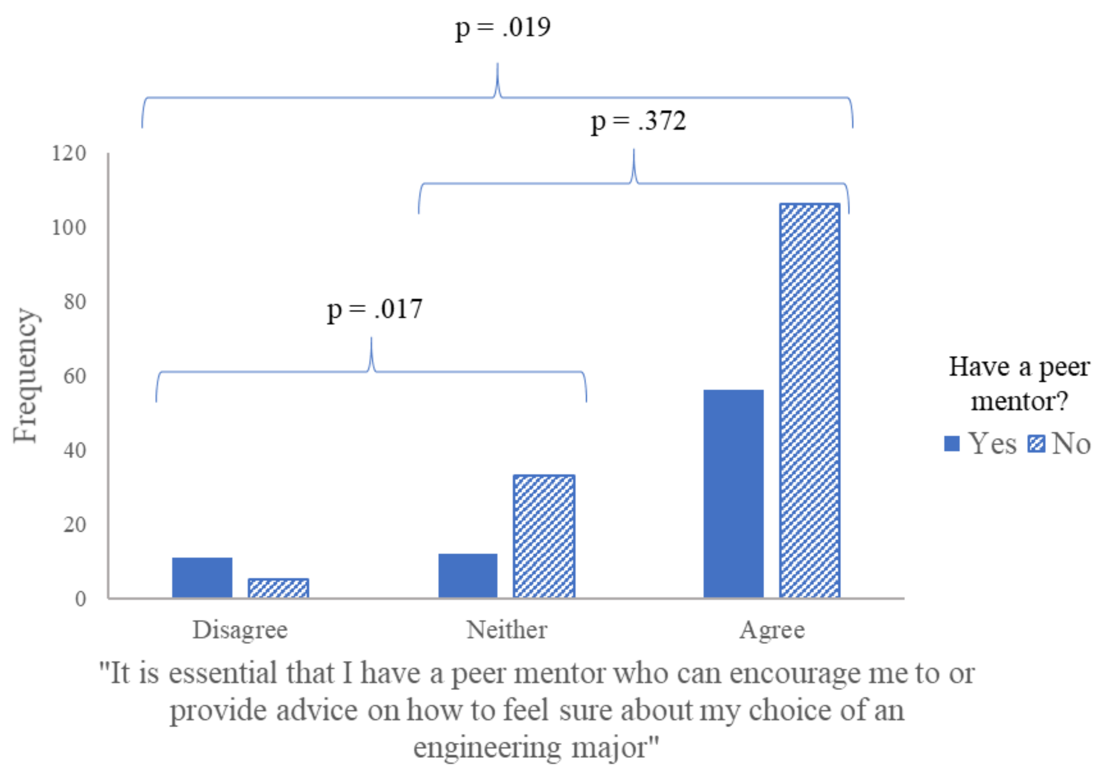
	"It is essential that I have a peer mentor who can encourage me to or provide advice on how to feel sure about my choice of an engineering major"			
Do you have a peer mentor?	Disagree	Neither Agree or Disagree	Agree	Totals
Yes	11	12	56	79
No	5	33	106	144
Totals	16	45	162	223

From the post-hoc analysis, it was determined that there was a statistically significant difference between "Disagree" to "Neither Agree or Disagree" ($p = .017$) and "Disagree" to "Agree" ($p=.019$), but not between "Neither Agree or Disagree" and

“Agree” (p = .372) for those who indicated they had a peer mentor versus those who did not. Figure 19 allows for a visualization of these relationships.

Figure 19

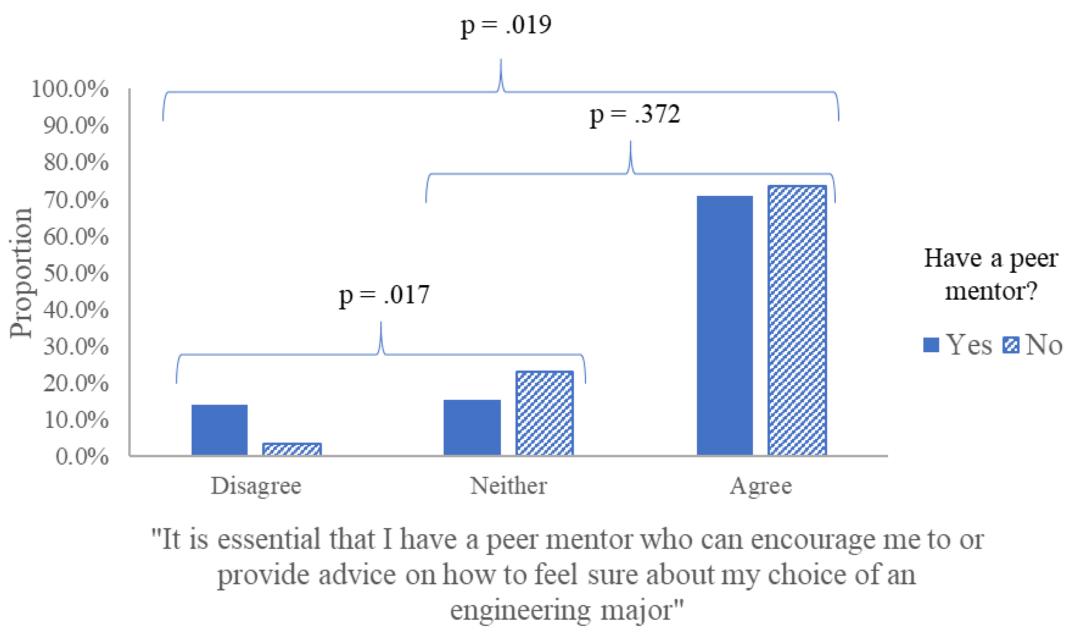
Frequency of Importance of Encouragement/Advice Needed to be Sure of Major Choice Grouped by Having a Peer Mentor



The number of those who indicated they had a peer mentor and disagreed (11 participants, 13.9%) was higher than the number of those who indicated they did not have a peer mentor and disagreed (5 participants, 3.5%), which was unexpected considering the proportional normalized trends for “Neither Agree or Disagree” and “Agree” (Figure 20). This pattern in trends indicate that those who have a peer mentor currently may feel more strongly against the essential need for encouragement or advice in feeling sure of major choice coming from their peer mentor. This suggests that students who already have a peer mentor may either already feel they are receiving support to feel sure of their major choice or have found through their past or existing relationships that this may not be as important as some other factors.

Figure 20

Proportion of Importance of Encouragement/Advice Needed to be Sure of Major Choice Grouped by Having a Peer Mentor



The other relationship to return statistically significant categorical differences after applying the p-value correction was participants indicating the degree to which participants agreed that it is essential that they have a peer mentor who is the same first-generation status as them (Q3_3, Appendix A) and their gender identity (Q23,

Appendix A). As a reminder, first-generation status in this context was defined as someone who was the first in their immediate family (e.g., mother, father, sibling[s], grandparent[s]) to attend college. Fisher's Exact Test returned that a statistically significant difference somewhere in the contingency table existed (Table 22; p = .004).

Table 22

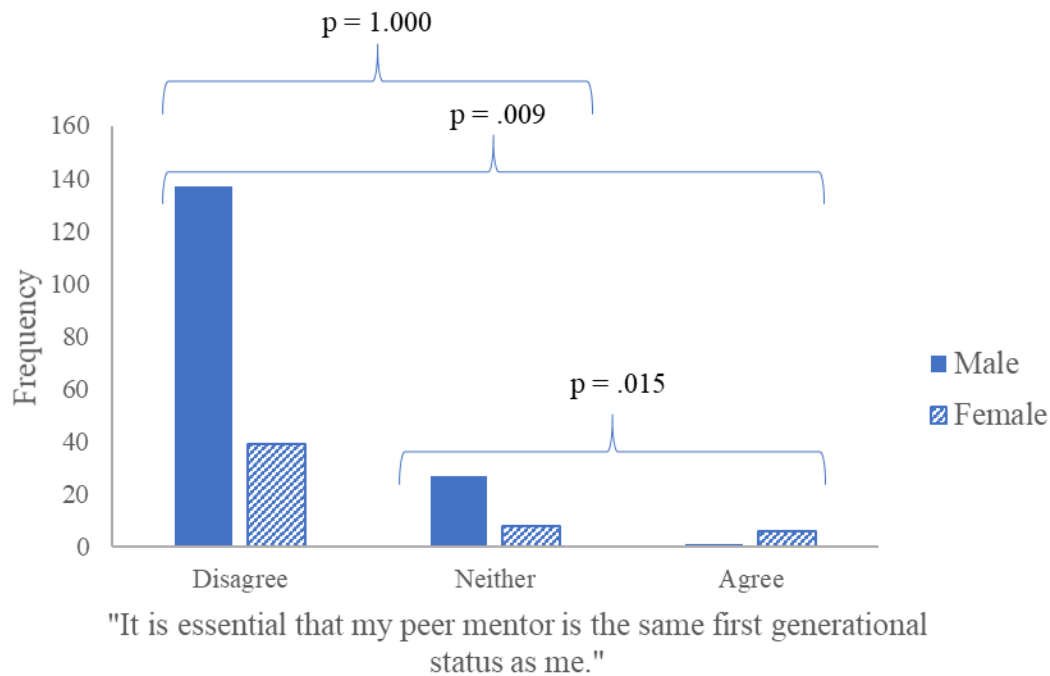
Contingency Table for Importance of that Peer Mentor should be the Same First-Generation Status Grouped by Self-Identified Gender Identity

	"It is essential that my peer mentor is the same first generational status as me."			
Gender Identity	Disagree	Neither	Agree	Total
Male	137	27	1	165
Female	39	8	6	53
Prefer not to answer	3	2	0	5
Total	179	37	7	223

From the post-hoc analysis, it was determined that there was a statistically significant difference between "Disagree" to "Agree" (p = .009) and "Agree" to "Neither Agree or Disagree" (p=.015), but not between "Neither Agree or Disagree" and "Disagree" (p = 1.000) for those who identified as women versus men. A visualization of these relationships can be found in Figure 21.

Figure 21

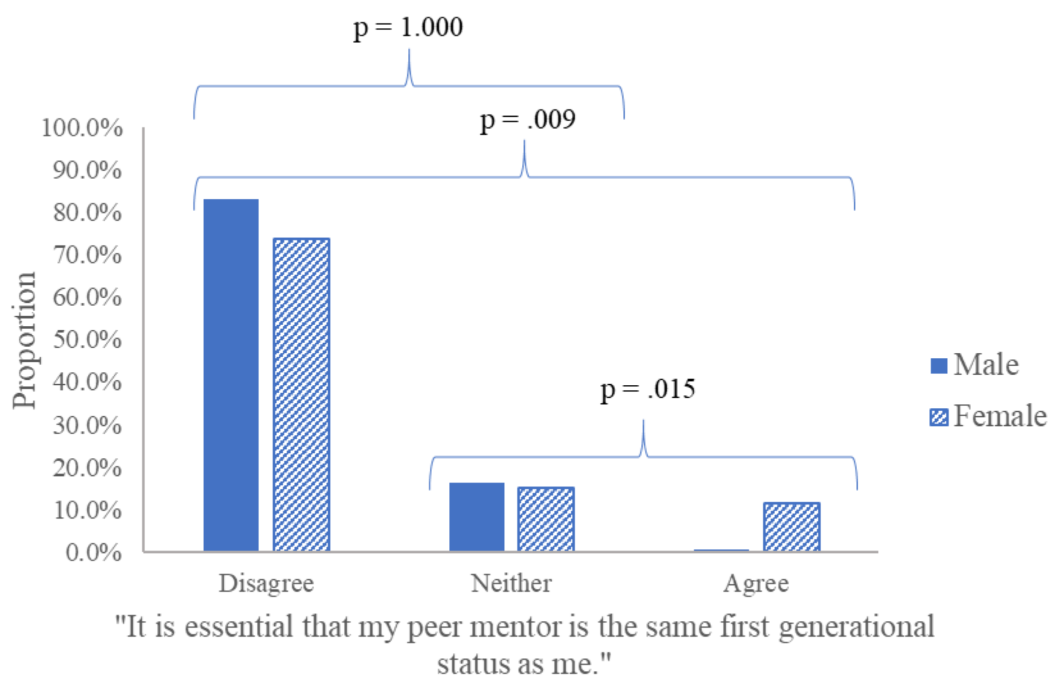
Frequency of Importance that Peer Mentor should be the Same First-Generation Status Grouped by Gender Identity



The number of those who indicated they agreed and identified as women (6 women, 11.3%) was higher than the number of those who indicated they agreed and identified as men (1 man, 0.6%), which was unexpected considering the proportional trends for "Neither Agree or Disagree" and "Agree" (Figure 22). Of those six women who agreed, four of them (i.e., 66.7%) were first generation students themselves. This pattern in trends indicate that those who identify as women, especially if they are first generation students, may feel more strongly about having a peer mentor who is the same first-generation status as them. While this significant trend was only for first-generation status, this may suggest that those who identify as women may have more of a need for matching with peer mentors based on attributes or characteristics.

Figure 22

Proportion of Importance that Peer Mentor is Same First-Generation Status Grouped by Gender Identity



5.1.3 Linear Regression

Self-reported GPA was obtained as an academic indicator within the survey. It was desired to determine if there were any significant linear relationships between GPA and the way that questions within the survey were answered, so linear regression was conducted. Questions were analyzed both individually and as factors. There are four main assumptions of linear regression (Field, 2016; JMP, n.d.):

1. Linear relationship exists between the independent and dependent variables
2. Errors are independent
3. Residuals are equal across the independent variable
4. Residuals are normally distributed

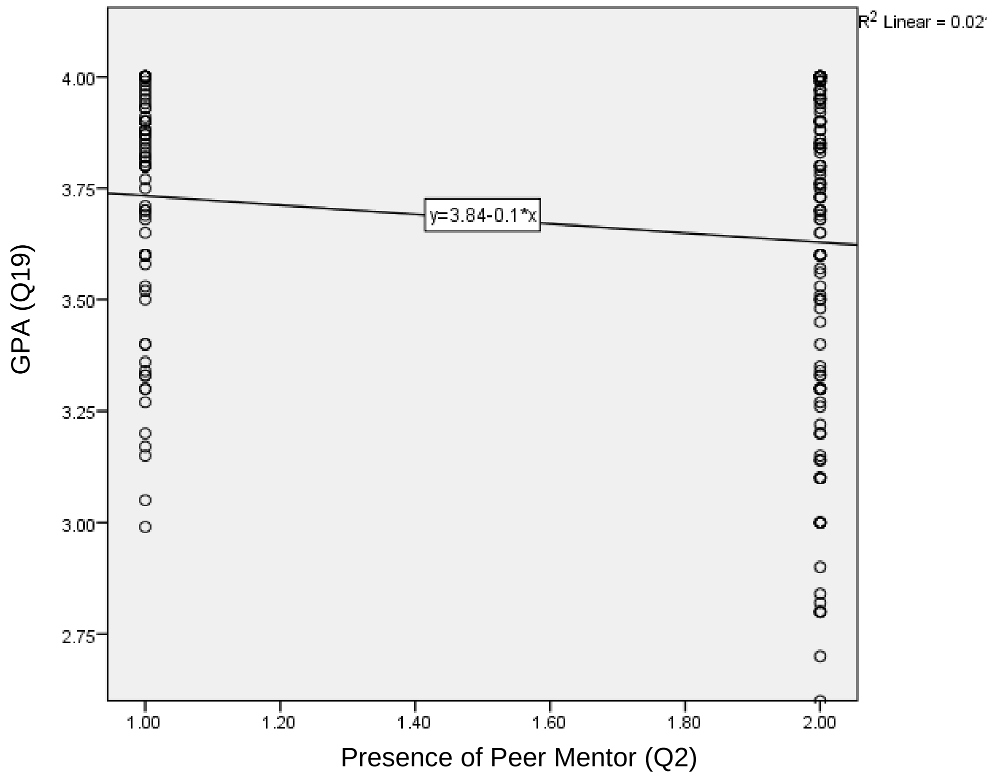
It was assumed that a linear relationship could exist between the independent (Likert-scale item) and dependent (self-reported GPA) variable because the questions asked were categorical and the dependent variable was continuous. To test the independence of errors, the Durbin-Watson test was used, which can vary from 0 to 4 with values closer to 2 indicating the residuals are uncorrelated (Field, 2016). To determine if the residuals were normally distributed and equal across the independent variable, three plots were developed: a histogram of the standardized residuals, a P-P plot of standardized residuals, and a scatterplot of the residuals. To determine if there were significant outliers, the standardized residuals were examined to see if they were between ±3.29, which is the z-score range of which 99.9% of values should lie within (Field, 2016). For the models that used the factors, the multicollinearity was tested by looking at the correlations between all questions and most values were below .50 and none were above .70 (Field, 2016).

One relationship of interest that was significant at the 95% level was the relationship between whether or not the students indicated they had a peer mentor (Q2, Appendix A) and GPA (Q19, Appendix A). The scatterplot of these two factors with the linear relationship is shown in Figure 23. The standardized residuals were within the indicated range (-3.024, 1.092), the Durbin-Watson statistic was 2.319, indicating there were not significant outliers and the errors were independent of one another. When looking at the charts for whether the residuals were equal and normally distributed, it was found that the residuals were slightly left-skewed and deviant from normality (Figure 24). The residuals were primarily equally distributed (Figure 25). It was attempted to transform the data by both square root and log transformations but neither normalized the residuals.

The linear regression from this analysis was statistically significant ($p = .032$), though it accounted for only 2.1% of the variance. While this R^2 value is low, the relationship is still considered significant by the ANOVA and significant coefficients ($p < .05$) since Q2 (Appendix A) was categorical. This significant relationship indicates that there is a statistically significantly higher GPA (0.1 point or 2.5% higher; $p = .032$) for those who *do* have a peer mentor when compared to those who *do not* have a peer mentor (Figure 23). As you will notice from Figure 23, the spread for those who do not have a peer mentor is larger than those who did have report to have a peer mentor. It should be noted that these are self-reported GPA, which may skew the results since especially lower performing students tend to inflate their actual GPA (Cassady, 2001; Schwartz & Beaver, 2015).

Figure 23

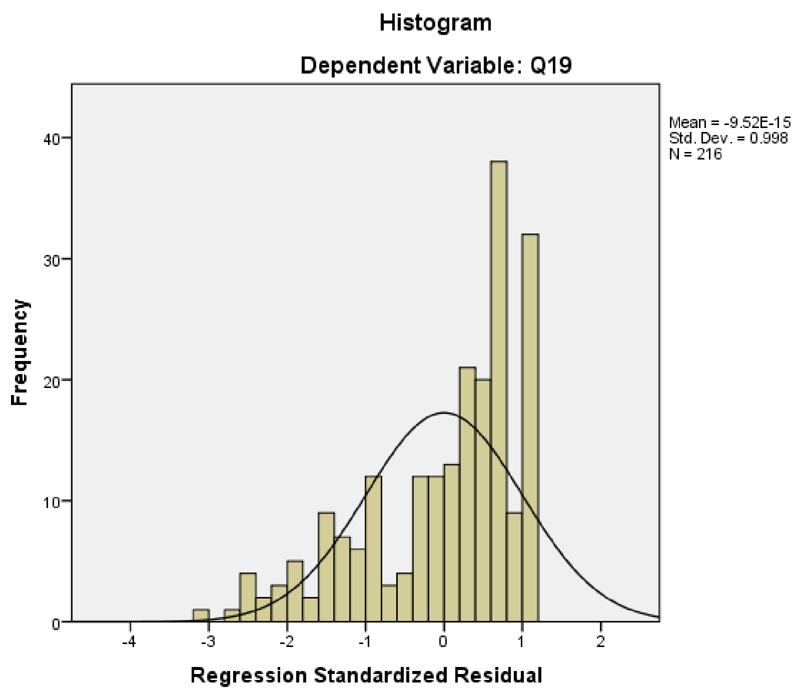
Scatterplot for Self-Reported GPA versus Presence of a Peer Mentor



Note. For presence of a peer mentor, 1.00 indicates the participant has a peer mentor and 2.00 indicates the participant does not have a peer mentor.

Figure 24

Histogram (top) and Normal P-P Plot (bottom) of Standardized Residuals



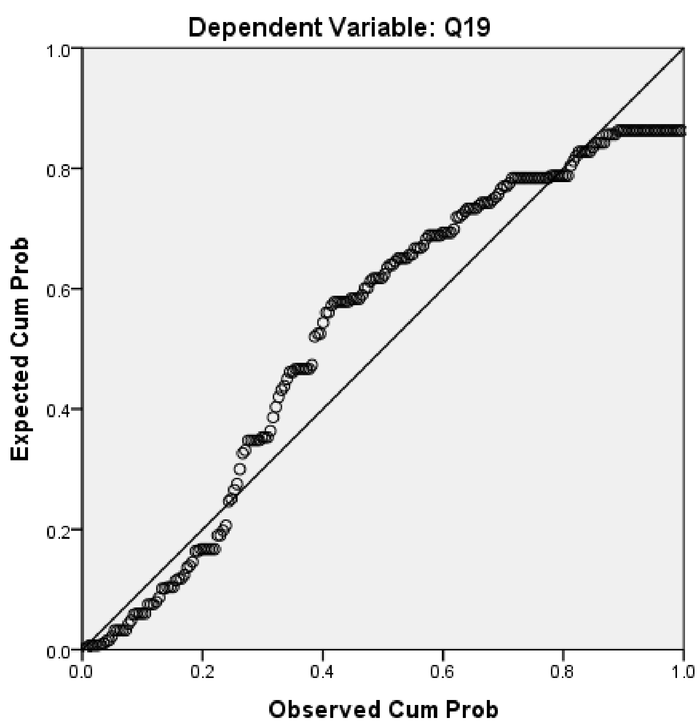
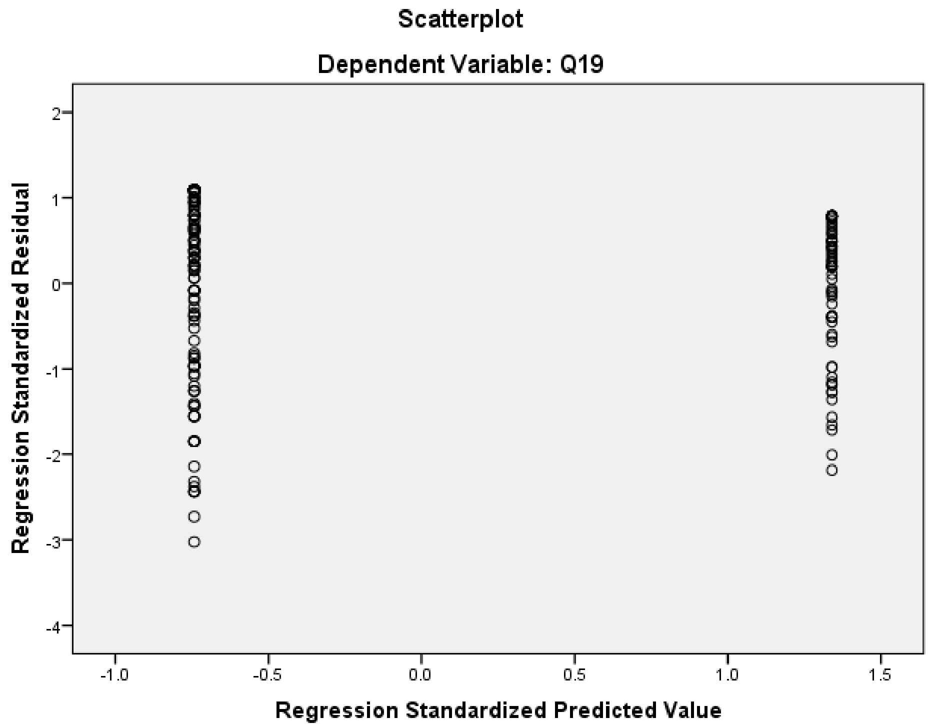


Figure 25

Scatterplot of Standardized Residuals Versus Standardized Predicted Values



While not formally analyzed using linear regression, it should be noted that these trends for higher GPA for those who have a peer mentor hold across all years of the engineering program except freshman year. This is likely due to less credits being on the students' transcript at the freshman level, so less opportunity for differentiation in GPA. This trend is displayed in Figure 26.

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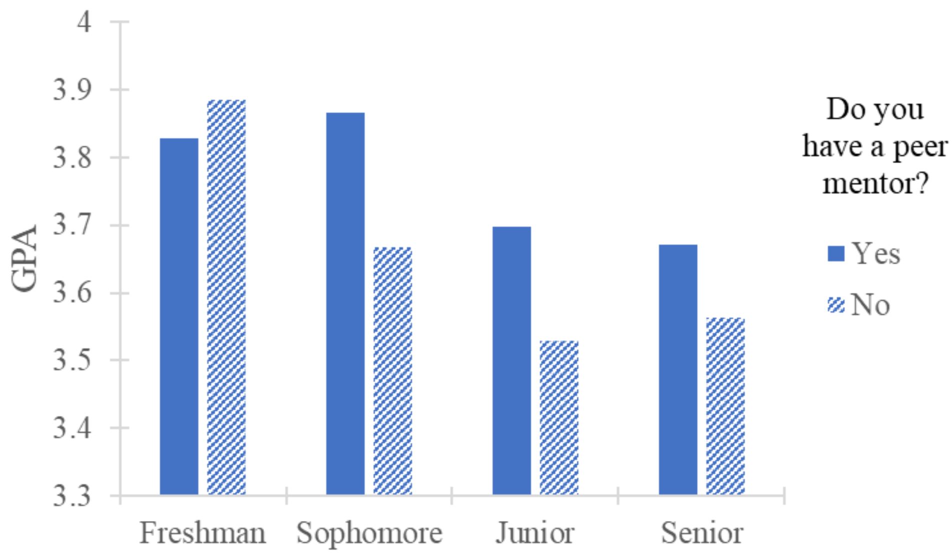
Figure 26

Summary of Average GPA by Year Grouped by Presence of Peer Mentor



5.2 Qualitative Analysis

The overall goal of the qualitative analysis was to determine the common experiences around training and matching/initiating needs that participants expressed (Research Question 2). As mentioned previously, all data coding was performed using MAXQDA 2020 (VERBI GmbH, 2021) on two qualitative questions from the instrument (Q9 about barriers to peer mentorship and Q10 about support needed from the College of Engineering, Appendix A). Initially, the researcher read through the transcripts to perform in-vivo coding, which were then grouped into larger code categories using focused coding to be applied to the data set at-large. The results of this coding will be presented here, which align with the codes featured in the codebook

(Appendix B). When examining these responses, it should be noted that participant numbers up to 79 indicated that they currently have a peer mentor. Participants 80 to 223 indicated that they do not have a peer mentor.

5.2.1 Barriers to Peer Mentorship (Q9, Appendix A)

As a reminder, this question asked, “What challenges or barriers **currently** exist for you in establishing peer mentoring relationships?” (Q9, Appendix A). From participants’ responses, there were four main themes that arose from the eight code categories that came from focused coding. Each of these themes of exiting barriers will be discussed below.

5.2.1.1 Theme 1: Perceived Deficiencies

Two main code categories fit under this theme of perceived deficiencies, which were deficiencies in current or prior relationships (Code 1.1, 10 occurrences, Appendix B) and lack of available or suitable mentors (Code 1.2, 17 occurrences, Appendix B). This theme emerged from students referring to current or prior mentoring experiences, either as a mentor or a mentee, that featured deficiencies and difficulties with building an effective relationship as well as participants simply expressing that they felt there were barriers to finding mentors who are willing and eligible to be an effective mentor.

Within this theme, one of the primary ideas mentioned was that there was a lack of communication or connection in the participants’ prior mentoring relationships. The mentor or mentee may have failed to connect or communicate, which could have been due to time conflicts, lack of external support, participant relocation, or just a difference in “learning and communication styles” (Q9, Participant 8). As a representative example, one participant stated:

> I remember that I was assigned to someone my freshman year, but I was never contacted by them and had no idea who they were. So I feel the lack of an established means of getting peer mentors is the biggest barrier. (Q9, Participant 196)

The aforementioned example also alluded to the next theme of a lack of knowledge or opportunity (Theme 2) of the process of finding peer mentors. It was primarily categorized within this theme though because the final idea of a lack of established means to obtain a peer mentor originated from lacking authentic and productive connections from their assigned peer mentor.

Another participant exemplified the lack of benefit from previous mentoring relationships because of being busy and the mentors, both peer and faculty, not facilitating the relationship by stating the following:

> Previous peer mentors were upper classmen occupied with their own projects and homework, and I really didn't gain much from the experience. Similarly, assigned faculty mentors did not facilitate a mentorship experience. All faculty mentors I have found at [institution blinded] came through me reaching out in office hours and research opportunities. (Q9, Participant 212).

This response emphasized the need to have peer mentors that are readily available and have very recently or are currently going through the same experiences as their mentees. When mentors are too far ahead and invested in other activities, they may not be able to focus their efforts or benefit their mentees in the same way as a near-peer mentor.

As far as being able to find willing and suitable mentors, one of the common mentions by participants was feeling that their age, status in the program, or personal factors were a barrier to building a productive relationship, such as “being a senior now it is much harder to find such people i trust” (Q9, Participant 13), “I'm a senior in college, so finding someone older and "wiser" than me to mentor me through some of my challenges can be difficult” (Q9, Participant 76), or “being married when others are single” (Q9, Participant 61).

Perceptions were also mentioned of the mentor’s age or status in the program as well as personal factors and how that played into a productive mentoring relationship, such as in the following participant response: “I don't really know any older students, usually older students are either married and/or busy studying and so I don't get much interaction with them” (Q9, Participant 97).

Participants also commonly mentioned that they felt there was a lack of availability of mentors as well as specifically, a lack of availability of mentors with similar interests, field, or motivation, such as the participant who mentioned that they are “Naturally only making connections with people outside of my engineering major -

not ideal for a peer mentor that I'd prefer” (Q9, Participant 131). To expand upon that thought as well, a participant mentioned the following:

> But definitely it would be hard if the level of motivation is different. I don't think it matters as much if they have the same interests, but if the peer mentor is not as motivated as me, it will not work. I don't want to have to constantly follow up and ask for help. If they are my mentor, they should be there. So I believe that if someone wants to be a peer mentor, they should be prepared to mentor actively, not passively. (Q9, Participant 84)

It should be noted as well that there were individual mentions of gender (Q9, Participant 53) and religion (Q9, Participant 53) as well. While these were not commonly referenced in the 27 occurrences of codes within this theme, they are important in knowing the breadth of student needs within the realm of barriers to peer mentoring relationships.

5.2.1.2 Theme 2: Lack of Knowledge or Opportunity

One of the most prominent coding categories, and thus its own theme, was the lack of knowledge or opportunity (Code 1.5, 63 occurrences, Appendix B) as a barrier to building peer mentoring relationships. The overarching idea behind this theme is that participants mention difficulty in knowing how to find a peer mentor or even in knowing what a peer mentor is, which also includes lacking the opportunity to build and develop a peer mentorship. One simple participant response that sums up what this coding theme was all was “Not knowing where to start” (Q9, Participant 105). This can entail that the participants “did not know that they existed” (Q9, Participant 145), meaning they did not know that peer mentors were an option, a lack of “College of Engineering advertisement for it” (Q9, Participant 111), meaning they didn’t know about the small existing program, or simply that students “do not know how to find a peer mentor or connect with someone who could be my mentor” (Q9, Participant 146).

One of the main ideas behind the responses given by participants was based upon the “lack of connections to people who could serve as a peer mentor” (Q9, Participant 31). Four of the mentions were specific to transfer students, such as “Being a transfer student, it can be challenging to make new connections” (Q9, Participant 27). Many mentioned that they just do not have the opportunity provided for “meeting people” (Q9, Participant 103), specifically meeting other students who are older than them, which is tied to the common perception that mentors are older. The following quote from a participant is representative of this, which states, “I don't meet a lot of people who are a grade ahead of me, and having somebody in the same year doesn't feel like a mentorship to me” (Q9, Participant 4).

Another common concern stated by participants was that they do not know what they need from a peer mentorship and what questions/concerns would be addressed, such as this participant who asked, “What do I want to know from them? I am not even sure what path I want to take” (Q9, Participant 80). Another participant stated that “I also have trouble identifying where I need help, so I wouldn't know where to start when asking for help with a mentor” (Q9, Participant 43).

An interesting, unique barrier mentioned is the balance between being a mentor and being mentored. Older students felt that they should be mentors, but also still have needs that exist that must be met, such as was emphasized by the student who stated, “I feel like I’m old enough in the program to be a mentor, yet I would still love someone to mentor me” (Q9, Participant 113).

Overall, the complexity of this theme is summarized well in the following participant’s response, which stated, “I don't really know what a peer mentorship entails. Do I just walk up to someone and ask if they want a mentor? Or want to be one? And then what do they actually do?” (Q9, Participant 92).

5.2.1.3 Theme 3: Personal Priorities, Habits, & Preferences

There were two main code categories that fell under this theme of personal priorities and preferences, which were time (Code 1.3, 25 occurrences, Appendix B) and social habits, fears, or desires (Code 1.6, 39 occurrences, Appendix B). This theme included either specific or general mentions of not having time to build a mentoring relationship or expressing barriers connected to their personal social habits, fears, or desires relating to developing or maintaining a peer mentoring relationship.

Many participants who mentioned time as a barrier simply said they had a “lack of time” (Q9, Participant 125), were “very busy” (Q9, Participant 132), or they had a "complicated schedule" (Q9, Participant 170). Other participants mentioned specifically what was a burden on their time, such as external work, homework, family responsibilities, and extracurricular activities. An example of a participant response that is representative of the consensus of the time barrier, both as it pertains to mentors and mentees, is as follows:

> Just having the time to dedicate to working with a peer mentor is the biggest barrier. It is hard work with other people's busy schedule and my already busy schedule to find time to meet and study or work through things I am struggling with. (Q9, Participant 5)

Along with time and personal priorities serving as a barrier, related to that are a person's social habits, fears, and desires since this is very individually based and governs priorities, preferences, and needs. One of the ideas shared was the fear of feeling like a burden in their mentoring relationships, such as the participant who wrote, "I would say that the hardest part of a peer mentoring relationship is trying not to drag your peer mentor down with you when you're struggling" (Q9, Participant 26). This was also shared from the mentor's perspective by the participant who mentioned, "I would not be the greatest peer mentor myself because I do not know of many resources to help engineering peers and I do not have many connections. I am still trying to figure this out myself" (Q9, Participant 64). This indicates the importance of the training portion of the peer mentoring constructs. It also suggests the dual responsibility that mentors and mentees have in such a relationship.

There is also fear tied to a confidence in a peer mentoring relationship and a general fear of the relationship failing. This was emphasized by the participant who said they were, “Nervous that someone else won't understand my mindset about school and Engineering in particular; maybe they'll end up adding to my stress load instead of helping” (Q9, Participant 151). Participants also mentioned that they, “don’t feel confident to get someone” (Q9, Participant 117).

A popular response was with regards to being socially awkward, anxious, shy, introverted, or disinterested. The following response from a participant emphasized multiple facets of this concern:

> I'm shy and and generally keep to myself in class. Even before Covid, I didn't know very many people in my engineering classes. I also never express when I am confused about a topic, so I just try and figure it out myself. (Q9, Participant 188)

Others mentioned as well that they “don’t socialize” (Q9, Participant 130) or that they simply need to “be more friendly” (Q9, Participant 3).

5.2.1.4 Theme 4: COVID-19 Pandemic

Since this was the most mentioned code category and did not closely relate with other code categories, the COVID-19 code (Code 1.4, 106 Occurrences, Appendix B) was its own theme. Participant responses coded in this category were for any mention about something related to the COVID-19 pandemic. This could be a direct statement about the pandemic, or it could be something stated that was a result or consequence of the pandemic. Examples of these are “In the covid era it is difficult to meet people when you lack in person classes” (Q9, Participant 13), “Covid-19. Nuff said” (Q9, Participant 136), or “The pandemic has obviously been a barrier in my relationships with other students this semester” (Q9, Participant 99).

An indirect or implied statement related to this theme was related to a consequence or result of the pandemic, such as social distancing, online learning, and lack of in-person contact. A verbatim example from a participant states that, “Since meeting with people outside your household is currently discouraged, it is difficult to meet new people. It is also difficult to talk to my classmates because everything is online” (Q9, Participant 213). The principle behind these indirect statements was related to the pandemic because the primary learning method of these students outside of the pandemic would be face-to-face classes and in-person activities. The participants used wording that was directly related to the pandemic, but they did not use the specific wording calling out the pandemic, such as statements like “Zoom university” (Q9, Participant 201). This statement would be confusing and not applicable outside of the context of the COVID-19 pandemic.

Overall, this theme emphasized that students felt very hindered and held back in building relationships because they are primarily online for classes and socializing. One participant stated simply, “Being online and not seeing anyone makes it virtually impossible to establish peer mentoring relationships by myself” (Q9, Participant 7).

This suggests that students need help establishing peer mentoring relationships, especially while navigating new and unfamiliar experiences.

5.2.1.5 Theme 5: No Need, Benefit, or Barriers

There were two main code categories that fell under this theme of no need or benefit (Code 1.7, 19 occurrences, Appendix B) and no barriers (Code 1.8, 9 occurrences, Appendix B). This theme simply incorporated all responses where participants stated that they did not have barriers or do not see the need and benefit for peer mentorship.

Multiple participants simply said the barriers to peer mentorship were that there were not any. It should be noted that these responses came equally from both those who indicated they had a peer mentor and those who did not. Many students voiced that they “don’t really care to find one” (Q9, Participant 69) or “feel no pressing urgency to meet my assigned peer mentor” (Q9, Participant 67). Some of the ideas shared stemmed from similar principles that have been discussed in previous sections, such as dealing with the age of the participant. “I am a senior and not looking for advice from any of my peers here” (Q9, Participant 81). Others expressed being satisfied with their current informal relationships, such as the participant who mentioned that “the tight network of people I have met through my minor are far more valuable networks than peer mentors in engineering” (Q9, Participant 158).

Participants also mentioned not really knowing why they need a peer mentor when they did not really have a lot of needs or questions. This was exemplified by the participant who said the barrier to peer mentorship was “Feeling like I dont need someone, only having specific questions that may only take a minute to answer” (Q9, Participant 207). This may originate from a lack of understanding about definitions, benefits, and roles within peer mentorship.

5.2.2 College of Engineering Support (Q10, Appendix A)

As a reminder, this qualitative question stated, “In what ways could the College of Engineering support you in establishing peer mentoring relationships?” (Q10, Appendix A). From participants’ responses, the four main themes that arose are discussed below.

5.2.2.1 Theme 1: COVID-19 Pandemic

This theme originated from the code pertaining to participants mentioning the COVID-19 pandemic (Q10, 22 occurrences, Appendix B). As in Q9’s coding with COVID-19, this could have been either a direct mention of the COVID-19 pandemic or it could be indirectly mentioned as the results or consequences of the pandemic. These mentions could be tied to other forms of support, which will be discussed in the other themes for this question, or it could be tied solely to COVID-19.

Some participants expressed that here was, “Not much we can do during COVID-19. I'm too paranoid of getting coronavirus to go meet new people to establish those kind of relationships" (Q10, Participant 2). Many wanted the College of Engineering to "not be locked down by covid?" (Q10, Participant 16), "Get rid of COVID" (Q10, Participant 36), or "cure covid so we can meet in person and have more engineering activities" (Q10, Participant 67). As was to be expected, students felt limited in being able to reach out to other students and wanted more communication from the College, which was emphasized by this participant who thought the College of Engineering could support "By reaching out more to connect with students during the current pandemic that has made it hard to get to know more students within the same major" (Q10, Participant 24). Participants just wanted to be able to have "in person classes, so you can meet people" (Q10, Participant 162) and "face to face meetings, classes, clubs, etc." (Q10, Participant 157).

There was an overall sentiment amongst participant responses that the lack of peer mentorship was "all do to COVID" (Q10, Participant 154). As a summary for the theme, students overall wanted more support in navigating the virtual realm that came along with the COVID-19 pandemic, which was summarized well by the participant who answered that the College of Engineering "could improve virtual help as COVID has made it difficult to establish those relations" (Q10, Participant 14).

5.2.2.2 Theme 2: Not Sure or Nothing

This theme originated from the code pertaining to participants mentioning that they were not sure what the College of Engineering could do or did not think the College of Engineering should do anything to support their peer mentoring efforts

(Q10, 46 occurrences, Appendix B). They may have not known or had an idea, or they thought the responsibility was on themselves to build peer mentoring relationships.

First presented are the participant responses that related to the College of Engineering not being able to do anything or that it is not the responsibility of the College to support peer mentoring relationships. One participant said, “I don't think the College of Engineering can do anything that is actually effective to establish this type of relationship” (Q10, Participant 1). Specifically, participants were concerned about the authenticity of relationships that the College of Engineering would create and support, such as the participant who said, “I'm not sure honestly. It's hard for an organization to establish that organic relationship that is comfortable for the majority of people” (Q10, Participant 7). Participants communicated that “A classmate, roommate, coworker of friend could be a better peer mentor” (Q10, Participant 48) versus an assigned peer mentor. This brought forth the idea that the definition of an effective peer mentor may just be a trusted friend, which was emphasized with statements like, “The College of Engineering can’t make friends for me. It’s something I need to do on my own” (Q10, Participant 89).

Some participants “think the College of Engineering is doing a good job of helping establishing peer mentoring relations” (Q10, Participant 14). Overall, the following participant response summarized these thoughts about the College of Engineering’s efforts and what was expected for their support:

> I think that the tutor lab does a good job of doing this. I've gone in, asked for help, made friends and learned a lot from the tutors that work there. Also, at the end of the day, I don't think it's the school's responsibility to make friends for me, and I need to learn to seek help and reach out to people of my own accord. I think the resources already available are sufficient. (Q10, Participant 34)

Whether it was not something they had thought about before or may still not fully understand about what constitutes peer mentorship, many students were “unsure” (Q10, Participant 211) and said, “I don’t really have any ideas” (Q10, Participant 143). Some students stated being satisfied with their peer mentoring experiences, whether the College of Engineering played a role in that or not, such as the participant who currently has a peer mentor and mentioned “I don't think there is much more that could be done, I have been very satisfied with my experiences dealing with peer mentors” (Q10, Participant 54). In this realm, the College of Engineering may still be able to facilitate spaces for organic and meaningful peer mentorships to form for more students.

5.2.2.3 Theme 3: Create, Advertise, & Facilitate Opportunities

This theme included the largest portion of codes within Question 10, which was College of Engineering support being in the form of creating, advertising, or facilitating opportunities (Q10, 154 occurrences, Appendix B). This theme contained a large breadth of ideas and efforts that could be made by the College of Engineering with a specific focus on anything outside of the classroom.

The most basic of the suggestions was to introduce students to what peer mentorship is and what efforts are already being made at the college level. One participant said, “If we have a program, I’ve never heard of it” (Q10, Participant 4). Another said, “This is the first time I’ve even heard the term ‘peer mentor’ so maybe start by just introducing it” (Q10, Participant 15). The terms of peer mentor, tutor, friend, and fellow students were used fairly interchangeably, introducing a lack of understanding in what actually constituted peer mentorship.

Many of the responses dealt with the College of Engineering giving opportunities for students to organically meet one another. They wanted the College to “encourage us to get to know each other” (Q10, Participant 9) and provide “Just more opportunities to interact with people in engineering from the beginning” (Q10, Participant 22). This is especially important in giving “More opportunities to network with upperclassmen that are not during common classes” (Q10, Participant 37). They also want “socials with small groups” (Q10, Participant 12) and, in general, “ways to communicate with students outside of the classroom for help and friendship” (Q10, Participant 42). This all comes down to the ability to network through formalized events, which was emphasized by the participant who said the College could support their peer mentorship efforts by, “Holding networking events for people throughout the college or major to meet others with like interests that are at different stages in their degree (Q10, Participant 63). Though the College of Engineering hosts many social and professional development events, the events are not intentionally designed around notions of peer mentoring efforts. There are opportunities to integrate peer mentorship into these existing events to develop authentic and lasting peer mentoring relationships.

Suggestions also included creating some sort of platform or list where students could express their interest in being a peer mentor or mentee, or they at least wanted a centralized venue where students could reach out to get questions answered by other students. This included a “volunteer tutoring database that was published and organized based on course” (Q10, Participant 167). Another example came from the following response:

> I think if there was a platform for juniors and seniors to say what they're interested in, and that they wish to be mentors, and for younger students looking for a mentor to be able to say what is important to them in a peer mentor and have them assigned based on their answers, that could facilitate establishing peer mentor relationships. (Q10, Participant 190)

Students would like a balance of the College of Engineering providing structure and support, but also allowing for flexibility if something in the relationship did not work out. This was emphasized by the participant who mentioned, “Assign one, and if I met someone I would rather be my mentor for the situation or something, we could switch it out” (Q10, Participant 51). This was further emphasized by the following participant response:

> There needs to be a way to group students long enough together that they learn to trust each other and can talk openly. Those groups need to be able to change

> periodically so engineering students can meet more friends. This needs to be enforced loosely enough that I don't feel coerced into working with my group, but also tightly enough that I don't forget they're there. That I gain experience learning with and from them. (Q10, Participant 60)

Some participants suggested implementing more concerted efforts through clubs and student organizations to form authentic peer mentoring relationships. One participant said, “I think that having student organizations to participate in helps, because the best mentors are just good friends” (Q10, Participant 71). It was also suggested that mentors have monetary incentives or payments for their involvement. A participant stated the following with regards to expanding and building a peer mentorship program:

> I wonder if there is potential to expand mentorship beyond E-Council through the tutoring center and ambassadors in the College of Engineering as part of their paid responsibilities (with a commensurate pay increase for their additional responsibility). Most students in these organizations are Juniors and Seniors, and it could be a way to help mentors pay more attention to mentoring as part of their paid responsibilities. (Q10, Participant 212).

Overall, participants wanted a “place where students who are interested in peer mentoring could go to get study groups etc. with online school would be very helpful” (Q10, Participant 35) and that the College should “Expand the mentorship program to include all levels, such that a senior can be a mentor to a senior” (Q10, Participant 32).

Whether participants thought peer mentorship should be expanded formally through "assigning peer mentors for all the students" (Q10, Participant 176), providing "more socials and opportunities to meet other students" (Q10, Participant 164), increasing "group work areas" (Q10, Participant 36), or simply "reaching out to the student, notifying them of peer-mentorship opportunities" (Q10, Participant 24), the overall consensus was that the College of Engineering could be of support to peer mentoring efforts.

5.2.2.4 Theme 4: Classroom Support & Encouragement

This theme focused on efforts that the College of Engineering could make to support peer mentorship efforts through classroom support and encouragement (Q10, 30 occurrences, Appendix B). These were unique from creating, advertising, or supporting opportunities because the focus was specifically on efforts within the classroom, which may be more focused on teaching efforts and strategies versus general College efforts.

An interesting point brought up by two participants was the size of engineering classes. The students suggested that "engineering class sizes are so big that potential mentors would have a hard time picking out those in need" (Q10, Participant 188). Even in larger classes, students wanted more faculty to facilitate "Breakout sessions in classes" (Q10, Participant 12) and that encouraging "study groups in more classes (not discouraging them) would get more students to work together and build friendships" (Q10, Participant 47).

A surprisingly common occurrence was participants mentioning the desire for "More group projects in class to learn how to work together with our peers" (Q10, Participant 61). While this may be a desire to only have "a slight increase in the number of group-oriented assignments" (Q10, Participant 8), students recognized the value of group projects giving "ways to meet someone in your classes especially when most classes are online and you don't see people face to face" (Q10, Participant 10).

Overall, students wanted faculty and the college as a whole to "Encourage them in classes" (Q10, Participant 42) with regards to peer mentorship efforts. Whether that comes through "Classes where students actually have some time to meet and work with their peers" (Q10, Participant 28), giving "group assignments where we pick our groups" (Q10, Participant 68), or assisting "to setting up study groups within courses" (Q10, Participant 201), students see the value in classroom initiation and encouragement of peer mentorship efforts.

5.3 Integrated Qualitative and Quantitative Analysis

After analyzing both quantitative and qualitative data, lines of integration were explored to determine those priority elements that should be the focus of future peer mentoring initiatives (Research Question 3). There were three critical points of integration recognized across the qualitative and/or quantitative analyses: lack overall of knowledge and support, COVID-19 pandemic, and no need, benefit, or barrier. This integration is summarized in Table 23. Each of these will be discussed individually with representative quotes.

Table 23

Summary of Points of Integration

Point of Integration	Q9 Qualitative Themes	Q10 Qualitative Themes	Quantitative	Training and Matching/Initiating Priorities
Lack of Overall Knowledge and Support	• Lack of Knowledge or Opportunity • Perceived Deficiencies • Personal Priorities, Habits, and Preferences	• Create, Advertise, & Support Opportunities • Classroom Support & Encouragement	• Factors 1, 4, 5, and 6 (psychosocial and academic career support roles) were the highest in the factor mean comparison	• Teach what peer mentorship is & its importance • Provide resources on finding & maintaining peer mentoring relationships
COVID-19 Pandemic	• COVID-19 Pandemic	• COVID-19 Pandemic	• Factor 1 (Psychosocial Support Roles) was the highest mean value	• Communication about building relationships & connecting, especially virtually & during crises situations • Guidance in building comfortable and trusting relationships with other students
No Need, Barrier, or Benefit	• No Need, Barrier, or Benefit	• Not Sure or Nothing	• 14 (6.3%) participants answered 10 (47.6%) or more questions as "Neither Agree or Disagree" • 88 (39.5%) participants answered 5 (23.8%) or more questions as "Neither Agree or Disagree"	• Provide spaces to where authentic personal mentoring relationships can form

5.3.1 Lack of Overall Knowledge and Support

While this category is general and could garner a much more detailed breakdown and analysis in the future, students gave an overall sense that there is a lack in understanding of what peer mentorship is, why peer mentorship is worth the time, how to find and maintain a peer mentor, and what the College of Engineering can do to better support students in combatting these barriers. As was evident from the factor mean comparison, students ranked the psychosocial support and academic career support roles as higher than the mentor/mentee matching. This indicates the prevalence of student needs for information, guidance, and support, regardless of who it comes from.

This category of integration included many of the themes for both Q9 and Q10 (as indicated in Table 23), which further showed these student needs for increased knowledge and support because of a lack of overall knowledge and support. For Q9, these included lack of knowledge or opportunity, perceived deficiencies, and personal priorities, habits, and preferences. For Q10, these included creating, advertising, & supporting opportunities and classroom support & encouragement. Representative quotes for both Q9 and Q10, which summarize the overall lack of knowledge and support from students, are provided in Table C-1 (Appendix C). Emphasis through bolding has been added to these quotes to show important commonalities that existed throughout the responses that relate to the lack of overall knowledge and support. These responses were chosen specifically because they gave a good idea of how the responses to Q9 and Q10 could be integrated to determine priority needs for developing future peer mentorship initiatives.

Overall, in the qualitative responses to Q9 and Q10 (Appendix A), it was noticed that many of barriers and suggested ways for the College of Engineering to support peer mentorship relate to the lack of prioritization and emphasis of importance of peer mentorship both on a personal level and at the college level. Time (Q9, Participants 31 & 60; Q10, Participants 178 & 189) was viewed as a barrier to participants because they did not know the importance of prioritizing peer mentorship ahead of other activities, which partly may be attributed to the College of Engineering not advertising, supporting, or encouraging students (Q10, Participants 155, 166, 184). Students may feel like there may not be someone who can or will mentor them adequately (Q9, Participants 31, 53, 113, & 185), which may partly be attributed to the College of Engineering not providing advice, training, and facilitation in how to find a peer mentor or giving students access to students who could serve as a peer mentor (Q10, Participants 155, 166, 175). Overall, students felt inadequate (Q9, Participant 60) and needed additional promotion and encouragement of peer mentoring resources (Q10, Participants 178 & 184).

5.3.2 COVID-19 Pandemic

While this was a very event-based category (data collection during COVID-19 pandemic), very important ideas and implications arose from this category. The representative quotes are shown in Table C-2 (Appendix C). These quotes are shown by individual participant.

The essence of the COVID-19 experience found in these representative quotes (Appendix C, Table C-2) emphasized that participants felt that they needed to be on campus having face-to-face interaction, or least they needed intentional support in meeting others by virtual means. Participant attitudes trended towards the idea that having in-person interactions would overcome the barriers of not being able to establish peer mentoring relationships, though as evidenced from the previous integrated analysis category of lack of overall knowledge and support, this is likely not a COVID-19 specific problem. This will be discussed further in the next chapter. Regardless, students felt they needed encouragement and support in knowing how to navigate building relationships with others while functioning primarily virtually.

The quantitative portion of this dissertation study that ties into this category of integration is the finding that Factor 1, which was related to psychosocial support roles, was the highest mean (Figure 18 and Table 18). As a reminder, this factor included items related to feeling sure about major choice, setting goals for a future in engineering, gaining persistence strategies, and developing time-management skills to meet engineering course demands. These psychosocial support roles are focused on developing emotionally and psychologically (NASEM, 2019), which are likely perceived to require a personal connection by someone who cares. Many likely envision this support to originate as in-person because of the typical delivery of engineering courses at this institution. Participants also mentioned study groups (Q9, Participant 150) and group projects (Q10, Participant 10), which are situations where personal, trusting relationships can be built. Though they may not always qualify as peer mentorships, students may receive a level of interpersonal comfort and mentoring that will support these psychosocial support roles.

5.3.3 Lack of Need, Benefit, or Barriers

The third category of integration was the lack of need for peer mentorship or support from the College of Engineering. Quantitatively for this point, 14 participants answered 10 (47.6%) or more of the 21 questions as “Neither Agree or Disagree” and 88 participants answered 5 (23.8%) or more of the 21 questions as “Neither Agree or Disagree”. While this constitutes only 6.3% and 39.5% of participants respectively there appears to be a level of passivity and lack of strong opinion by these participants on at least 23.8% (i.e., 5 out of 21) of the validated questions.

These quotes are included in Table C-3 where it is mentioned that the College of Engineering does not really need to play a role in peer mentoring efforts (Q10, Participants 89 & 223) and that students did not feel a desire (Q9, Participant 69) or pressing need (Q9, Participant 211) for peer mentoring. Some participants also thought that the College of Engineering was doing a fine job already (Q10, Participant 195) and there were responses for both Q9 and Q10 that were just about not knowing or no barriers, again showing a level of passivity and a lack of priority placed on peer mentorship. While these participants did not perceive a need for the College of Engineering to be complete facilitators and initiators of these relationships, the college can still facilitate spaces for more students to be able to build authentic peer mentoring relationships.

5.3.4 Summary of Priority Areas as Told by Students

Based on the integrated analysis presented above, the following priority student perceived needs were summarized for what should be the focus moving forward in developing peer mentoring initiatives with relation to training and matching/initiating:

1. Provide information about the importance of peer mentorship in their degree. Students need a reason to prioritize peer mentorship.

2. Facilitate the formation of authentic peer mentoring relationships through formal (programs, classrooms) and informal (socials, study spaces) avenues where peer mentoring is encouraged and promoted.

3. Train faculty and staff to communicate the importance of peer mentorship in their in-person and virtual classrooms and meetings.

4. Help potential peer mentors, advisors, staff, and faculty get training in supporting other students emotionally, mentally, socially, or academically through existing campus resources (e.g., Office of Student Affairs).

CHAPTER VI

DISCUSSION

The purpose of this chapter was to discuss the implications to the results and emerging themes pertaining to each research question involved in this dissertation study. For this study, the research questions guided the development and validation of a research instrument to determine student needs relating to peer mentorship in engineering. After validation, the data from the survey was analyzed and explored for emerging findings that can impact future peer mentoring initiatives in the College of Engineering of interest.

6.1 Participant Identifier Relationships Around Perceptions of Needs

While the difference in GPA between those who had a mentor versus those who did not have a peer mentor was only 0.1 points, with the findings confirming previous studies (Budny et al., 2010; Campbell & Campbell, 2007; Gattis et al., 2007; Good et al., 2000; Leidenfrost et al., 2014) that found mentored students had a higher GPA. It is anticipated that this result may be more pronounced with this instrument with a larger sample size as well as by obtaining actual GPA instead of self-reported GPA since there may be a source of participant bias present (Cassady, 2001; Schwartz & Beaver, 2015).

Overall, in the quantitative results, it was found that participants are more concerned about the potential outcomes of peer mentorship in providing support for both psychosocial and academic career support roles compared to who is providing that mentorship. This may be the result of a lack of existence of mentorship (for those who have not had a mentor) or a lack of benefits from mentorship (for those who have had a mentor). Students are looking for support, regardless of who is providing it (e.g., faculty in traditional mentorship, peers in peer mentorship). It is acknowledged that those who identified as women had more of a tendency to need matching when it came to first-generational status (Figure 22), which may be more apparent with other participant identifiers in a larger or more diversified population as to prior studies from other scholars (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017). That being said, by participants more strongly agreeing with the importance of psychosocial support and career support versus participant similarities in identifiers, there is evidence that mentors and mentees who strive to mutually benefit and support one another despite their weaknesses or differences (Ensher et al., 2001; NASEM, 2019).

The result of psychosocial support and career support being more essential than participant similarities in identifiers does not speak to the interpersonal comfort that may be present in relationships that are gender or race matched (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017), and it alludes again to the difficulty of having students report their needs versus their wants (McGregor et al., 2009) since needs may not focus on the interpersonal comfort aspect of a peer mentorship. This difference between students' perceptions of essentiality (i.e., needs) versus nice-to-have (i.e., wants) is something that could be explored in the future in a mixed-methods manner around what students foundationally need, but also want in peer mentoring relationships.

6.2 Common Experiences Around Needs

Within participant responses to the survey instrument, the barriers to peer mentorship aligned consistently to the commonly found barriers in mentorship (Table 1, Chapter 2, Section 2.1.2). These included lack of time, lack of motivation, lack of support, difficulty in finding a suitable peer mentor, mismatched or inflexible expectations, and needs. The stark and concerning difference was that the studies where common barriers were extracted from (Leary et al., 2016; NASEM, 2019; Pieterson & Ridgway, 2019; Sambunjak et al., 2010) consisted of primarily evaluation-based studies, looking into past or current mentoring relationships. In this dissertation, only 35% of the student participants claimed to have a current peer mentoring relationship (Figure 12, Chapter 3, Section 3.4.1), yet the barriers and concerns are the same. These findings may suggest that, based on evaluation, existing programs may not have adequately focused on participant barriers, needs, and concerns in the design of the program(s) and instead focused on determining programmatic issues (Crisp & Cruz, 2009). Funding for programmatic efforts may have influenced the way the program was developed instead of focusing on designing based on needs (Altschuld & Watkins, 2014).

When considering support, participants especially emphasized themes surrounding the training and matching/initiating constructs as were suggested by

Garringer et al., (2015). Students being trained and informed in peer mentorship is critical in forming, sustaining, and succeeding in mentoring relationships (Garringer et al., 2015) because, from this dissertation's findings, students confirmed they were lacking in their overall knowledge, definitions, and access to peer mentorship, both in formal programming in the College of Engineering as well as in classroom initiatives.

Both participant responses in this study and what has been found in the literature suggest that mentors and mentees need authentic mentoring. Authentic mentoring relationships are a "voluntary and ultimately personal relationship between two individuals. No one can mandate and monitor such a relationship. Much more is involved in mentorship" (Davis Jr., 2001). In order to encourage participation in and sharing of information around the notions of peer mentoring, the current regimented implementation and practices in mentorship must be revisited and revised to encourage authentic relationships that are prioritized but not forced (Davis Jr., 2001). Authenticity can be sensed in mentoring relationships and allows for comfort in expressing difficulties, which results in an enduring mentoring relationship (Fries-Britt & Snider, 2015).

Ultimately, structure may be needed, especially in finding and building peer mentoring relationships as well as providing access to all students for peer mentorship (discussed further in the next section), but the relationships must be adapted and adjusted as changes happen in the mentor and mentee's situations (Weinberg, 2019). This suggests that the College of Engineering should be focused on cultivating authentic peer mentoring relationships by formalizing facilitation, encouraging, and creating equal access to peer mentoring, but not forcing peer mentoring relationships through excessive and inflexible formalization.

6.3 Priority Student Communicated Needs

Many of the findings discussed with the quantitative and qualitative sections above apply to the integrated discussion, but two additional unique perspectives resulting from the integration are (1) goal orientation (Kaplan & Maehr, 2006) and future time perspective (Kooij et al., 2018) of the students; and (2) hidden curriculum (Kentli, 2009) implications and how that applies to accessing peer mentorship by students.

In the quantitative results in this dissertation, psychosocial and academic career support roles were statistically significantly higher in essentiality than mentor/mentee similarities in characteristics and attributes. This finding speaks to the necessary focus on training initiative aspects of a peer mentorship program. Yet, students emphasized in the qualitative analysis the lack of understanding why peer mentorship is important and how to make it happen, which suggests the importance of the initiation standard of practice for a peer mentorship program. These findings suggest that students know what type of support they need and have a vision of what they need to accomplish but may not understand why peer mentorship is important, how to form peer mentorships, and how this form of mentorship may support them in those roles.

6.3.1 Mastery Goal Orientation & Future Time Perspective

Mastery goal orientation is referred to as the purpose that one has with regards to personal development, which can affect behavior and engagement (Kaplan & Maehr, 2006). This type of goal orientation refers to the *why* of someone's developing competence and focuses more on learning, understanding, developing skills, and mastering information (Kaplan & Maehr, 2006). This is in contrast to performance goal orientation where a person is more focused on how others will perceive your demonstrated competence (Kaplan & Maehr, 2006). It has been found that mentors and mentees gained more positive support in their mentoring relationships when they (i.e., mentor, mentee, or both) received training and had higher levels of goal orientation (Scielzo, 2008). Goal orientation can help mentors and mentees to be successful in their mentoring relationships as well as in their general career outcomes and development in addition to receiving the highest levels of psychosocial support (Godshalk & Sosik, 2003; Scielzo, 2008). By providing training to mentors and mentees before they engage in peer mentoring relationships can provide both the vision for what the goals of peer mentorship are as well as supporting them in the matching/initiating stages of the peer mentorship program development.

While it is important to help people determine the *why* of mentorship, future time perspective (FTP) must be considered. FTP is the recognition that people will react and perceive things differently depending on their current situation, which shifts throughout time (Kooij et al., 2018). Anticipated time left and anticipated future experiences can make a difference in perceptions of needs (Kooij et al., 2018).

Depending on how participants feel about their future time, they may prioritize goals differently (Lang & Carstensen, 2002), which may be discerned through their survey instrument responses. This future time perspective was especially evident in the qualitative findings where there were multiple mentions that students who were seniors did not feel that there was any need for or anyone available for peer mentorship that they could trust (Participants 13, 76, 81, 95, and 166). The views shared from seniors were different compared to younger students who have more time ahead of them and who may not know where to find a peer mentor but need the support. While both upper and lower level undergraduates in engineering may both have mastery goal orientation instead of performance goal orientation (Kaplan & Maehr, 2006), their perceived remaining time in their degree may override in their prioritization of peer mentorship. Those who have a stronger FTP may also have a stronger vision of the benefits of mentoring, which may not be immediate or tangible compared to those who may not have a vision of their future time (Kooij et al., 2018). Within FTP research, it has been found that when psychosocial goals are prioritized, social satisfaction was increased (Lang & Carstensen, 2002). This is an encouraging finding since students prioritized the psychosocial support roles as most essential, as shown in the quantitative findings of this dissertation.

6.3.2 Hidden Curriculum

As was mentioned in the abstract, “Nobody makes it alone. Nobody has made it alone” (NOVA SHRM & Dulles SHRM, 2012, p. 5). This is a widely accepted and well-known thought, but much of the knowledge and opportunity relating to fulfilling this is unwritten. Especially within the College of Engineering studied in this dissertation, mentorship in general but peer mentorship specifically seems to be a unique aspect of hidden curriculum. Curriculum in courses is consciously and formally planned and explicitly listed (e.g., lesson plans, syllabus, accreditation), yet "curriculum" relating to mentorship has a lack of formality, planning, advertisement, and continuity (Kentli, 2009), and as such, is considered "hidden". This hidden curriculum is even more pronounced when looking at virtual peer mentoring, which was emphasized by the participants in the qualitative findings that they felt they had to be face-to-face to have a meaningful peer mentoring relationship.

A student's norms may affect how they approach the hidden curriculum and socially supported ideas (Kentli, 2009) that peer mentorship is important in their success. While some schools of thought may posit that mentorships need to be authentic and not forced or monitored (Davis Jr., 2001), it is important that the departmental and college cultures create an environment and framework of training and matching/initiating within peer mentorship, as they are key components to messaging and resource allocation of collective student support and success (Villanueva et al., 2020, 2018).

6.3.2.1 Virtual Learning

While some participants mentioned needing to be face-to-face for peer mentoring relationships, the COVID-19 pandemic has elevated greater consciousness of the need for virtual/online peer mentorship. COVID-19 was a worldwide pandemic, where institutions of higher education and society may have not been prepared to facilitate learning, let alone peer mentoring relationships, online. At the same time, as a new normal may surface because of this pandemic, colleges will need to recognize that in the future, more and more students will be involved in some form of virtual/online training. For example, in the United States, the total number of students studying solely on campus has decreased by 6.4% from 2012 to 2016, yet the percentage of students taking at least one distance course grew by 17.2% between 2012 and 2016 (Seaman et al., 2018). Tied to these increases are the forms of practice-based strategies that have been created by online educators to maintain or even increase interactions between students versus traditional modes of delivery through intentionality, purpose, and planning (Arbaugh, 2002; Bowman, 2001; Hay et al., 2004). From the findings of this dissertation, it is proposed that meaningful and intentional spaces for peer mentorship can and need to be facilitated. This facilitation both inside and outside of the classroom can benefit more students, but particularly underrepresented students (e.g., first-generation women) in undergraduate engineering education.

6.4 Peer Mentorship Implementation

It is known that "in the real world, there is never enough money to meet all needs [but it can serve] to help program planners identify and select the right job before doing the job right" (Office of Migrant Education, 2001, p. 2). While the mixed-methods instrument was critical in determining needs and prioritizing solutions or strategies, it may not be practical to collectively identify and meet all solutions and student needs simultaneously. There may be budget, timing, and staffing limitations that can limit the ability to implement programs as well as the quality of those programs. In addition, students “with different background and educational experiences (e.g., racial/ethnic group and first-generation status) may have somewhat different mentoring needs, perceptions, and experiences” (Crisp et al., 2017, p. 75). As such, this makes decision-making about what elements of a peer mentorship program to focus on a bit more burdensome as not all populations may be considered in the formation of such a program and there may not be enough funding, staffing, or time to implement effective programming to meet all needs. The availability of budget, timing, and staffing must be analyzed regarding the specific context of implementation and are not within the scope of this dissertation. However, by identifying essential yet common experiences from students through the qualitative questions, which were explored in this dissertation, it was the hope of this researcher that administrators can take a more intentional approach to leverage existing campus resources to implement small but effective efforts.

When considering the implementation of a new initiative or program, the management of that project must be seriously considered. A simple, standard way to frame project management is by using the project management triangle, also known as the Iron Triangle, which can portray the success of a given project (Pollack et al., 2018; Van Heerden et al., 2016). The three points of the triangle are quality, cost, and schedule, which ideally will be balanced, but in most projects tend to be unbalanced with a bias toward cost and schedule with the expense being quality (Van Heerden et al., 2016). While it is nice to know the priority elements that need to be addressed, the practicality of implementing solutions must be considered.

In knowing the importance of balancing this triangle while still respecting the need for practical implementation, the researcher has formulated three practical, low-cost, and minimally time demanding steps (described in the following paragraphs) to begin with in increasing peer mentoring efforts in the College of Engineering. Because the deficits of mentorship at large can be overwhelming, the aim of this dissertation was to focus simply on peer mentorship to begin the journey of meeting student needs. The following steps focus on how to begin this process.

One step would be to analyze and utilize existing resources on campus (i.e., tutoring center, undergraduate research, clubs, career services, counseling services, Office of Student Affairs) that may be utilized to avoid unnecessarily duplicating a resource. This may also include understanding what resources faculty, staff, and students are aware of and utilizing. By utilizing existing resources that exist in the university at-large, additional cost and staffing can be minimized while still increasing the quantity and quality of peer mentorship.

Another step would be to explore and share the definition and benefits of mentoring for both mentors and mentees. It is well known that mentorship is generally positive for mentees (Campbell & Campbell, 2007; Crisp & Cruz, 2009; Jacobi, 1991; Pfund et al., 2016), but it is also known that the benefits of mentors are also reciprocated in mentors, such as increased career success and satisfaction, commitment to an organization, and performance (Ghosh & Reio, 2013). This could be achieved in simple ways, such as sharing the infographic (Appendix D) created within this dissertation with faculty, staff, and students. Information could be shared in systematic communication methods that already throughout the college, such as weekly emails or advertisements, announcements on learning management systems, etc.

The final step would be to explore ways to formalize existing peer mentorship efforts for a larger population based on already existent resources and programs. This would tie to the second step by advertising and encouraging existing mentorship efforts by faculty, staff, and students. This may include adjusting the prioritization of mentorship in schedules, especially for advisors and faculty who have many demands on their time. It may also include the involvement of peer mentorship in current clubs, events, socials, advising appointments, etc. All these steps will begin to establish a culture of mentorship in the college. As the College of Engineering tries to prioritize and package peer mentorship in a positive and visible manner, this valuable resource of peer mentorship will become more widely available, desired, and used amongst students.

6.5 Limitations

The biggest limitation to this study was that the action stopped at the knowledge-sharing stage and did not proceed to the point of implementation due to time restraints and other administrative priorities. However, it is the hope of this researcher that this dissertation will serve as a solid foundation for seamless peer mentorship program implementation in the future.

The data collection focused only on the training and matching/initiating needs within peer mentorship rather than all six of its constructs (e.g., recruiting, screening, training, matching/initiating, monitoring/supporting, and closing; Garringer et al., 2015). This narrowed down selection was chosen because the constructs related most heavily to student needs are training and matching/initiating (Garringer et al., 2015). While a comprehensive assessment of needs would ideally cover possible aspects of all six standards of practice, for the sake of keeping the study simple yet thorough, the focus was on the two standards of training and matching/initiating.

The instrument and mixed-method study are also limited in the sense that open-ended questions within the quantitative survey were used in place of in-depth interviews with participants. Due to the concerns of interviewing face-to-face with the COVID-19 pandemic and IRB restrictions for privacy on virtual platform interviews (i.e., Zoom), it was decided that open-ended questions within the survey instrument would be a safer way to collect meaningful responses from participants in an anonymized way. It is realized that the depth of detail and information gained from open-ended questions was limited when compared to interviews (LaDonna et al., 2018), but based on the number of participants that responded to this survey in writing to the qualitative questions of this survey, it is safe to presume that adequate qualitative information was obtained to enhance and expound upon the quantitative results. It is important to point out that there are benefits to written, self-administered, open-ended questions in surveys as they can serve to eliminate a level of bias that may happen in an interview where the interviewer can intentionally or unintentionally guide or influence the participant in their responses (Harland & Holey, 2011). While the qualitative data collected were substantial enough to stand on their own without the quantitative data, preliminary understanding was obtained to help with future research and decision-making (Creswell & Plano Clark, 2018; LaDonna et al., 2018)

Because of the limitation of access to participants due to COVID-19, the same set of data was used on both for both EFA and CFA, which was acceptable for this situation, but may pose some limitations. There is not consensus in the guidelines for EFA and CFA, which makes the process of validating difficult (Cabrera-Nguyen, 2010). EFA is the beginning step in building and validating new scales in order to discover factors while CFA is used to confirm the hypotheses of items loading on factors discovered through EFA (Yong & Pearce, 2013). The EFA in this case returned strong results for the six factors, so CFA was warranted, but ideally, CFA would need to be conducted on a new set of data to obtain better confirmatory information and avoid potentially confusing results (Cabrera-Nguyen, 2010; Henson & Roberts, 2006). In the case of this dissertation study, since it was a brand new instrument and the limitation of participant access due to COVID-19, an EFA and CFA analysis in conjunction were justified with a future recommendation to collect a new data set and further confirm the structure of the research survey instrument (Orcan, 2018).

It is also realized that this dissertation study focused on one specific College of Engineering with a limited, convenient population (R. B. Johnson & Christensen, 2017). While the needs that result from this dissertation study may be different from other contexts, the study process is easily transferable to other contexts because it allows readers and fellow researchers to transfer knowledge and tools from this study to their own situation (Maxwell & Chmiel, 2014). This dissertation study was not considered generalizable because it came from a limited population and was instead considered transferable to other similar contexts (Maxwell & Chmiel, 2014).

The dissertation study was also limited in the sense of the relatively small population that was collected. While 223 participant responses were considered adequate, better analyses of the quantitative data, especially with relationships based on participant identifiers, could have been better extracted with a larger set of data. Considering the circumstances surrounding the COVID-19 pandemic, the number of participant responses was acceptable.

Another limitation was regarding the lack of a formal mentoring program, specifically peer mentoring within the College of Engineering studied. Many students seemed generally unaware of what mentorship is, what mentorship looks like, and how they are supposed to be involved in mentorship. When students enter the professional program (which is typically at the end of their second year, beginning of their third year), they are randomly assigned to a faculty mentor. No information, training, support, or structure is given for this mentorship program other than randomly assigning the students to a mentor and emailing the student their mentor's name. From personal experience and as an insider, I do not recall receiving any guidance on how to establish a relationship with a faculty mentor. I suspect a similar experience could be commonly identified among other engineering students in this College of Engineering. The current peer mentorship program is also very limited in its scope and reach, further limiting students' understanding of definitions and approaches in mentorship.

One final limitation recognized in this dissertation study was the difficulty in determining the differences between student needs and wants. This differentiation tends to be a common point of conflict in these types of studies, especially when determining priorities in the use of resources (McGregor et al., 2009). It was also challenging to have participants truly reflect on what they needed versus what they wanted, especially in the context of peer mentorship where outcomes may not be truly representative as participants due to participants' intrinsic motivation to present themselves in a positive light (Campbell & Campbell, 2007; Crisp & Cruz, 2009; Jacobi, 1991; NASEM, 2019; Pfund et al., 2016).

CHAPTER VII

CONCLUSIONS AND IMPLICATIONS

The overall conclusion from this dissertation was that exploring student needs before investing resources and developing any mentorship program is warranted. Past research has primarily focused on evaluation of programs with the goal to resolve programmatic issues (Crisp & Cruz, 2009) instead of gaining a consensus of student needs that have been and need to be met. The transferrable mixed-methods instrument developed, revised, validated, and employed in this dissertation study served as a foundational starting point to this type of exploration. Instead of determining if past initiatives were working by measuring outcome factors, the dissertation served to explore the importance of peer mentoring constructs within a given student's context. The validation of this research survey instrument was also critical in allowing for a rigorous and reliable interpretation of results that came from the study. While limited in its population and with room for future changes in better determining student needs versus wants, critical findings from this dissertation can serve as the foundation to future peer mentorship initiatives.

Students felt that a peer mentor fulfilling psychosocial and academic career support roles was more essential than a peer mentor having similar characteristics or attributes to them, though those who identified as women did give some indication that having someone who was the same first-generation status as them was more essential compared to those who identified as men. Whether this would stand if interpersonal comfort were considered instead of simply essentiality is a potential avenue for future research. The psychosocial support of students was deemed the most critical priority since it was the highest ranked. This finding invites an opportunity for the College of Engineering to provide training to students in order to fulfill these support roles when they are developing and sustaining peer mentoring relationships with one another.

Students who already have a peer mentor indicated higher proportions of disagreement with the importance of encouragement or advice needed to help students feel sure of their major choice than those who did not have a peer mentor, which may be indicative of the type of support that is currently being provided. Those who identified as women indicated that it was more essential for them to have a peer mentor who was the same first-generation status as them. While the population of women was considered representative of what is present in engineering nationwide, both in this College and in general (American Society for Engineering Education, 2020; Office of Analysis Assessment and Accreditation, 2020b, 2020a), a larger population of participants may have further emphasized this relationship, both regarding first-generation status and other participant identifiers. In line with other research, this type of matching on participant identifiers may increase interpersonal comfort, but not necessarily academic or career outcomes (Blake-Beard et al., 2011; Dennehy & Dasgupta, 2017).

Lastly, it was found that the linear relationship for self-reported GPA between those who had a peer mentor and those who did not was statistically significant. Those with a peer mentor had a 0.1 point (2.5%) higher GPA compared to those who did not.

This finding is in line with previous studies indicating that those who had a peer mentor had an increased GPA compared to those without a peer mentor (Budny et al., 2010; Campbell & Campbell, 2007; Gattis et al., 2007; Good et al., 2000; Leidenfrost et al., 2014). This finding further confirms that academic outcomes may be positively impacted by peer mentoring initiatives. It should be noted that this is not implying a causal relationship since there may be other factors at work in this relationship. One potential example of a confounding factor is that of conscientiousness (i.e., desire to do work well and thoroughly), which is strongly correlated with college GPA (Noftle & Robins, 2007). Conscientiousness is also correlated with the desire to engage in social and community improvement behaviors such as mentoring (Ilies et al., 2009; Kennecke & Hauser, 2016). This personality trait could play into the higher GPA found for those who currently have a peer mentor.

With regards to students' common experiences, students indicated that they had hesitations about peer mentoring because of perceived deficiencies (Q9, Theme 1), both in previous relationships and in the current availability of mentors. They also portrayed an overall lack of knowledge about who a peer mentor is, what a peer mentoring relationship entailed, how to balance being a mentor and being mentored, and how to have access to peer mentorship opportunities (Q9, Theme 2). Even if they did understand these aspects, personal priorities, habits, and preferences (Q9, Theme 3) such as time limitations and social priorities (i.e., introverted, fearful, socially awkward) play into the prioritization of peer mentorship.

The unexpected but still critically important finding were the implications of barriers due to the COVID-19 pandemic (Q9, Theme 4). Primarily, this finding implied that being virtual, for whatever reason, was a barrier to peer mentorship. This finding was especially concerning considering that nationwide, the number of students in at least one online class is consistently increasing (Seaman et al., 2018). Also, a small subset of students did not see a need/benefit from peer mentorship or did not report having any barriers to having a peer mentoring relationship (Q9, Theme 5). This finding implies that students in this subset may feel that they must organically build authentic peer mentoring relationship and do not consider rigid, inflexible, and formal programmatic efforts to be beneficial to them. But, overall, majority of participants showed an interest in formalized efforts regarding peer mentorship by the College of Engineering.

When it came to support needed from the College of Engineering, there was also an acknowledgement of the COVID-19 pandemic (Q10, Theme 1). Students wanted the College of Engineering to allow for "normal" College activities to return because they were having difficulty in navigating a crisis situation, such as COVID-19, specifically the struggles with being virtual. This perception may be caused by a lack of recognition and intentionality by the college in opening mentoring spaces, both in "normal" conditions, but especially in the special circumstances warranted by the COVID-19 pandemic. A small subset of students were unsure of what the College could do to help support them in their peer mentorship efforts or thought that the College did not need to play a role in their peer mentorship efforts (Q10, Theme 2).

This again emphasized the need and importance for authentic peer mentoring relationships to be built (Davis Jr., 2001). A majority of students want the administrative framework and guidance, but it should allow for the flexibility to be able to adapt to given situations and the state of a peer mentoring relationship (Weinberg, 2019).

Students emphasized they need the College to create, advertise, and facilitate opportunities (Q10, Theme 3) to better understand what a peer mentorship is, how to form these relationships, and have opportunities to build these relationships. There were many suggestions of how this could be done, but overall, it was emphasized that students needed encouragement (i.e., psychosocial support) and knowledge (i.e., academic career support) in being able to form these peer mentoring relationships. Students also wanted efforts to be made in the classroom (Q10, Theme 4) to better encourage and promote the development of authentic peer mentoring relationships. Surprisingly, students wanted more group projects where they could build these friendships and relationships within classroom environments. They also wanted faculty encouragement and smaller class sizes to further facilitate these efforts.

Additionally, from the integrated analysis, four priority elements were extracted to serve as the primary focus and incorporation of findings for this dissertation. The top priority element was that students needed information about the importance of peer mentorship, giving them a reason to prioritize peer mentorship. This can be encouraged by the College of Engineering providing information, training, and facilitation of peer mentoring relationships and/or events. If the College truly believes that peer mentorship is important and that it can make a difference in the psychosocial and academic career outcomes of students, then their efforts should not be a matter of hidden curriculum (Kentli, 2009; Villanueva et al., 2020, 2018) but instead be explicitly framed to allow the breadth of students, including online students, within the College to have access to peer mentoring instead of a limited population. By providing students the training that they need with regards to goals and a vision for the future as well as acknowledging the different perceptions that students will have, students will have more success in their relational and academic outcomes (Kaplan & Maehr, 2006; Kooij et al., 2018).

As has been mentioned previously students need authentic peer mentoring relationships, which came in as the second priority area of focus. Students cannot do it alone (NOVA SHRM & Dulles SHRM, 2012), but they also know the importance of the authenticity of relationships, which comes from an ability to choose what and how to contribute as well as a flexibility in changing up relationships as needed (Davis Jr., 2001; Weinberg, 2019). The College can do this by emphasizing the importance and providing a framework to all students for the building of these relationships while not micromanaging these relationships (Davis Jr., 2001). This framework needs to be informed by evidence-based findings, such as those found in this dissertation. The College of Engineering can provide spaces to build organic and meaningful relationships in both formal and informal ways (e.g., list of tips for creating and maintaining peer mentoring relationships, hosting socials, available and interested mentor/mentee list, provide group work areas). Even when peer mentoring is not formalized, it is still important.

The College of Engineering also must provide training to faculty and staff so that they can adequately communicate the importance of peer mentorship. This includes both in-person and virtual situations, such as advising meetings and the classroom. If a culture of mentorship is going to be built within the College, faculty, staff, and students must be sufficiently and effectively trained in the importance and how-to of mentorship. It is recognized in this context that there are time impacts on faculty and advisors who may already have full schedules of teaching, researching and/or supporting students. To cope with these demands, two suggestions are given. One is to increase the formal recognition and credit given for mentoring efforts, especially in the tenure process, which may typically remain primarily invisible (Misra & Lundquist, 2016). Effective mentorship is rarely recognized with mentor or mentee awards and it is typically not considered as a separate category to teaching in the promotion and tenure process (Allen et al., 2017; NASEM, 2019). This also can result because "advising" and "mentoring" are equated to "teaching" even though they are not the same. The second suggestion is that time should be built into these faculty or staff's positions to allow for regular mentoring activities (Misra & Lundquist, 2016). Faculty and staff's demands for time and their responsibilities in higher education may affect their availability to students outside of the classroom (Allen et al., 2017)

Lastly, students need support and would like additional communication from the College in navigating their education and utilizing existing campus resources, especially in times of transition and crises such as the COVID-19 pandemic. This is achieved by the College of Engineering making their hidden curriculum, intentions, directions, resources, and goals not so hidden (Villanueva et al., 2020, 2018) by training, facilitating, and encouraging peer mentorship for all students, whether directly in the College or within the University as a whole (i.e., Office of Student Affairs). Peer mentorship has been acknowledged as a way to help students navigate transitions and has generally positive outcomes (Dennehy & Dasgupta, 2017; Garringer et al., 2015). Students need this type of social involvement and connection to campus, which can come from a peer mentoring relationship (Colvin & Ashman, 2010). Overall, peer mentorship can help students be more confident and feel less isolated (NASEM, 2019) regardless of the current situation they are navigating.

7.1 Future Research

In the future, further analysis needs to be done with a specific focus on the additional qualitative questions that were not analyzed in this dissertation (Q11 to Q16, Appendix A), which were focused on needs based on whether a participant had a peer mentor or not. Those who had a peer mentor were asked about which type of support is most essential to them in peer mentorship (i.e., personal, professional, or educational; Appendix A, Q13) and were asked to describe their current peer mentor (i.e., attributes, characteristics, effectiveness, additional support desired; Appendix A, Questions 14-16). Those who did not have a peer mentor were also asked about which type of support is most essential to them in peer mentorship (Appendix A, Question 11) as well as further exploring their need for a peer mentor (Appendix A, Question 12). This exploration will provide a more thorough understanding of what the landscape of peer mentorship looks like within a College of Engineering with minimal peer mentoring support and formal programming. Additional exploration could also include exploring the similarities and differences in perceptions of needs between those in the first half of their engineering program versus the last half of their engineering program, both qualitatively and quantitatively.

As was mentioned in the limitations, running the CFA with an additional set of data would be ideal (Cabrera-Nguyen, 2010; Henson & Roberts, 2006; Orcan, 2018). This would allow for further confirmation of the factors extracted from EFA as well as offer additional insight in the qualitative responses. As part of this analysis, items that were flagged for having low communalities (CS4, EI1, EI2, EI4, and FS1) in the CFA as well as those that were not retained with factors in the EFA could be revisited (12 of the original 33 items). Wording and content alterations in the items could be performed to better represent the extracted factors.

Ideally, this dissertation would be integrated as part of a larger, longitudinal study that would include the development, implementation, and evaluation of a peer mentoring program in a college of engineering. The purpose of this dissertation study was that in addition to identifying needs, “plans should be communicated and “made to use the information in a practical way” (Office of Migrant Education, 2001, p. 17). Thus, a purposeful involvement of key personnel that could be involved in a peer mentoring program in the future can help create a more meaningful investment for change (Sallis & Henggeler, 1980).

Instruments or assessments of needs can be considered either formal or informal in their design. Informal designs include data that is gathered person-to-person and the needs emerge as information is collected (Marshall & Caldwell, 1984). Formal designs include data that are gathered in a systematic way and result in data that is more generalized than individualized informal insights (Marshall & Caldwell, 1984). This means that the need categories are developed by way of studying previous research, theory, and consensus (Marshall & Caldwell, 1984). While the two methods may provide different information, it has been found that the two methods are both valid in program planning (Marshall & Caldwell, 1984). Marshall & Caldwell (1984) found that the macro-level information provided by formal designs can be especially helpful in initial planning of programs, which was the focus of this dissertation and what the instrument was aimed at obtaining. Future work could include retrieving micro-level information from informal designs to get more specifics to clarify macro-level information (Marshall & Caldwell, 1984).

This mixed-methods instrument could also be developed into a more comprehensive survey that examines needs within each of the six standards on practice (Garringer et al., 2015) instead of just two of the standards. While it was discussed why training and matching/initiating were chosen as the focus, it would be worthwhile to conduct an assessment on all six constructs to determine contextually bound aspects connected to each practice. The research findings from the development and validation of the research study instrument could be published in a journal for future efforts to assess needs in the realm of peer mentorship in engineering.

It is also recommended that this mixed-methods instrument is revisited periodically to continually assess the *current* needs of students. The pragmatic nature of this study was based upon the assumption that the context, need, and individual nature are consistently changing and so uncertainty must be acknowledged (Dewey, 1938; Ormerod, 2006). A one-time assessment of needs should not and will not accurately depict the constant changes that may occur in each population of interest. Especially in the interest of programmatic developments within the College of Engineering, the data could be revisited with additional techniques (i.e., statistical, coding, etc.) to further clarify and find other relationships that may inform the efforts. An evaluation of the implementation of a peer mentorship program should also be used in conjunction with the mixed-methods instrument to make sure the program is meeting the original priority of needs as assessed. There were also many responses in the “Neither Agree or Disagree” category of the Likert scale responses. In the future, it would be interesting to explore the reasons for why participants chose this category, which may evolve over time and with different populations.

Also, a full phenomenological study would also be insightful to further exploring the current experiences of students with regards to peer mentorship. It would be useful in both the planning stages and the evaluation stages of the peer mentorship program to analyze both past and current experiences with peer mentoring. A phenomenographic study would also be useful in considering the differences between given populations with relation to emerging needs (Larsson & Holmström, 2007).

7.2 Final Remarks

As a conclusion to this dissertation, an infographic of the critical findings and priority elements regarding developing peer mentoring initiatives in the future is presented in Appendix D. This flyer serves as a succinct summary of this dissertation as well as a report to the College of Engineering on where the focus of peer mentorship, at the time of this study, should lie with regards to training and matching/initiating constructs in future developments. While there is much work still to be conducted in this realm since no other study like this has been done in the past, these findings are foundational to the future of peer mentorship programs, specifically at this College but also in other similar institutional contexts. The importance of mentorship is well established, and many programs have been developed and evaluated (NASEM, 2019). Now is the opportunity to go back to the *why* of peer mentorship, which is focused on meeting the needs of students. This cannot be done without exploring the needs of students before a program is created instead of just examining if a peer mentorship program had positive outcomes (Office of Migrant Education, 2001; Witkin & Altschuld, 1995), which was the central focus of this dissertation.

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APPENDIX A: APPROVED SURVEY INSTRUMENT

Institutional Review Board

Exemption #2
Certificate of Exemption

From: Melanie Domenech Rodriguez, IRB Chair

Nicole Vouvalis, IRB Director

To: ***Idalis Villanueva***

Date: ***October 7, 2020***

Protocol #: ***11464***

Title: **A Mixed-Methods Approach to Explore Student Needs for Peer Mentoring in a College of Engineering**

The Institutional Review Board has determined that the above-referenced study is exempt from review under federal guidelines 45 CFR Part 46.104(d) category #2:

> *Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subject; (ii) Any disclosure of the responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation, or (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and the IRB conducts a limited IRB review to make required determinations.*

This study is subject to ongoing COVID-19 related restrictions. As of March 15, 2020, the IRB has temporarily paused all in person research activities, including but not limited to recruitment, informed consent, data collection and data analysis that involves personal interaction (such as member checking and meaning-making). If research cannot be paused, please file an amendment to your protocol modifying procedures that are conducted in person. The IRB will notify you when in person research activities are once again permitted.

This exemption is valid for five years from the date of this correspondence, after which the study will be closed. If the research will extend beyond five years, it is your responsibility as the Principal Investigator to notify the IRB **before** the study's expiration date and submit a new application to continue the research. Research activities that continue beyond the expiration date without new certification of exempt status will be in violation of those federal guidelines which permit the exempt status.

If this project involves Non-USU personnel, they may not begin work on it (regardless of the approval status at USU) until a Reliance Agreement, External Research Agreement, or separate protocol review has been completed with the appropriate external entity. Many schools will not engage in a Reliance Agreement for Exempt protocols, so the research team must determine what the appropriate approval mechanism is for their Non-USU colleagues. As part of the IRB's quality assurance procedures, this research may be randomly selected for audit during the five-year period of exemption. If so, you will receive a request for completion of an Audit Report form during the month of the anniversary date of this certification.

In all cases, it is your responsibility to notify the IRB **prior** to making any changes to the study by submitting an Amendment request. This will document whether or not the study still meets the requirements for exempt status under federal regulations.

Upon receipt of this memo, you may begin your research. If you have questions, please call the IRB office at (435) 797-1821 or email to irb@usu.edu.

The IRB wishes you success with your research.

435.797.1821 | 1450 Old Main Hill | Logan, UT 84322 | MAIN 155 | irb@usu.edu | FWA#00003308

Peer Mentorship Survey - STUDENT

Start of Block: Survey Introduction

IRB **A Mixed-Methods Approach to Explore Student Needs for Peer Mentoring in a College of Engineering**

You are invited to join a research study done by Idalis Villanueva, Ph.D. (Adjunct Faculty and Dissertation Advisor) and Darcie Christensen, M.Eng. (Ph.D. Candidate) in the Engineering Education Department at Utah State University (USU).

The purpose of this research is to study engineering students' common needs for peer mentoring. The results of this dissertation can shape the future of peer mentoring in the College of Engineering (COE). You are being asked to participate in this study because you are likely an undergraduate student with a declared major in engineering at Utah State University.

Your participation in this research is completely voluntary. If you agree to participate now and change your mind later, you may withdraw at any time by exiting the instrument. You may contact the researchers with any concerns with your partial participation. If you have already completed the instrument and desire to withdraw, your responses cannot be removed. The survey is anonymous, and we will be unable to determine whose data is whose. You may still contact the researchers with any concerns.

If you take part in this study, you will be asked to fill out a single, anonymous online survey. It will take about ten to fifteen minutes to complete. You can participate in this study if you have a declared major in engineering at USU. You must also be 18 years or older. We expect that a minimum of 350 people will participate in this research study. You may also choose to enter your contact information for a randomized distribution of thirty $10 Amazon gift cards upon completion of the survey.

The possible risks of participating in this study are no more likely or serious than those you face in everyday activities. The main risks or discomfort include taking the time to participate in the study. It is also possible that negative experiences may be recalled. This can cause slight distress or discomfort. As a participant, you may also choose to give up part or all your confidentiality. This happens when you choose to share personal information in the open-ended questions, release your responses, or reveal your input to others. However, please note that we will combine all findings to lessen the chance of identification of such an experience. You will always have the choice to stop the survey at any time. If you choose, you may enter your contact information upon completion of the survey in order to enter the drawing for a gift card.

You will enter your name, email, and A-number in a form separate from the research survey so as not to tie your answers to identifying contact information.

Please note we aim to provide a secure and safe research experience for you. However, if you have a bad research-related experience, please contact Idalis Villanueva, Darcie Christensen, or the IRB office. This contact information is provided below.

Although you may not directly benefit from this study, it has been designed to give students a voice. This can build the future of peer mentorship within the COE at USU. Your input and experience relating to your peer mentorship needs may shape the foundation of peer mentorship. Depending on your year in school, you may see direct benefits by being involved in a program developed based on the results from this study. Your input may also allow for the validation of a research instrument to be used at other campuses. This may allow more students to have a voice in developing peer mentorship programs at their own institutions. **We appreciate the time you decide to volunteer for this study.**

We will make every effort to ensure that the information you provide remains confidential. Your identity will not be collected. However, depending on the information you choose to provide within the peer mentoring survey, it may be possible for someone to recognize your responses. If there is identifying information provided in the open-ended questions, it will be de-identified before analysis. A separate form will be used to gather your name, email, and A-number if you choose to enter the randomized drawing to receive a gift card. This will ensure the contact information is not tied to your peer mentoring survey responses. Regardless of the results of this incentive distribution, we appreciate the time you decide to volunteer for this study.

We will collect your information through Qualtrics. Online activities always carry a risk of a data breach. We will use systems and processes that minimize breach opportunities. All data will be securely stored in a restricted-access folder on Box.com. Box is an encrypted, cloud-based storage system. All data from the survey will be kept until the project is complete and all results are published. This is estimated to be between Summer 2021 to Fall 2021. Our published work, in the form of a dissertation, will become public access through the USU library during this time. The contact information you provide for the possible incentive distribution will be deleted upon completion of data collection and incentive distribution. It is unlikely, but possible, that others (i.e., USU, the National Science Foundation, or state/federal officials) may require us to share the information you give us in the survey. This is to ensure that the research was conducted safely and appropriately. We will only share the data if law or policy requires us to do so.

The Institutional Review Board (IRB) for the protection of human research participants at Utah State University has reviewed and approved this study. If you have any questions about this study, you can contact the Principal Investigator at idalis.villanueva@usu.edu. If you have questions about your rights or would simply like to speak with someone other than the research team about questions or concerns, please contact the IRB Director at (435) 797-0567 or irb@usu.edu.

Q1 **I have reviewed this information, I am 18 years of age or older, and I agree to participate in this study.**

You agree that you understand the risks and benefits of participation, and that you know what you are being asked to do. You also agree you know how to contact the research team with any questions about your participation and are clear on how to stop your participation in this study if you choose to do so.

○ Yes

○ No

Skip To: End of Survey If I have reviewed this information, I am 18 years of age or older, and I agree to participate in th... = No

End of Block: Survey Introduction

Start of Block: Peer Mentorship Experience

Q2 **Peer mentorship** is a relationship between two or more people at a **similar stage** in their personal, educational, or professional development. They work together to support each other.

In the case of **undergraduate engineering education,** an example of a peer mentor would be **another student** (undergraduate or graduate) that is in the **same semester or ahead of you** in their university education. This person could either be simply someone you **consider** to be a peer mentor or someone who has been **formally** assigned as your peer mentor.

Do you currently have a **peer mentor**?

○ Yes, I have a peer mentor within the College of Engineering

○ Yes, I have a peer mentor at this institution, but they are outside of the College of Engineering

○ Yes, I have a peer mentor within engineering, but they are at another institution

◯ Yes, I have a peer mentor, but they are at another institution and outside of engineering

◯ No, I do not have a peer mentor

End of Block: Peer Mentorship Experience

Start of Block: Theoretical Mentor Information & Roles

INSTR
The following items aim to determine **what you expect and what would be most beneficial to you** within an engineering peer mentoring relationship.

As a reminder, **peer mentorship** is a relationship between two or more people at a **similar stage** in their personal, educational, or professional development. They work together to support each other.

In the case of **undergraduate engineering education**, an example of a peer mentor would be **another student** (undergraduate or graduate) that is in the **same semester or ahead of you** in their university education. This person could either be simply someone you **consider** to be a peer mentor or someone who has been **formally** assigned as your peer mentor.

Q3

For each of the following statements, indicate your level of agreement.

"It is essential that my peer mentor is the same _____________ as me."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Race/Ethnicity	○	○	○	○	○
Gender Identity (i.e., male, female, transgender, genderqueer, agender, cisgender)	○	○	○	○	○
First Generational Status (i.e., first person in your immediate family [e.g., mother, father, sibling(s), grandparent(s)] to attend college)	○	○	○	○	○
Select "Neither Agree or Disagree"	○	○	○	○	○

Q4

For the following statements, indicate your level of agreement.

"It is essential that my peer mentor..."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Has the same level of commitment toward studying engineering	○	○	○	○	○
Is interested in the same engineering major as me	○	○	○	○	○
Has interest in the same engineering specialty areas as me (e.g., fluids, thermodynamics, prosthetics, wastewater treatment, dam design, robotics, etc.)	○	○	○	○	○
Has similar engineering career interests to me (e.g., work in industry, consulting, design, research, academia, etc.)	○	○	○	○	○
Has similar career interests outside of engineering to me (e.g., business, leadership, management, education, communication, psychology, etc.)	○	○	○	○	○

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Has similar hobbies to me (e.g., biking, hiking, reading, crocheting, gaming, etc.)	○	○	○	○	○
Exerts a similar level of effort into their engineering studies as me	○	○	○	○	○
Select "Agree"	○	○	○	○	○

Q5 Indicate your level of agreement with each of the following statements.

"It is essential that I have a peer mentor who can encourage me to or provide advice on how to..."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Establish a healthy school/work-life balance	○	○	○	○	○
Navigate my current living situation (e.g., living away from home, still living at home, etc.)	○	○	○	○	○
Set goals for my future in engineering	○	○	○	○	○
Gain strategies needed to persist in engineering even when I face failure	○	○	○	○	○
Build friendships with other students in engineering	○	○	○	○	○
Feel comfortable in my engineering college	○	○	○	○	○
Select "Disagree"	○	○	○	○	○

Q6 Indicate your level of agreement with each of the following statements.

"It is essential that I have a peer mentor who can encourage me to or provide advice on how to..."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Develop time management skills to meet engineering course load requirements	○	○	○	○	○
Feel sure about my choice of an engineering major	○	○	○	○	○
Become involved in engineering clubs and organizations	○	○	○	○	○
Become informed and involved in engineering events and/or socials	○	○	○	○	○
Become involved in engineering research opportunities	○	○	○	○	○
Select "Strongly Agree"	○	○	○	○	○

Q7 Indicate your level of agreement with each of the following statements.

"It is essential that I have a peer mentor who can encourage me to or provide advice on how to..."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Create or join engineering study groups	○	○	○	○	○
Take appropriate notes in engineering classes	○	○	○	○	○
Develop skills to effectively handle group projects	○	○	○	○	○
Develop communication skills	○	○	○	○	○
Build valuable relationships with an engineering network (i.e., other professors, students, working professionals, etc.)	○	○	○	○	○
Select "Agree"	○	○	○	○	○

Q8 Indicate your level of agreement with each of the following statements.

"It is essential that I have a peer mentor who can encourage me to or provide advice on how to..."

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Find valid sources to review engineering homework for correctness	○	○	○	○	○
Seek formal engineering tutoring services	○	○	○	○	○
Utilize campus resources related to engineering (e.g., career services, design studios, computer labs, etc.)	○	○	○	○	○
Visit my academic advisor to choose engineering classes and/or instructors	○	○	○	○	○
Visit my academic advisor to better understand engineering degree requirements	○	○	○	○	○

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Visit my academic advisor to check that I am on the correct track with engineering degree requirements	○	○	○	○	○
Find and pursue jobs, internships, and/or scholarships that may be a good fit for my engineering career interests	○	○	○	○	○
Select "Strongly Disagree"	○	○	○	○	○

End of Block: Theoretical Mentor Information & Roles

Start of Block: Barriers to Mentorship

Q9
What challenges or barriers **currently** exist for you in establishing peer mentoring relationships?

____

____

____

____

____

End of Block: Barriers to Mentorship

Start of Block: College of Engineering Support

Q10 In what ways could the College of Engineering support you in establishing peer mentoring relationships?

____

____

____

____

____

End of Block: College of Engineering Support

Start of Block: NO MENTOR - Reflection on Peer Mentorship Experience

Q11
As a reminder, **peer mentorship** is a relationship between two or more people at a **similar stage** in their personal, educational, or professional development. They work together to support each other.

In the case of **undergraduate engineering education**, an example of a peer mentor would be **another student** (undergraduate or graduate) that is in the **same semester or ahead of you** in their university education. This person could either be simply someone you **consider** to be a peer mentor or someone who has been **formally** assigned as your peer mentor.

Which of the following types of support is most essential to you in peer mentorship? If you have time, please explain.

○ Personal ____

○ Professional ____

○ Educational ____

Q12 A **need** is defined as a **gap between your current state and your desired future state**.

Since you indicated you do not currently have a peer mentor, do you have a need for a peer mentor? Please explain.

◯ Yes, I have a need for a peer mentor.
____

◯ No, but I would like and could benefit from a peer mentor
____

◯ No ____

◯ Not sure ____

End of Block: NO MENTOR - Reflection on Peer Mentorship Experience

---

Start of Block: WITH MENTOR - Reflection on Peer Mentorship Experience

Q13 As a reminder, **peer mentorship** is a relationship between two or more people at a **similar stage** in their personal, educational, or professional development. They work together to support each other.

In the case of undergraduate engineering education, an example of a peer mentor would be **another student** (undergraduate or graduate) that is in the **same semester or ahead of you** in their university education. This person could either be simply someone you **consider** to be a peer mentor or someone who has been **formally** assigned as your peer mentor.

Which of the following types of support is most essential to you in peer mentorship? If you have time, please explain.

◯ Personal____

◯ Professional ____

◯ Educational ____

Q14 You indicated that you currently have a peer mentor. **Please describe who your peer mentor is.**

This can include both **attributes** (i.e., race, gender identity, year in school, first generational status, and major) as well as **characteristics** (i.e., enjoyment of engineering, value placed on engineering, career interests, extracurricular interests, hobbies, and effort exerted in engineering).

____

____

____

____

____

Q15 What makes your peer mentor an effective peer mentor to you?

____

____

____

____

____

Q16 What additional support do you wish the peer mentor could provide?

____

____

____

____

____

End of Block: WITH MENTOR - Reflection on Peer Mentorship Experience

Start of Block: Participant Demographic Information

Q17 What is your approximate year in your undergraduate engineering education?

○ Freshman

○ Sophomore

○ Junior

○ Senior

○ Other, please explain ____

○ Prefer not to answer

Q18 What is your declared major?

○ Mechanical Engineering

○ Civil or Environmental Engineering

○ Biological Engineering

○ Electrical or Computer Engineering

○ General Engineering

○ I have not declared my major, but my intended major is ____

○ Other, please specify ____

○ No declared major

Q19 What is your current estimated college GPA?

____

Q20 Are you the first person in your immediate family [e.g., mother, father, sibling(s), grandparent(s)] to attend college?

○ Yes

○ No

○ Prefer not to answer

Q21 Are you Hispanic, Latinx, or of Spanish origin?

○ Yes, I am of Hispanic, Latinx, or Spanish origin

○ No, not of Hispanic, Latinx, or Spanish origin

○ Prefer not to answer

Q22 What is your race? **Choose all that apply.**

☐ American Indian or Alaska Native

☐ Asian

☐ Black or African American

☐ Native Hawaiian or Other Pacific Islander

☐ White

☐ Other race, please specify

____

☐ Prefer not to answer

Q23 How do you currently describe your gender identity? **Choose all that apply.**

☐ **Male**

☐ **Female**

☐ **Transgender** (i.e., gender identity differs from biological sex assigned at birth)

☐ **Genderqueer** (i.e., do not subscribe to traditional genders)

☐ **Agender** (i.e., identifies as not belonging to any gender)

☐ **Cisgender** (i.e., gender identity matches the biological identity assigned at birth)

☐ **Not listed**, please specify ____

☐ ⨂ Prefer not to answer

End of Block: Participant Demographic Information

APPENDIX B: CODEBOOK

Code System

1 Q9	0
1.1 Deficiencies in Current or Prior Relationship	10
1.2 Lack of Available or Suitable Mentors	17
1.3 Time	25
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2 Q10	0
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1 Q9

1.1 Deficiencies in Current or Prior Relationship

Description: Participant refers to current or prior mentoring experiences, either as a mentor or a mentee, that featured deficiencies and difficulties with building an effective relationship.

Examples:

- "My peer mentor has since move out of the valley, so I can only talk with him through text/call."
- "I remember that I was assigned to someone my freshman year, but I was never contacted by them and had no idea who they were."

1.2 Lack of Available or Suitable Mentors

Description: Participants reference difficulty in finding a mentor who is willing to be a mentor and/or who is a suitable candidate for being an effective mentor.

Examples:

- "often times i would go to people in an older year at [blinded for identification purposes] than me for advice, being a senior now it is much harder to find such people i trust"
- "it would be hard if the level of motivation is different"
- "there is generally not a lot of individuals who are willing to specifically be a mentor"

1.3 Time

Description: Participants mention they don't have time to build a mentoring relationship, either specifically (i.e., family, work, etc.) or generally (i.e., I don't have time).

Examples:

- "I have so much homework I have no time to go to the store let alone meet with and establish relationships with other chumps."

- "Lack of time."

- "I work full time, have a family, and do school full time. I am always running from one thing to another."

1.4 COVID-19 Pandemic

Description: Participants mention in any form something about the COVID-19 pandemic. This could be stated both directly (i.e., "COVID-19" or "Pandemic") or implied (i.e., "social distancing", "online school" or "unable to meet in person")

Examples:

- "The lack of ability to meet with other students in person is a challenge. I know there are ways to meet online, but it's just not the same."
- "Well social distancing and masks obviously."

1.5 Lack of Knowledge or Opportunity

Description: Participants refer to the difficulty in knowing how to find or having the opportunity to develop a peer mentoring relationship.

Examples:

- "I don't really know what a peer mentorship entails. Do I just walk up to someone and ask if they want a mentor? Or want to be one? And then what do they actually do?"
- "I don't really get the chance to talk to upperclassmen that are ahead of me in my program."

1.6 Social Habits, Fears, or Desires

Description: Participants share barriers relating to their personal social habits, fears, or desires relating to developing or maintaining a peer mentoring relationship.

Examples:

- "I would say that the hardest part of a peer mentoring relationship is trying not to drag your peer mentor down with you when you're struggling."
- "I am quite shy and struggle to talk to people I dont already know."
- "Social anxiety."

1.7 No need or benefit

Description: Participants mention not having a need or seeing the benefit to having a peer mentor. This includes not having a desire to have a peer mentor.

Examples:

- "There's not much motivation to meet up with them either."
- "Desire. I don't really care to find one."
- "I don't really need a peer mentor."

1.8 No Barriers

Description: The participant mentions that there are no barriers to them developing a peer mentoring relationship.

Examples:

- "Little to none."
- "I've never seemed to have a problem, but I am more outgoing than lots of engineering students."

2 Q10

2.1 COVID-19 Pandemic

Description: Participants mention in any form something about the COVID-19 pandemic. This could be stated both directly (i.e., "COVID-19" or "Pandemic") or implied (i.e., "social distancing", "online school" or "unable to meet in person")

Examples:

- "They could improve virtual help as COVID has made it difficult to establish those relations."
- "Enabling better ways to meet up with students during this pandemic."
- "Get rid of COVID."

2.2 Not Sure or Nothing

Description: Participants either share that they do not know how the College of Engineering can support them in their peer mentoring efforts, they do not feel it is the responsibility of the College to support them, or they think the College is already doing fine.

Examples:

- "I don't think the college of engineering can do anything that is actually effective to establish this type of relationship."
- "None that I can think of."
- "I think they already do a great job because they have so so many clubs."

2.3 Create, Advertise, & Facilitate Opportunities

Description: Participants mention ways that the College can create, advertise, and support opportunities. This category is meant to be broad and focuses on anything outside of the classroom that the college can do.

Examples:

- "Having an available list of people who are willing to meet other students in the major who are either needing help or offering help."
- "Set up ways to communicate with students outside of the classroom for help and friendship."
- "Increasing the number and frequency of socials would help."
- "Advertise how to participate in a peer mentoring relationship."

2.4 Classroom Support & Encouragement

Description: Participants mention efforts that can be made within the classroom to support their peer mentoring relationships.

Examples:

- "Smaller class sizes really help me get to know people."
- "Group projects are great ways to meet someone in your classes especially when most classes are online and you don't see people face to face"
- "Offering study groups for specific classes"

APPENDIX C: REPRESENTATIVE QUOTES FOR QUALITATIVE AND QUANTITATIVE INTEGRATION

Table C-1

Representative Quote Summary for Lack of Overall Knowledge and Support

Q9 (Barriers to Peer Mentorship)	Q10 (College of Engineering Support)
• Participant 31: "**Time** is a big barrier. I am constantly doing school work and therefore don't have adequate time to develop gain a solid peer mentor. I also **lack connections** to people who could serve as a peer mentor, I know people who are my peers but they don't act as a mentor figure." • Participant 53: "It's also hard for me to make close relationships with my peers sometimes **because they are all men**... The biggest thing though is that **I just haven't had an opportunity to meet people older than me in my major** because the clubs I've gotten involved in didn't have high representation of my major." • Participant 60: "I have so much homework **I have no time** to go to the store let alone meet with and establish relationships with other chumps. I also **fear my ignorance or slow-paced processing would be a hindrance** to anyone else. I don't want to be a burden to someone else."	• Participant 155: "**Reaching out** to the student, **notifying** them of peer-mentorship opportunities, such as saying that there is a student seeking to be a peer mentor to someone. **The task can be daunting to take initiative and seek a mentor out, especially when you are unsure if others are interested.**" • Participant 166: "I think **promoting [the current peer mentoring program] more would be great.** Also, I think mentorship is often promoted for freshman or sophomores; however, **I know plenty of juniors or seniors that would probably benefit from that mentorship**. In the junior/senior years the classes get really difficult and the time to start thinking about jobs/grad school has come, and if there wasn't a mentorship established earlier, it is a lot more difficult for upperclassmen to find that." • Participant 184: "**Providing more information, in a highly available, and noticed place**. Possibly even some sort of demo, but I am not sure what that would entail."

Q9 (Barriers to Peer Mentorship)	Q10 (College of Engineering Support)
• Participant 113: “**Don’t know how**. I feel like **I’m old enough to mentor, yet I would still love someone to mentor me.** Don’t know how to find them.” • Participant 185: “there is generally **not a lot of individuals who are willing to specifically be a mentor**: most peer-mentors are TAs and therefore not always obligated to provide subjective advice.”	• Participant 175: “You can't really force students to study together, but **providing more opportunities for students to interact together would help**. This could be scheduled times for reviewing a class together in person etc.” • Participant 178: “The college could implement **more resources in the mentoring respect**. Or find a way to better advertise them. I also think it is kind of hard with the workload of engineering, **students don't have a ton of time to spare**, so getting them to go to something not required can be a struggle. “ • Participant 189: “I just see **sophomores and freshmen expecting peer mentoring relationships to be another thing to steal time away from homework**. I wish more would be brave enough to give it a chance.”

Note. Bold emphases were added by the researcher to show the essence of student response that could be translated into priorities for future peer mentoring initiatives.

Table C-2

Representative Quote Summary for COVID

	Participant 10	Participant 14	Participant 150
Q9 (Barriers to Peer Mentorship)	"With covid-19 restrictions it **is hard to meet new people, and even to interact with people in your same major**"	"**Social Distancing**. Not all virtual help is helpful, and it's not always a guaranteed thing like in person recitations and study sessions are. **In person help is also just more helpful than virtual help**."	"Covid-19. Honestly, **this is it**. If I was on campus I would have a study group."
Q10 (College of Engineering Support)	"**Group projects** are great ways to meet someone in your classes especially when most classes are online and you don't see people face to face"	"They could **improve virtual help** as COVID has made it difficult to establish those relations."	"**Enabling better ways to meet up with students during this pandemic**. This might be impossible to do right now. Considering that, I would rather study by myself than meet with someone over Zoom for a study group."

Note. Bold emphases were added by the researcher to show the essence of student response that could be translated into priorities for future peer mentoring initiatives.

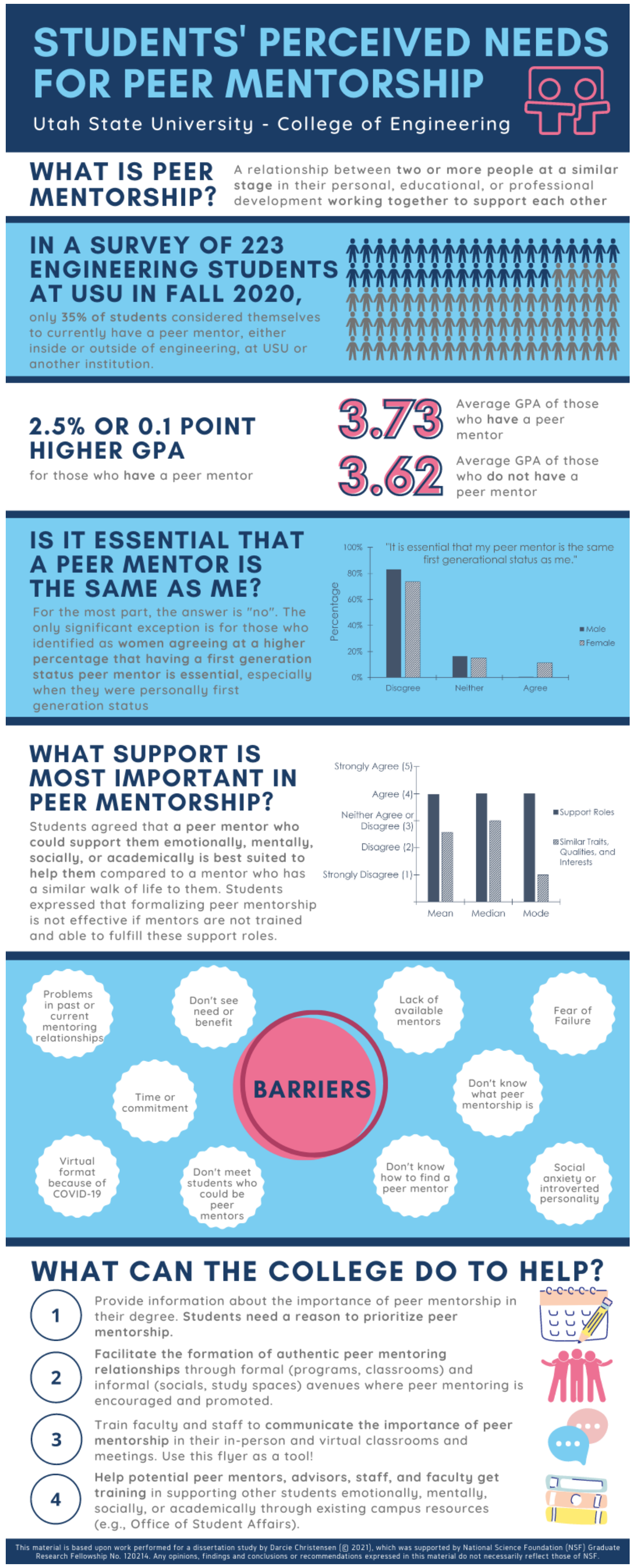
Table C-3

Representative Quote Summary for Lack of Need

Q9 (Barriers to Peer Mentorship)	Q10 (College of Engineering Support)
• Participant 65: "**I've never seemed to have a problem**, but I am more outgoing than lots of engineering students." • Participant 69: "**Desire**. I don't really care to find one." • Participant 84: "**I don't have any**." • Participant 211: "**Lack of a pressing need** for that type of relationship"	• Participant 89: "**The College of Engineering can't make friends for me.** It's something I need to do on my own." • Participant 109: "**I don't know**" • Participant 195: "N/a, **the College of Engineering encourages and supports the mentorship program very well already**." • Participant 223: "I do not think that the College of Engineering should play an active role in supporting peer mentoring relationships between students. **Such relationships will develop naturally**."

Note. Bold emphases were added by the researcher to show the essence of student response that could be translated into priorities for future peer mentoring initiatives.

APPENDIX D: INFOGRAPHIC SUMMARY OF RESULTS



APPENDIX E: CURRICULUM VITAE

DARCIE CHRISTENSEN

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Enthusiastic engineering educator with extensive undergraduate and graduate experience in teaching, outreach, leadership, and research who has a passion for assisting underrepresented and underprepared engineering students to succeed

EDUCATION

Ph.D. Engineering Education, 4.0 GPA 2017 – Summer 2021

Utah State University, Logan, Utah

Dissertation: "A Mixed-Methods Approach to Explore Student Perceived Needs for Peer Mentorship in a College of Engineering." The dissertation developed, validated, and implemented a survey instrument to determine engineering student needs with regards to peer mentorship.

Advisor: Dr. Idalis Villanueva, Associate Professor, University of Florida, Gainesville, Florida

M.Eng. Environmental Engineering, 4.0 GPA May 2019

Utah State University, Logan, Utah

B.S. Biological Engineering, 3.97 GPA May 2017

Utah State University, Logan, Utah

- University and Departmental Honors
- Passed Fundamentals of Engineering Exam, November 2016

TEACHING & WORK EXPERIENCE

Academic Year Intern January – July 2021

Smithsonian National Air and Space Museum, Udvar-Hazy Center

- Original internship would have been Summer 2020 with the SHE Can STEM Camp
- Duties will include designing and implementing virtual and accessible STEM curriculum for middle-school aged students

Instructor of Record January – December 2020

Introduction to Engineering, Utah State University

- Manage a three-person teaching team by teaching and designing innovative hands-on course curriculum, activities, and projects through continual revision based on student feedback and outcomes
- Attended Empowering Teaching Excellence Conference, Inclusive Excellence Symposium, Implicit Bias Training, QPR (Question, Persuade, and Refer) Suicide Prevention Training, and other workshops to further teaching professional development

Graduate Research Assistant August 2017 – Summer 2021

Department of Engineering Education, Utah State University

- Assisted in designing a research classroom being renovated under a Steelcase Foundation Grant
- Developed necessary content and survey documentation for IRB submissions for research study performed in a research classroom to determine students' perceptions of their ideal learning environment
- Provided research, design, analysis, and logistical support for a National Science Foundation research project exploring engineering student exam experience using electrodermal activity, cortisol and salivary alpha amylase assays, and surveys
- Assisted in the validation of protocols and collection of data relating to student experiences in Makerspaces

Graduate Teaching Fellow January 2018 – December 2019

Introduction to Engineering, Utah State University

- Assisted in redeveloping and redesigning course structure, presentations, innovative design activities, assignments, rubrics, and general course content
- Managed online learning management system (Canvas by Instructure)

Chaperone June 2015 – June 2019

Engineering State, Utah State University

- Guided high school juniors and seniors in learning about engineering disciplines through hands-on lab activities
- Served as a panelist on a women-in-engineering panel
- Served twice as the keynote speaker to 500+ attendees at the closing banquet

FELLOWSHIPS & AWARDS

National Science Foundation Graduate Research Fellow April 2018 – May 2021

- 17% acceptance rate
- $46,000 per year for three years

Outstanding Engineering Education Graduate Scholar of the Year February 2020

School of Graduate Studies Travel Award ($800) June 2019

Ph.D. College of Engineering Student Travel Grant ($300) June 2019

Tau Beta Pi Record No. 6 Fellow August 2018 – May 2019

- 9.4% acceptance rate
- $10,000 for one year

Nominee for Utah State University Graduate Student Teacher of the Year April 2019

College of Engineering Graduate Student Teacher of the Year February 2019

Engineering Education Graduate Student Teacher of the Year February 2019

Ph.D. College of Engineering Student Travel Grant ($300) February 2019

Office of Research & Graduate Studies Travel Award ($400) October 2018

LEADERSHIPS AND MEMBERSHIPS

Graduate Studies Director August 2018 – May 2021

Engineering Council

- Created the "Lost Lecture" lunchtime seminar and "The Great Grad Student Race" for graduate students
- Developed and retrieved results from current graduate students in the College of Engineering to determine awareness levels of college resources

College of Engineering Representative August 2018 – May 2021

Utah State University Graduate Student Council

- Represented the College of Engineering during monthly meetings in discussing questions, concerns, and obstacles for graduate students
- Hosted a university-wide social for graduate students in the College of Engineering

Vice President May 2017 – May 2019

Tau Beta Pi – Utah Gamma Chapter

- Organize and coordinate chapter meetings and activities
- Attend annual district conference

Society of Women Engineers Fall 2011 – Present

- Participated in STEM outreach activities to promote engineering as an achievable career to women of all ages

SERVICE

Fall Student Research Symposium Judge December 2020

Utah State University

- Judged four virtual undergraduate research presentations based on core presentation elements, presentation structure, need for project, and knowledge of project

National Science Foundation Graduate Research Fellowship Mentor Fall 2019 – Fall 2020

Utah State University

- Mentored students throughout the application process in developing, writing, and revising their fellowship applications
- One mentee from Fall 2019 received the NSF GRFP award in April 2020

Student-Alumni Mentor August 2017 – May 2020

Utah State University Honors Program

- Mentor one student within the Utah State University Honors Program each school year
- Provide professional and academic advice to students pursing a related field

Student Research Symposium Judge April 2020

Utah State University

- Judged seven virtual undergraduate research poster presentations based on core presentation elements, presentation structure, need for project, and knowledge of project

Utah Conference on Undergraduate Research Volunteer February 2020

Utah State University

- Assisted student and faculty attendees check into the event

Technology Fee Board Member August 2019

Utah State University Student Association

- Consult with other students and staff about technology concerns and funding across campus

Preview Day October 2018

Utah State University

- Represented the College of Engineering to high school seniors by presenting in a breakout session about research, outreach, and extracurricular involvement

PROFESSIONAL DEVELOPMENT & CERTIFICATIONS

Teaching for Learning Conference February 2021
Implicit Bias Training October 2020
Inclusive Excellence Symposium, Black Lives Matter: A Community Calling October 2020
Question, Persuade, Refer (QPR) Training for Suicide Prevention October 2018, January 2020
Empowering Teaching Excellence Conference August 2020
European Society for Engineering Education (SEFI) Doctoral Symposium September 2019
Human Research: Social, Behavioral, Educational Researchers September 2016 & 2019
Responsible Conduct of Research: Physical Science May 2016

REFEREED JOURNAL PUBLICATIONS

Idalis Villanueva, Jenefer Husman, **Darcie Christensen,** Kate Youmans, Md Tarique Hasan Khan, Paul Vicioso, Shawn Lampkins, and Matt Graham (2019). A Cross-disciplinary and Multi-modal Experimental Design for Studying Near-real-time Authentic Examination Experiences. *Journal of Visualized Experiments,* (151), https://doi.org/10.3791/60037.

REFEREED CONFERENCE PAPERS WITH PRESENTATION *(presenter underlined)*

Darcie Christensen, Md Tarique Hasan Khan, Idalis Villanueva, and Jenefer Husman (2019). *A Case Study of Engineering Exam-Related Predicted Performance, Electrodermal Activity, and Heart Rate,* European Society of Engineering Education (SEFI), September 16-19, 2019, Budapest, Hungary.

Darcie Christensen, Idalis Villanueva, and Sheree Benson (2018). *Understanding First-Year Engineering Students' Perceived Ideal Learning Environments*, World Engineering Education Forum – Global Engineering Deans Council (WEEF-GEDC), November 12-16, 2018, Albuquerque, New Mexico. Available https://weef-gedc2018.org/wp-content/uploads/2018/11/51_Understanding-First-Year-Engineering-Students-Perceived-Ideal-Learning-Environments.pdf

REFEREED CONFERENCE PRESENTATIONS *(presenter underlined)*

Jenefer Husman, Matt Graham, Keith Zvoch, Idalis Villanueva, **Darcie Christensen,** Md Tarique Hasan Khan, Shawn Lampkins, and Reinhard Pekrun (2020). *Electrodermal Activity and Self-Report Measures: Converging and Independent Evidence of Emotions' Impact on Exam Performance,* In The Power and Possibilities of Physiological Data to Explore Students' and Teachers' Experiences Special Session, American Educational Research Association (AERA), April 17-21, 2020, San Francisco, California *[Cancelled due to Coronavirus]*

Darcie Christensen, Cynthia Rigby, Idalis Villanueva, and Jenefer Husman (2019). *An Exploration of Engineering Student Effort: Correlations to Exam Performance,* Northern Rocky Mountain Educational Research Association (NRMERA), October 10-11, 2019, Denver, Colorado.

Idalis Villanueva, Jenefer Husman, Matt Graham, **Darcie Christensen,** and Md Tarique Hasan Khan (2019). *The Possibility and Peril of Using Multimodal Physiological Approaches to Measure Academic Emotions, Race and Gender Bias, and Motivation,* The Scholarly Consortium for Innovative Psychology in Education (SCIPE), October 3-4, 2019, Savannah, Georgia. **Received Founders Award for Most Innovative and Creative Conference Session.**

Darcie Christensen, Idalis Villanueva, Jesse Wheeler, Paul Vicioso, Shawn Lampkins, and Kate Youmans (2019). *Exploring Potential Relationships Between Self-Efficacy, Performance, and Electrodermal Activity in Engineering Exams,* American Educational Research Association (AERA), April 5-9, 2019, Toronto, Canada.

Jenefer Husman, Matt Graham, Idalis Villanueva, **Darcie Christensen**, Kate Youmans, Robyn Wright, and Bobbie Bermudez (2019). *Connecting to the Future, Feeling Better in the Present: Academic Achievement Emotions, Future Oriented Value, and Arousal,* American Educational Research Association (AERA), April 5-9, 2019, Toronto, Canada.

Jenefer Husman, Matt Graham, **Darcie Christensen**, and Idalis Villanueva (2018). *Keeping Your Cool: Exploring Interactions Between Cortisol and Emotional Regulation on Test Performance,* Society for Personality and Social Psychology Conference (SPSP), February 7-9, 2019, Portland, Oregon.

Jenefer Husman, Shawn Lampkins, Idalis Villanueva, **Darcie Christensen**, Paul Vicioso, and Kate Youmans (2018). *If I Value the Test Do I Feel More or Less Shame When I Fail? Exploration of Value and Emotions,* International Conference on Motivation, August 15-17, 2018, Copenhagen, Denmark.