What Makes an Effective Peer Mentor? Perceptions of Undergraduate Engineering Students During COVID-19

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Introduction

This complete research paper is focused on sharing undergraduate engineering students' perceptions of what made an effective peer mentor during COVID-19. These students were at a western institution of the United States in a college of engineering.

Traditionally, mentors are thought to have more experience and may hold more power when compared to their mentee [1]–[4]. These relationships may tend to be more one-sided, with the senior mentor conveying information to the junior mentee [2], [4], [5]. Contrastingly, peer mentorship are non-hierarchical relationships that occur when a mentor and a mentee are at approximately at the same level of their personal, professional, or academic path [1], [2], [5], [6].

Peer mentorship has been shown to introduce a level of reciprocity, mutuality, and interpersonal comfort that may not be available in traditional mentorships, allowing for trust and credibility to be built in the two-way relationship [1], [2], [5]–[7]. This is due in part to their developmental needs, whether that is in career or academic aspects, unfolding at similar times [6]. Identity, belonging, student experience, and emotional competency have all been shown to have improvements when in a positive peer mentorship as well as increased retention, particularly for those who are underrepresented or in the first year of their engineering program [7]–[15]. Peer mentorship allows for a student-centered relationship to form where the mentee feels comfortable and gains valuable perspectives, which can allow mentees who may be first-year students to overcome the intimidation of a new situation [16]. Benefits of creating a better retention and transition for first-year engineering students being peer mentored have been shown [15], [17], [18]. These benefits can occur for both mentors and mentees in peer mentoring relationships, including building confidence, growing personally, developing skills, feeling a sense of achievement and satisfaction, and learning about university resources [12], [13], [16], [19], [20]. Even though the outcomes of peer mentorship are generally found to be positive, it is often underutilized to support students psychosocially and in their academic trajectories. These responsibilities typically fall to faculty and staff who may not have the time or resources due to their other professional demands to provide the additional mentorship students need [1], [6], [7], [16].

At the end of 2020, amidst the COVID-19 pandemic, a mixed-methods dissertation study was conducted to determine students' perceived needs for peer mentoring [21]. In this study, 223 undergraduate engineering students provided their perceptions of peer mentoring needs via a custom-developed exploratory mixed-methods instrument that was tested for both validity and reliability (i.e., quantitative Cronbach's Alpha = .783; qualitative content and face validation in multiple rounds). The instrument started with a definition and examples of peer mentorship followed by a question to determine whether a student currently felt they had a peer mentor. The latter question was preceded by 33 total quantitative items and 2 open-ended qualitative

questions. Additionally, there were two open-ended qualitative questions for those who indicated they *did not* currently have a peer mentor and four open-ended qualitative questions for those who indicated they *did* currently have a peer mentor. All participants completed the survey with seven additional demographic questions. The overall conclusion of the study was that it is worthwhile to explore student needs before expending time and resources in developing a mentorship program [21].

The focus of this current analysis, which parallels similar studies conducted after the original study [22], [23], was to delve into one of the unexplored qualitative questions: "What makes your peer mentor an effective peer mentor to you?". Responses to this question were given by the 79 students who indicated they currently had a peer mentor. A phenomenological-type analysis of the responses to this question allowed a summary to be compiled on common practices and traits of an effective peer mentor. The paper concludes with relevant and evidence-based practices mentors can use and should be trained on when participating in peer mentorships, particularly those that impact first year and underrepresented engineering students in an academic context.

Methods

The following sections describe the methods used to conduct this research, which are similar to the methods employed and cited in the associated dissertation and follow-up studies [21]–[23]

Research Instrument & Rationale for Exploration

The research instrument employed in the dissertation study was developed, validated (i.e., quantitative Cronbach's Alpha = 0.783; iterative qualitative content and face validation), and administered by Christensen [21] in 2020. The full research instrument can be found in the original study [21]. The instrument [21] was a mixed-methods instrument that was exploratory in nature focused on determining students' peer mentoring needs. Within the instrument, there were 33 Likert-scale quantitative questions, 8 qualitative questions, and 7 participant identifier questions [21]. In the original study [21], analysis was conducted on only two of the eight qualitative questions. As of now, those two qualitative questions have been re-explored from a different perspective [23] and one additional qualitative question has been analyzed [22].

After introducing the study, the students were presented a definition and example of peer mentorship in the context of undergraduate engineering education; they were then asked to indicate whether they currently had a peer mentor [21, p. 258]. Students were able to select one of four versions of "Yes, I have a peer mentor…", which allowed them to indicate whether their peer mentor was at the same institution or not and within engineering or not; otherwise, they could select "No, I do not have a peer mentor" [21, pp. 258–259]. Depending on how they responded, students were presented with an additional set of questions. This paper focuses on one of the additional qualitative questions posed to the students who responded with one of the four "yes" options. The qualitative question of interest for this analysis is, "What makes your peer mentor an effective peer mentor to you?" [21, p. 270].

Research Question

Exploring the perspectives of what makes an effective peer mentor for those who currently have peer mentor provides an opportunity to provide effective selection and training of potential mentors. Since these relationships that students were currently participating in could have been created through formal assignments, or they could have been self-created by individual, informal ways, it can be valuable to gauge what is working well for mentors and mentees in a variety of peer mentoring scenarios. Thus, the research question, "What are the common characteristics or activities of an effective peer mentor?" guided this study.

Researcher Positionality

It should be noted that the first author of this publication attended the institution of interest and was part of both the undergraduate and graduate engineering student populations. As summarized in previous publications [21]–[23], this placed her as an insider [24] who had personal experiences in various roles throughout the College of Engineering of interest. However, as this author has transitioned roles to a different institution, she considers that her role is in transition to that of an outsider [24]. Throughout the analysis, she was mindful of this position and sought support through external perspectives as well as personal memoing to provide ethical analysis. A hermeneutic approach [25] was also used to allow an awareness and balance of interpreting without bias and in conjunction with her personal experiences. The second author has extensive experience in mentorship, teaching, and research to support this analysis. The third author is an undergraduate engineering student in his junior year who is interested in and understands the personal importance of mentorship. He is growing his understanding of the scholarly realm of mentorship while garnering experience in research. Together, they recognize and appreciate the opportunity to explore and share these valuable and underutilized student perspectives in building the future of effective peer mentorship.

Recruitment

All recruitment procedures and Utah State University Institution Review Board (IRB) approvals are thoroughly documented by Christensen [21]. Since the analysis in this study was on deidentified secondary data, it did not require further approval by the first author's current institution. The participants were all undergraduate engineering students at a western institution in the United States within a College of Engineering. All recruitment and survey participation was done virtually because of the hybrid nature of learning situations during the COVID-19 pandemic. The survey responses were all anonymous, though 199 of the participants chose to share their information in a completely separate form to enter a randomized gift card drawing. Overall, 325 survey submissions were received, and after cleaning the data, 223 complete responses were retained. From these 223 complete responses, 79 participants responded "yes" to the question "Do you currently have a peer mentor?" These 79 participants are the interest of this study. Of the 79 participants, only 1 (1.3%) left the answer to the question of interest blank. Thus, analysis of 78 complete participants' responses will be the focus of the results. The demographic information for the 79 participants as well as the entire 223 participants is shown in Table 1.

Table 1. Demographic information for the 223 participants (abbreviated "part.") and the 79-participant subset who indicated they currently have a peer mentor [21], [22].

Year in Undergraduate Engineering			Declared Major		
Category	**All Part.**	**"Yes" Part.**	**Category**	**All Part.**	**"Yes" Part.**
Freshman	19.7%	16.5%	Mechanical	55.6%	58.2%
Sophomore	13.0%	13.9%	Civil / Environmental	18%	11.4%
Junior	40.4%	39.2%	Biological	6.7%	10.1%
Senior	24.2%	25.3%	Electrical / Computer	15.7%	15.2%
Other	2.7%	5.1%	Intend to Pursue	0.9%	0.0%
			Other	3.1%	5.1%
Self-Identified Gender Identity			**Of Hispanic, Latinx, or Spanish Origin**		
Category	**All Part.**	**"Yes" Part.**	**Category**	**All Part.**	**"Yes" Part.**
Male	74.0%	72.2%	Yes	3.0%	5.0%
Female	23.8%	25.3%	No	90.0%	89.0%
Prefer not to	2.2%	2.5%	Prefer not to answer	7.0%	6.0%
First Generational Status			**Race**		
Category	**All Part.**	**"Yes" Part.**	**Category**	**All Part.**	**"Yes" Part.**
Yes	7.6%	6.3%	White	91.0%	92.4%
No	91.5%	92.4%	Person of Color	3.2%	2.5%
Prefer not to	0.9%	1.3%	Prefer not to answer	5.8%	5.1%

Note: More options may have been included in the multiple-choice answers, only responses that participants chose are shown in the table. All other options can be found in Christensen [21]. Table obtained directly from Christensen [22], which was adapted from Christensen [23].

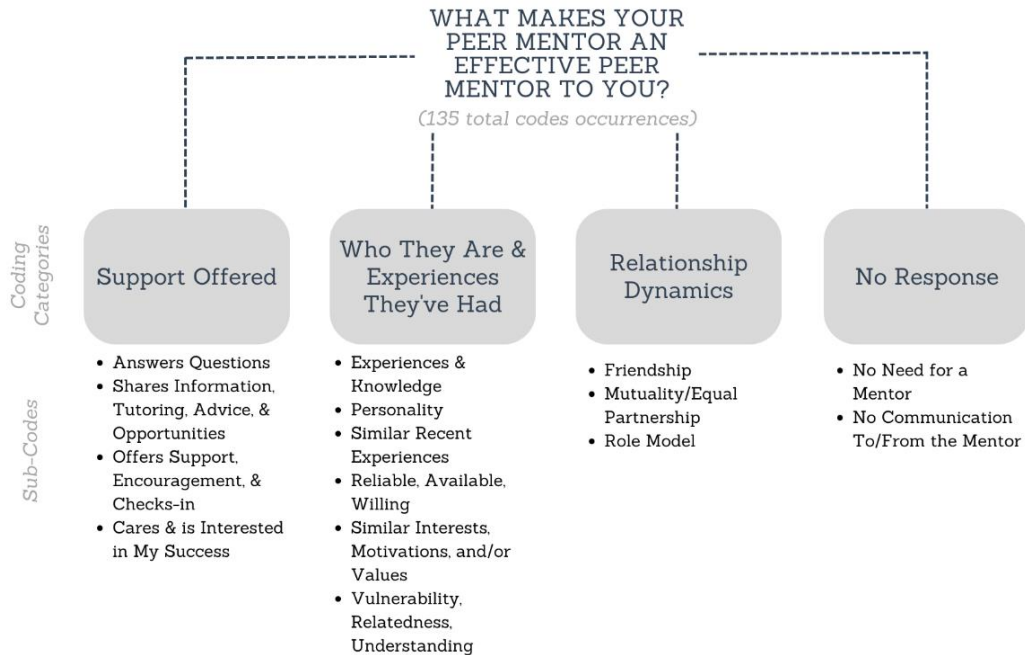*Qualitative Analysis Approach & Procedures*

Within this qualitative analysis, the goal was to find the commonalities in participants answers about what made their peer mentor an effective mentor. Because of this, a phenomenological-type approach was used, similar to Christensen's approach [21]–[23], keeping in mind the first author's positionality throughout.

Forty of the 79 responses were randomly selected for initial coding. These were coded on a participant-by-participant basis to allow significant ideas to emerge. The first author used primarily in-vivo coding to initially code the data, which were then focus coded into codes that were conceptually similar [26]. A codebook (Appendix A) was created to describe the categories, which was then provided to two undergraduate researchers, who were not students at the western institution of interest. These students used the established code book to perform intercoder agreement and check for biases [26]. After the first round of intercoder agreement, the research team met to discuss the results and the coding scheme was adjusted and simplified to allow for consensus (Appendix B). This simplification considered and incorporated all codes previously within the codebook by grouping similar themes together into coding categories. The 40 random responses were then re-coded using the new coding scheme and it was agreed that the intercoder results were acceptable (i.e., within 10% deviation) and that the codes sufficiently covered the participant responses [26]. This coding scheme was then used by the primary author to code the full 79 participant responses. The final coding scheme included four coding categories (Appendix B), indicating the themes of what makes an effective mentor, which are presented more fully in the results.

Results & Discussion

This study aimed to investigate what was perceived to make an effective peer mentor in engineering education amongst undergraduate students by asking them the research question, "What are the common characteristics or activities of an effective peer mentor?". In this section, the survey results are presented, which will be further discussed with implications and recommendations.

As previously stated, the survey sent out to the undergraduate engineering students received 325 submissions, of which only 223 were considered complete responses. Of these responses, 79 participants answered "yes" to the question, "Do you currently have a peer mentor?". The 78 complete participants' responses were the focus of the results. The coding categories (i.e., themes) and the sub-codes are represented in Figure 1. Overall, 135 total coding occurrences emerged for the 78 responses.

WHAT MAKES YOUR PEER MENTOR AN EFFECTIVE PEER MENTOR TO YOU?
(135 total codes occurrences)

Coding Categories

| Support Offered | Who They Are & Experiences They've Had | Relationship Dynamics | No Response |

Sub-Codes

- Answers Questions
- Shares Information, Tutoring, Advice, & Opportunities
- Offers Support, Encouragement, & Checks-in
- Cares & is Interested in My Success

- Experiences & Knowledge
- Personality
- Similar Recent Experiences
- Reliable, Available, Willing
- Similar Interests, Motivations, and/or Values
- Vulnerability, Relatedness, Understanding

- Friendship
- Mutuality/Equal Partnership
- Role Model

- No Need for a Mentor
- No Communication To/From the Mentor

Figure 1. Coding categories and sub-codes.

The results indicated that peer mentorship overall is an effective tool for supporting the success of engineering students who currently have a peer mentor, in alignment with previous research [7]–[16], [21], [23]. The responses from students who currently have a peer mentor help us determine the common characteristics or activities of effective peer mentoring relationships. Based on the comprehensive coded segment list, which contained 135 statements coded across 78 complete participant responses, the chart in Figure 2 gives us a visual representation of the frequency for each coding category. This response quantity indicates what the participants saw as the most effective characteristics or activities of their peer mentoring relationships.

Only 2.2% of 135 coded responses fell in the "No Mentorship" category, all of which resulted from about 3.8% of the participants, meaning that 96% of the students who indicated they

currently have a peer mentor felt that their peer mentor was effective in some way. Support offered by the mentor was the most common characteristic that was compelling to participants, making up just under half (40.7%) of responses. This speaks to the strength of **what** mentors do to support mentees. The next most frequent category was who the mentor was and the experiences they have had, which made up about one-third of the responses (34.1%). This speaks to the importance of **who** mentors are in terms of their personality, qualifications, and experiences. The relationship dynamics were also important to students, making up about one-fourth of the responses (23.0%). This speaks to the importance of **how** the mentoring relationship functions. Table 2 features the coding categories with accompanying representative quotes. More thorough definitions for the coding categories can be found in Appendix B. It should be noted that all participant quotes shared are directly copied from the participant's survey sheet, thus retaining all spelling and grammatical errors that may be present.
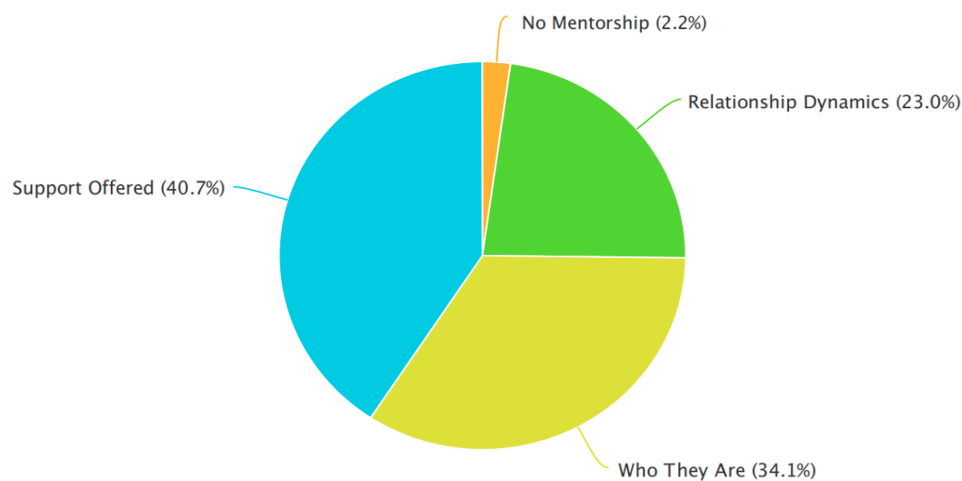
Figure 2. Visual representation for the total coded responses frequencies for each category across the 78 complete participant responses.

Ultimately, when examining what students identified that they perceived makes their peer mentor effective was the focus on the what, who, and how of the relationship. This speaks to the importance of having emotionally intelligent mentors who have relational skills such as being empathetic and honest (Table 2, Who They Are…), serving as a role model (Table 2, Relationship Dynamics), and being psychosocially and developmentally aware and supportive (Table 2, Support Offered) [27]. Throughout all three coding categories that were representative of effective mentorship, mentors were able to offer meaningful support through building strong connections with the mentee (Table 2, Relationship Dynamics), encouraging through both positive and negative emotions (Table 2, Support Offered), and managing their own stress and emotions well (Table 2, Who They Are…) [27]. Some instances were focused on the logistics of the mentor within "Who They Are.." (Table 2), such as being in the same major, having the mentor be older, etc., but overall, the responses were mainly focused on the ability of the mentor to be present, make connections, and share valuable information. It should be noted as well that the researchers rarely assigned only one code to a participant's response. Over half (55.1%) of the participants had more than one code assigned to their response. This emphasizes the importance of a mentor to not just provide single character trait or performance of a certain activity, but to express multiple of these characteristics or activities.

Table 2. Thematic coding categories with frequencies and representative quotes.

Themes (frequency)	Representative Quotes
Support Offered (55)	• Being involved in my life. None of my peer mentors are involved in only one aspect of my life. I may come to them for specific advice on specific things, but they know more than what I'm studying or the classes I'm in (Participant 2). • He knows basically everything I ask help on in the college of engineering (Participant 33). • Gives me information about opportunities and the state of the industry so that I can be better prepared to find and get a job in engineering (Participant 40). • He formed a study group there and kept it going into engineering. The study group shrunk over the years to be more condensed, but it was really effective (Participant 46). • It's not just about homework help, but about emotional support as well (Participant 58). • They give hints, show the homework is wearing on them too, ask about how I enjoyed that last assignment, and basically check on how I'm doing without ever asking "How are you doing?" We all know we can call each other and any hour (if you're up at midnight doing the homework, chances are at least 1 other of them is too), and it's nice to hash out any confusion in the information we have. It's there, but requires me to do the work (Participant 60). • She cares (Participant 73). • Willing to take the time to figure something out themselves first to help me, or get me in touch with someone that can (Participant 79).
Who They Are & Experiences They've Had (46)	• We both have similar busy schedules and similar amount of time we are able to dedicate to homework and study. We both are in the same classes, in the same major, and in the same stages of life that allow us to meet together, study, and do homework together (Participant 5). • Has similar interests and career goals (Participant 11). • Sincerity (Participant 16) • He is a good example of a studious and hardworking student (Participant 23). • The readiness to help (Participant 38). • They are reliable (Participant 47). • My peer mentor is effective because they understand the exact challenges I go through to complete my degree (Participant 49). • He's very willing and happy to help with no judgment (Participant 52). • They communicate well and are very helpful (Participant 63). • He was a senior when I was a freshman (Participant 76).
Relationship Dynamics (31)	• What makes her really an effective peer mentor though is that she is a true genuine friend (Participant 5). • She almost acts like a mother with the 'I want you to grow up better than I did' attitude (Participant 6). • She and I already get along well and have similar personalities (Participant 29). • Peer mentoring is often a two-way street where both people help one another (Participant 58). • We are not scared to argue our views of homework which ends in learning material more effectively. I believe our personal relationship provides better communication which in the end is the most support you or a peer mentor can provide. If you are not communicating then you are doing it yourself. Assigned groups can be frustrating since people fear to share information or communicate about their individual progress (Participant 59). • We live together so I get to see how another engineering student lives their day to day (Participant 70).
No Mentorship (3)	• NA (Participant 17). • He only reached out to me once and I didn't respond (Participant 50). • I never met them. So not effective. I havent asked them for help at all because I feel like I havent needed it yet (Participant 67).

In summary, in answer to the research question of "What are the common characteristics or activities of effective peer mentor?", the **what**, **who**, and **how** are critical. The **what** is the support that a peer mentor can offer, the **who** is who the peer mentor is and what experiences they have, and the **how** is the relationship dynamics between the mentor and mentee.

Implications & Recommendations

While the results of what makes an effective peer mentor may not be novel for peer mentoring in general [28]–[31], the studies in engineering are limited, especially for specific, narrow populations (e.g., undergraduates, minoritized, first-year, etc.). This study included all years of undergraduate engineering and all identities of students, but it does serve as a comprehensive look into the world of effective peer mentorship in undergraduate engineering, which does not seem to be widely available in current literature. This study will be a foundation for future studies that can look into the **what**, **who**, and **how** for a more diverse and large set of students in engineering.

It is also unique that the students in this study were under emergency hybrid learning circumstances, which brings relevancy to the findings in the changing landscape of engineering education specifically and higher education in general. The percentage of students in distance courses is continually and will continue growing [32]. This study serves as a foundation for determining what students needs and perceptions regarding peer mentorship look like in a hybrid or distance situation versus a fully face-to-face format.

By intentionally incorporating peer mentorship into a college of engineering's curricula and culture, engineering programs have the opportunity to provide students with the support and guidance they need to succeed at a minimum cost. Educators can also use these findings to develop and refine mentorship programs tailored to engineering students' needs.

As such, the following recommendations in implementing effective peer mentorship in undergraduate engineering are provided. It is important to implement effective peer mentorship for students' personal and professional growth. The ideas within the recommendations are by no means exhaustive or comprehensive, but they emerged based on the themes gathered from the student responses. These were created in relation to positive, effective peer mentorship, namely the **what**, **who**, and **how** of an effective peer mentor, which align with the screening and training standards of practice for effective mentoring created by MENTOR [33]. They can serve as a valuable resource and guide for those who want to encourage, support, and scaffold the development of peer mentoring in their educational setting:

- **What:** A peer mentor should possess the emotional and cognitive qualities to serve in this role. This may require a training and support program to not just identify potential peer mentors who can serve in this role but to help them in the process.
- **Who:** It is known that peer mentors should be close in age and grade-level. Consider opening incentive opportunities tailored to prospective peer mentors at every year of the undergraduate experience (e.g., freshmen, sophomore, junior, senior). Ask advisors, instructors, student chapter presidents and other representative to recommend to the names of students who possess the potential to become peer mentors. Consider selecting

a cohort of peer mentors per year and a implement a rotational program to avoid burn-out.

- **How:** Establish an incentive (not necessarily monetary) program to hire peer mentors that are a semester or year above each cohort back into classrooms and out-of-school activities. While these students normally are hired in formal tutoring programs and teaching assistantships, consider how peer mentors can be incentivized differently to better create productive mentorships and hopefully friendships. For example, peer mentors can also earn credits by how much departmental service they can provide to their students.

Limitations & Future Work

This study has some limitations that should be considered when interpreting the results. It is recognized that the sample size of this study was relatively small since only 79 of the 223 participant responses were from those with a peer mentor. This may not be representative of all engineering students in other colleges of engineering. The anonymous, short-answer question limited the ability to probe deeper into student responses since the researchers did not have the ability to follow up on the students' self-reported answer. It should also be acknowledged that this study was conducted during the COVID-19 pandemic. Students were in an emergency hybrid learning situation, which may have affected their responses as well as their peer mentoring practices. No demographic information was considered for analysis in this study because of the small and homogenous population size.

Future research on this same data set will include examination of descriptions of who their peer mentors were, which may include more in-depth information about what made them effective mentors. Future research could also build on these findings by examining the impact of effective engineering peer mentorship on student outcomes over a more extended period, especially with regard to first year participants, which made up 20% of our 79 participants who had a peer mentor.

Conclusion

The results of this study suggest that peer mentorship can be a valuable resource for engineering students. Being someone that can relate to their mentee and have a good relationship through strong emotional intelligence is important. For example, it takes someone who is not just going to give answers to homework problems but teach their mentee how to solve those problems in a supportive, safe, and relatable way. By determining how students perceive that **what** support was given, **who** the peer mentor is and what experiences they have, and **how** the relationship functions as what makes their peer mentor effective, engineering programs can know how to better screen, place, and train their mentors in mentoring relationships. These findings have important implications for engineering programs, as they suggest that peer mentorship should be encouraged and supported to benefit both mentees and mentors. The recommendations provide a framework by which those encouraging peer mentorship can help place and train mentors and mentees in circumstances that can support an effective peer mentoring relationship.

Acknowledgements

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Appendix A

Code Number	Code Description
1	FRIENDSHIP (Participant mentioned being friends with their peer mentor, either directly by calling out friendship or mentioning elements of friendship, such as enjoying time spent together and feeling comfortable.)
2	MUTALITY/EQUAL PARTNERSHIP (Participant discussed working together with their peer mentor in a way of mutuality and/or equal partnership, emphasizing that the relationship is not one-way, and they are working together.)
3	RELIABLE, AVALABLE, & WILLING (Participant mentioned that their peer mentor was reliable, available, and/or willing. This may be evidenced by time, effort, and responsiveness.)
4	SIMILAR INTRESTED, MOTIVATIONS, AND/OR VALUES Participant points out similar interests, motivations, and/or values between them and their mentor, such as seeking out similar activities/interests, having similar levels of commitment, and valuing education and career similarly.)
5	SHARES INFO, TUTORING, ADVICE & OPORTUNITIES (Participant discusses their peer mentor sharing information, tutoring, advice, and opportunities. This is primarily in the realm of being knowledgeable about the ins-and-outs of the college of engineering (including classes, professors, etc.), sharing advice on how to successfully navigate engineering, providing connections to additional network members, forming study groups, etc.)
6	OFFERS SUPPORT, ENCOURAGEMENT, & CHECK-IN'S (Participant discusses their peer mentor offering support and encouragement through checking in. This is primarily in the realm of providing encouragement and support when struggling, lifting when discouraged, providing hints and encouragement in hard times, etc.)
7	CARES & INTRESTED IN MY SUCCESS (Participants indicated that their peer mentor is interested in their life, both inside and outside of school, desiring them to be successful. This comes with having the mentee's best interest in mind.)
8	SIMILAR RECENT EXPERENCES (Participant mentioned that their peer mentor is currently or recently has been in a similar situation, such as major, classes, stage of life, semester, challenges, etc.)
9	ANSWER QUESTIONS (Participant indicates that their peer mentor is able to answer questions they have. These may or may not include the subject peer mentors are answering questions about.)
10	VULNERABILITY, RELATEDNESS, & UNDERSTANDING (Participant mentioned that the participant is relatable, vulnerable, and/or understanding, such as being willing to honor many points of view, show that they are struggling too, are down to earth, etc.)
11	ROLE MODEL (Participant indicated that their peer mentor is a role model to them in some way, such as being an example in studying and effort in school.)

Appendix B

Code Number	Code Description
1	SUPPORT OFFERED (Participant mentions the things the mentor offers as support, such as answering questions, sharing info, tutoring, giving advice, providing opportunities, encouraging, checking in, caring, OR being interested in a mentee's success)
2	WHO THEY ARE & EXPERENCES THEY'VE HAD (Participant indicates what personal characteristics, experiences, or knowledge that the mentor holds make them an effective mentor, such as having similar recent experiences, being reliable/available/willing, having similar interests, being similarly motivated, holding similar values, OR being vulnerable/relatable)
3	RELATIONSHIP DYNAMICS (Participant mentions the type of relationship dynamics making it an effective mentorship, such as friendship, mutuality or equality in partnership, OR role modelling)
4	NO MENTORSHIP Participants expressed/mentioned that the mentor either did not reach out to them or vice versa. This could be for multiple reasons, such as feeling no need for a mentor. They said having someone to report to was unnecessary. Alternatively, the participant left a blank response.