What Do Undergraduate Engineering Students at the Onset of Emergency Hybrid Learning During COVID-19 Say About Peer Mentorship?

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Introduction

This complete research paper addresses the perceptions of undergraduate engineering students during the onset of the worldwide pandemic (COVID-19) in an engineering college at a western institution of the United States. Specifically, these students were asked about their perceived needs around peer mentorship amidst pivoting between hybrid and in-person learning at the onset of COVID-19.

Mentorship is defined as the interaction between two individuals whose goal is to help one another in psychosocial matters, support personal and professional growth, and provide career guidance [1]–[4]. Generally, there are two main types of mentorships recognized: traditional and peer. Traditional mentorship involves a mentor who may be older, has much more experience, or holds a power differential when compared to the mentee [5]. Peer mentorship is a relationship between two persons who are at approximately the same personal, professional, or educational stages (with one who may have slightly more experience) [1], [5]–[8]. Peer mentorship has been shown to address both psychosocial and academic career support needs even though the individuals are at similar stages [1], [5], [8], [9]. Since these near-peers or step-ahead (i.e., mentors who are at the same or just slightly ahead in their development [1]) mentors have recently been in the same situation as the mentee, there is a level of mutuality and interpersonal comfort built, allowing for both the mentor and mentee to benefit from the peer relationship, which may not be present in traditional mentorships [5], [10].

Peer mentorship generally has positive outcomes for both the mentor and mentee, especially for underrepresented and first-year students, specifically with regards to retention, persistence, and student experience [7], [9], [11]–[16]. Despite this, peer mentorship is an often-overlooked resource for student support and success. Yet, peer mentoring may afford sustainable and economical ways to support students in their undergraduate programs while lessening the loads that many administrators, faculty, and staff juggle in their everyday academic responsibilities [1], [5]–[7], [9], [12], [17], [18]. From a solely retention standpoint, it is known that the first years of undergraduate engineering education is a pivotal time when many students leave engineering [19].

According to the literature, introducing mentoring during the first year of a college education has been found to be effective at increasing both recruitment and retention in STEM fields [1], [20]–[22]. For example, Dennehy and Dasgupta found that undergraduate women in engineering majors having a same-gender peer mentor early in their education promoted retention and academic success [20]. Freshman in engineering at the University of Arkansas who participated in a peer mentorship program were significantly more likely to return to campus after their first semester, and they also yielded a higher GPA than non-mentored students [21]. Sanchez et al. [22] found that those students who had peer mentors as a first-year student were overall more

satisfied with their institution and had stronger intentions of persisting. However, all the aforementioned studies occurred in-person.

While virtual peer mentoring programs are beginning to be explored in engineering (e.g., [23]–[25]), evaluation of student perceptions of their mentoring needs prior to beginning these campus initiatives are lacking. Even before COVID-19, scholarly research reported that feelings of isolation are common in virtual education situations, even for students that may be on-campus and taking fully or partially online courses [16], [26]; this was especially evident during COVID-19 where almost all students transitioned to emergency hybrid learning (EHL) situations and faced the challenge of distancing and isolation [27]. The chain of events and lessons learned during the onset of COVID-19 set an important stage to situate students' perceived mentoring needs for hybrid and fully online learning environments. As such, understanding these perceived needs before starting virtual mentoring programs will be important as the trends indicate an increasing demand for more accommodating learning and mentoring environments to more flexibly support students' feelings of isolation, socialization experiences, learning gains, and equitable educational experiences [26]–[30].

As part of a larger mixed-methods dissertation study by Christensen [31] that took place during the Fall of 2020, 223 undergraduate engineering students shared perceptions about their needs with regards to peer mentorship during the early onset of EHL in COVID-19. The focus of this study is a secondary analysis of those student perceptions of peer mentoring needs. This analysis resulted in the development of four recommendations to support implementation of hybrid or fully online peer mentoring efforts, namely normalizing the integration of hybrid peer mentoring options, providing opportunities early and continually, talking about it often, and providing a variety of informal and formal opportunities.

Methods

Rationale for Secondary Data Analysis

Since student peer mentorship needs in engineering have not been explored at length and lack consensus [31]–[34], an exploratory mixed-methods instrument was developed for validity and reliability (i.e., quantitative Cronbach's Alpha = .783; qualitative content and face validation in multiple rounds) to collect these perspectives [31]. The instrument contained 33 quantitative Likert-scale items, 8 qualitative questions, and 8 participant identifier questions [31]. Because of the timing of data collection during COVID-19 for Christensen's dissertation study [31], it was assumed that some students had solely been taking university classes in an EHL scenario (i.e., freshman) and others had transitioned to this EHL environment from a primarily in-person university learning (IP-EHL) scenario (i.e., sophomores, juniors, and seniors). However, the data in [31] required a deeper exploration of the needs of these groups.

Only two qualitative questions from the validated instrument were analyzed in Christensen's study [31], which were "What challenges or barriers currently exist for you in establishing peer mentoring relationships?" and "In what ways could the College of Engineering support you in establishing peer mentoring relationships?" Themes garnered from the qualitative coding of

students' responses to these questions were integrated with quantitative findings, which yielded three overall points of integration regarding priority student communicated needs: 1) lack of overall knowledge and support; 2) COVID-19 pandemic; and 3) no need, barrier, or benefit. These points of integration from Christensen [31], which included both EHL (44 participants) and IP-EHL (179 participants) students, were situated around the established theoretical bases of mastery goal orientation [35], future time perspective [36], [37], and hidden curriculum [38]–[40]. Administrative recommendations were primarily linked to supporting students in recognizing the *why* of peer mentorship and considering the difference in perceptions of those who may be at different points in their academic careers while keeping in mind analyzing and utilizing existing resources on campus, exploring and sharing the definition and benefits of mentoring to a wider audience of mentors and mentees, and investigating ways to formalize peer mentorship for a broader population of students.

While the recommendations from Christensen [31] were powerful for future efforts in primarily in-person, on-campus situations since that was the assumed main delivery method for peer mentorship at the given institution under "normal", non-emergency pandemic conditions, the analysis of the two qualitative questions was limited in recommendations for hybrid or virtual settings. Thus, this paper aims to fill that gap by reanalyzing EHL and IP-EHL student responses with a lens of considerations around student needs for peer mentorship for students in hybrid or fully virtual situations. Reflections were made to consider the potential differences in the perceptions of EHL and IP-EHL students. The results and implications garnered from this deeper dive allowed us to provide recommendations for future efforts in hybrid or fully virtual peer mentorship in engineering.

Research Question

The research motivation for this analysis emerged from the frequent participant responses in Christensen's study [31] related to the impossibility or difficulty in receiving peer mentorship in virtual or distance learning scenarios. As such, the research question for this study is: **What are the unique priority student communicated needs that should be considered with relation to fully or hybrid virtual peer mentoring relationships?**

Researcher Positionality

Within this study, the first author was able to research a student population that she had been a part of for many years. She had completed undergraduate and graduate degrees at the institution within the College of Engineering being studied. She brought personal experience to the study, both inside and outside of the classroom with both in-person and online courses, which positioned her as an insider since she was familiar with the organization and potential demands in that realm [41]–[43]. She was mindful of her positionality throughout the study to provide critical and beneficial yet ethical research findings. The secondary author provided ample experience in the scholarship of mentoring and has many years of experience teaching, training, and studying mentoring for both in-person and virtual spaces [31], [39], [40]. Together, the authors position the importance of equity in virtual and in-person peer mentoring programs by evidence-based research and practices.

Instrument Questions of Interest

The qualitative questions used for this study were from the mixed-methods instrument developed and validated by Christensen [31]. The full content of the survey can be found in Christensen's study [31]. For this study, the focus of the secondary analysis will be centered around the two following qualitative questions:

- Question 9: What challenges or barriers **currently** exist for you in establishing peer mentoring relationships?
- Question 10: In what ways could the College of Engineering support you in establishing peer mentoring relationships?

It should be noted that within the instrument, participants were provided with the following definition and example of peer mentorship:

> **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. [31, p. 258]

Recruitment

The Utah State University Institutional Review Board (IRB) approved all recruitment and research procedures [31]. All recruitment and survey participation occurred through virtual means due to the hybrid learning situation during the COVID-19 pandemic. The survey administered was completely anonymous, though 199 participants opted in to share their information in a separate form to enter a randomized drawing for gift cards. All participants were undergraduate students in the College of Engineering of interest. After data cleaning 325 survey submissions, a total of 223 responses were retained for analysis. The demographic information for all 223 participants is included in Table 1. The participant population was considered representative of the university of interest's population and national averages for engineering education where applicable [31]. Only approximately 4% (9 participants) of Question 9 and 6.3% (14 participants) of Question 10 responses were left blank.

Qualitative Analysis Approach

Similar to Christensen [31], a phenomenological-type of analysis [44], [45] was employed in the analysis of the responses to the two open-ended qualitative questions of interest. This approach was chosen to allow for truly exploring each participant's personal experience through their own

words [46]. Since the first author was an active participant within the population of interest, a hermeneutic phenomenological approach specifically was chosen so the researcher's insider positionality and potential subjective bias could be allowed to further interpret student responses [47], [48]. The first and second author discussed at length both the dissertation [31] and this study, being mindful and reflective on potential biases. By doing this, they were able to use past experiences and preconceptions within the given context to further unfold and expand upon student responses [47]. To further monitor and correct any potential biases, intercoder agreement [49] was additionally performed with undergraduate student researchers external to the institution studied (see Acknowledgements), which will be further described in the next section.

Table 1. Demographic information for all 223 participants [31]. Only responses that were completed by the participants are included even if there may have been more options as listed in the footnotes.

Year in Undergraduate Engineering		Declared Major	
Freshman	19.7%	Mechanical Engineering	55.6%
Sophomore	13.0%	Civil / Environmental Engineering	18.0%
Junior	40.4%	Biological Engineering	6.7%
Senior	24.2%	Electrical / Computer Engineering	15.7%
Other	2.7%	Intend to Pursue Engineering	0.9%
		Other	3.1%
Self-Identified Gender Identity[1]		**Of Hispanic, Latinx, or Spanish Origin**	
Male	74.0%	Yes	3.0%
Female	23.8%	No	90.0%
Prefer not to answer	2.2%	Prefer not to answer	7.0%
First Generational Status[2]		**Race[3]**	
Yes	7.6%	White	91.0%
No	91.5%	Person of Color	3.2%
Prefer not to answer	0.9%	Prefer not to answer	5.8%

1. Participants chose all that applied from: 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, or prefer not to answer.
2. The first person in immediate family [e.g., mother, father, sibling(s), grandparent(s)] to attend college
3. Participants chose all that applied from: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, Other race (please specify), or prefer not to answer

Qualitative Coding Procedures

The approach taken within the qualitative coding was to focus on determining and more fully embracing the unique needs of students in EHL situations to provide recommendations for peer mentorship in fully virtual or hybrid learning situations, as mentioned in the research question section above. From the 223 student responses, about 25% (60 responses) were first-cycle coded using initial coding to provide guidance for further exploration of the data [49]. Initial coding is an open-ended method that allows the researcher to begin examining the true breadth and depth of the data [49]. All the codes that emerged from initial coding allowed for in-vivo guidance in

the naming of code categories [49], [50]. The responses were analyzed on a participant-by-participant basis, then allowing the codes to be compiled based on similarities, typical of a phenomenological-type study [44]–[46].

The provisional codes were compiled into a basic codebook that included only a brief definition of the code, not exclusion and inclusion criteria or specific examples. Two undergraduate student researchers, one a current student and the other recently graduated at the home institution of the first author, were then enlisted to code the same 25% of the data on their own using the code book. Initial interrater agreements were 86.7% (Q9) and 88.3% (Q10). These were iteratively discussed, and the codebook was adjusted until full consensus was achieved [49]. The full data set was then coded using the resulting coding scheme.

Results

The following sections feature the results from the qualitative coding of both Q9 and Q10, which will be followed by an integration to provide implications and recommendations. It should be noted participant quotations shared are directly copied from their survey responses, so any spelling or grammatical errors are preserved. Each question and participant number are included in parentheses after direct quotations along with and indicator of whether the student was considered EHL or IP-EHL. Also, there were some codes that overlapped between in-person and virtual environments. For this study, we focus only on presenting and discussing the virtual-related codes.

Q9: Challenges or Barriers to Establishing Peer Mentoring Relationships

For Q9, which regarded the challenges and barriers that students face in establishing peer mentoring relationships, seven code categories emerged from focus coding the initial codes. Some of the categories were developed from a single, distinct code, while others were a compilation of multiple individual but related codes, as shown in Figure 1.

The three code categories of particular interest regarding virtual mentorship are aspects of Lack of Understanding, Distance / Online Environment, and COVID – no implications of effects. Each of these categories will be discussed here, with overall implications and recommendations being provided in the integration section.

1. Lack of Understanding

The "Lack of Understanding" code category was the most frequently occurring, primarily because of its breadth. Two primary codes fell within this coding category: difficulty defining peer mentorship and don't know where or how to find a willing and/or beneficial peer mentor. The where or how code also had two sub-codes of lack of opportunity or resources and perceived difficult timing or access. Some participants lacked understanding in the definition of peer mentorship and others lacked the knowledge of what needs they had and how peer mentorship could address them. Some expressed confusion over whether peers who are just friends, acquaintances, peers in study groups together are considered mentors. Majority of the responses

in this category related to students not knowing where to go to find a suitable and willing mentor. Table 2 contains representative quotes, expressing the many facets of this lack of knowledge.

Figure 1. Code categories for Q9 with applicable sub-codes that emerged from focus coding the initial codes. The total number of code occurrences overall as well as the individual frequency of occurrence are shown.

Table 2. Representative quotes for the coding category "Lack of Understanding" for Q9 (Challenges or Barriers to Establishing Peer Mentoring Relationships).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "I don't know very much about it at all. I hear "peer mentor" a lot but I still have no idea what it is or how it works or anything like that" (Q9, Participant 147) • "I have no Idea where to begin" (Q9, Participant 91)	• "What do I want to know from them? I am not even sure what path I want to take" (Q9, Participant 80) • "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" (Q9, Participant 31) • "You can always find people in your classes but then you are developing a study group and not a peer mentorship" (Q9, Participant 196) • "Not knowing where to start" (Q9, Participant 105, IP-EHL) • "It's also hard for me to make close relationships with my peers sometimes because they are all men" (Q9, Participant 53) • "There is generally not a lot of individuals who are willing to specifically be a mentor" (Q9, Participant 185) • "Finding someone older and "wiser" than me to mentor me through some of my challenges can be difficult" (Q9, Participant 76)

2. Distance / Online Environment

Like other studies that have cited geographic separation as a difficulty in mentoring relationships since it's more difficult to get to know someone on a personal level [51], there were many participants who mentioned distance or the online environment as an issue. Students struggle with not being able to initiate relationships as easily through virtual means and do not feel that virtual interactions are sufficient contact. Of the 70 code occurrences, 18.6% of the occurrences in this category were from participants who identified themselves as freshman, which was similar to the total percentage of freshman participants at 19.7% of the participants were freshman. This means that that all students felt similarly that the separation of EHL situations were a barrier. The representative quotes in Table 3 emphasize this struggle.

Table 3. Representative quotes for the coding category "Distance / Online Environment" for Q9 (Challenges or Barriers to Establishing Peer Mentoring Relationships).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "Everything being online makes it hard to actually get to know someone even if they help you with what you need" (Q9, Participant 79)	• "Online classes, lack of actual contact with my peers" (Q9, Participant 35) • "There are not a lot of opportunities to meet people and/or establish those relationships" (Q9, Participant 166)

It should be noted that 25 code occurrences were related to committing time to peer mentorship, which may be particularly important to consider with fully or partially online students as they may have a higher likelihood of non-traditional obligations, such as the participant who said, "I am a non-traditional student, and I do not spend a lot of extra time looking into what resources I have available to me on campus because I go home to take care of my family in the afternoon" (Q9, Participant 183, IP-EHL). This may especially impact their ability to make connections with others.

3. COVID – no implications of effects

This coding category may most thoroughly show the gap in students' understanding of what peer mentorship is and how it can be established and maintained. The participant responses in this category were claims that "the corona virus is the number 1 obstacle right now" (Q9, Participant 5, IP-EHL). Responses in other code categories could also include a mention of the COVID-19 pandemic, but they specifically gave the effect or implication of what the barrier was that was caused by COVID-19. For this code category, there was no explanation or implication of why COVID-19 was such a barrier to them building mentoring relationships, shown in the representative quotes in Table 4.

Table 4. Representative quotes for the coding category "COVID – no implications of effects" for Q9 (Challenges or Barriers to Establishing Peer Mentoring Relationships).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "global pandemic" (Q9, Participant 16) • "COVID" (Q9, Participant 30)	• "COVID 19 Restrictions" (Q9, Participant 37)

Of the code occurrences in this category, 31.7% were from participants who identified themselves as freshman, meaning that they likely had not had an opportunity to attend the university under "normal" circumstances. In the overall population, only 19.7% of the total participants in the study were freshman. This may be telling since these students had known nothing outside of EHL circumstances, with COVID-19 being a barrier not only to peer mentorship but also to their perceived "normal" university experience.

Q10: Proposed College of Engineering Support

For Q10, which regarded the potential support the College of Engineering could provide in establishing peer mentoring relationships, five code categories emerged from focus coding the initial codes. Similarly, some of the categories were developed from a single, distinct code, while others were a compilation of multiple individual but related codes, as shown in Figure 2.
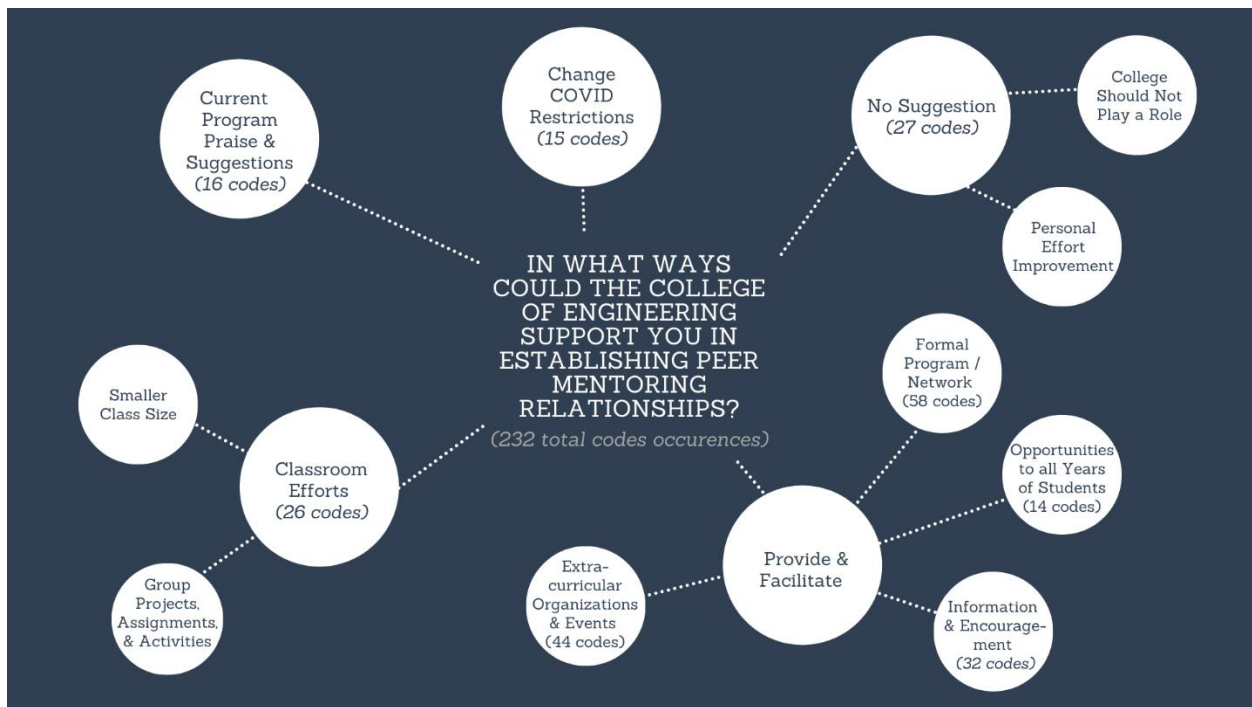
Figure 2. Code categories for Q9 with applicable sub-codes that emerged from focus coding the initial codes. The total number of code occurrences overall as well as the individual frequency of occurrence are shown.

The three code categories of particular interest regarding virtual mentorship are aspects of Classroom Efforts, Provide & Facilitate, and Change COVID Restrictions. Each of these categories will be discussed here, with overall implications and recommendations being provided in the next section.

1. Classroom Efforts

The two types of responses in this category related to the implementation of smaller class sizes as well as an increase of availability in group assignments, activities, and projects to allow them to "help me get to know people" (Q10, Participant 3, IP-EHL). Representative quotes for this category are shown in Table 5.

Table 5. Representative quotes for the coding category "Classroom Efforts" for Q10 (Proposed College of Engineering Support).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "They have allowed for us to have group projects that help us to meet more people" (Q10, Participant 30)	• "Engineering class sizes are so big that potential mentors would have a hard time picking out those in need" (Q10, Participant 188) • "Have several smaller classes that are more hands on earlier on in the engineering career. Classes where students actually have some time to meet and work with their peers" (Q10, Participant 28) • "A slight increase in the number of group-oriented assignments might be helpful especially considering the way the actual engineering industry operates. Teambuilding skills are essential and I feel that they are slightly lacking in the current curriculum" (Q10, Participant 8) • "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" (Q10, Participant 10)

2. Provide & Facilitate

By far the broadest category covering the most occurrences, students proposed many different ways that the College of Engineering could support them through providing and facilitating a formal program/network, extracurricular organizations and events, information and encouragement, and opportunities to all years of students, with incentives being included in some cases. The representative quotes in Table 6 show some ideas participants presented.

Table 6. Representative quotes for the formal portion of the coding category "Provide & Facilitate" for Q10 (Proposed College of Engineering Support).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "Helping set up first-time meetings, because from experience that is the hardest to set as a student, whether it be out of fear or making time out of a students schedule" (Q10, Participant 43) • "Maybe there could be an online place at the beginning of semesters for mentors and other students to all meet each other so they could choose each other based on common interests" (Q10, Participant 79)	• "Having an available list of people who are willing to meet other students in the major who are either needing help or offering help" (Q10, Participant 25) • "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) • "Offer credit to the mentors for helping" (Q10, Participant 191) • "Give incentives for senior level engineering students to be peer mentors" (Q10, Participant 159)

Some students just want the College to facilitate extracurricular activities and clubs where mentors are not necessarily assigned, but the opportunity is open, which could include better leveraging resources such as expanding the tutoring program and encouraging young engineering student participation in clubs (Q10, Participants 11, 34, & 212, IP-EHL). This is shown in the examples in Table 7.

Table 7. Representative quotes for the informal portion of coding category "Provide & Facilitate" for Q10 (Proposed College of Engineering Support).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "The college of engineering could have more socials and opportunities to meet other students" (Q10, Participant 164)	• "More opportunities to network with other upperclassmen that are not during common classes" (Q10, Participant 37) • "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) • "Increasing the number and frequency of socials would help" (Q10, Participant 66) • "Connect upper-classmen with lower-classmen through activities and events" (Q10, Participant 95)

Many students mentioned simply sharing information, encouraging, and advertising current, which is related through representative quotes in Table 8.

Table 8. Representative quotes for the sharing information, encouraging, and advertising portion of coding category "Provide & Facilitate" for Q10 (Proposed College of Engineering Support).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• "Provide more information on what it actually means to have a peer mentor and how to get one" (Q10, Participant 147)	• "If we have a program I've never heard of it" (Q10, Participant 4) • "Ensure that it is in the orientation of school. Or if it was in the intro classes for the Major" (Q10, Participant 87) • "Find ways to encourage them to reach out to each other in educational and productive ways" (Q10, Participant 97)

Across all these opportunities for providing support and facilitation, students wanted the resources expanded to include all students, regardless of year in school, with a specific emphasis on providing opportunities early in education. These sentiments are expressed in the representative quotes in Table 9.

Table 9. Representative quotes for the timing portion of coding category "Provide & Facilitate" for Q10 (Proposed College of Engineering Support).

EHL *(i.e., freshman)*	IP-EHL *(i.e., sophomores, juniors, and seniors)*
• N/A	• "I wish I had been given this connecting with a mentor my first year here. Instead I had to navigate engineering on my own which has been very difficult" (Q10, Participant 132, IP-EHL) • "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." (Q10, Participant 189, IP-EHL)

3. Change COVID-19 Restrictions

As with the COVID barrier under Q9, some participants did not see "much we can do during COVID-19" (Q10, Participant 2, IP-EHL). Students wanted the college to "get rid of COVID" (Q10, Participant 36, IP-EHL), saying "Its all do to covid. Bringing back on campus classes. That is where I meet people to help me out" (Q10, Participant 154, IP-EHL)

While "Having in person classes, so you can meet people" (Q10, Participant 162, EHL) may be helpful, it is not always possible, both inside and outside of the pandemic. It is important to keep in mind that distance scenarios may be the only way some students have access to a university education. The amount of freshman with responses coded in this category was disproportionately high, with 46.7% coming from them while they only made up 19.7% of the total population of the participants. This high percentage may be due to the strictly EHL students (versus IP-EHL) being limited in opportunities for peer mentorship since they would have been in their first semester of undergraduate engineering education at the time of the survey.

Discussion, Implications, & Recommendations

From the results shown above, simply put, distance students need support in finding peer mentorship. We know distance situations, whether inside or outside of EHL scenarios, bring feelings of isolation [16], [26] and peer mentorship is a way some of those feelings may be able to be addressed. The goal with these distance situations should be created following Michael Simonson's Equivalency Theory in Distance Education: even if the situations and approaches look fundamentally different, all students need equivalent learning experiences [52]. Overall, students communicated a need to "improve virtual help as COVID has made it difficult to establish those relations" (Q10, Participant 14, IP-EHL). Students still wanted equivalent virtual or hybrid peer mentoring experiences when compared to in-person mentoring experiences, but they needed support in achieving that.
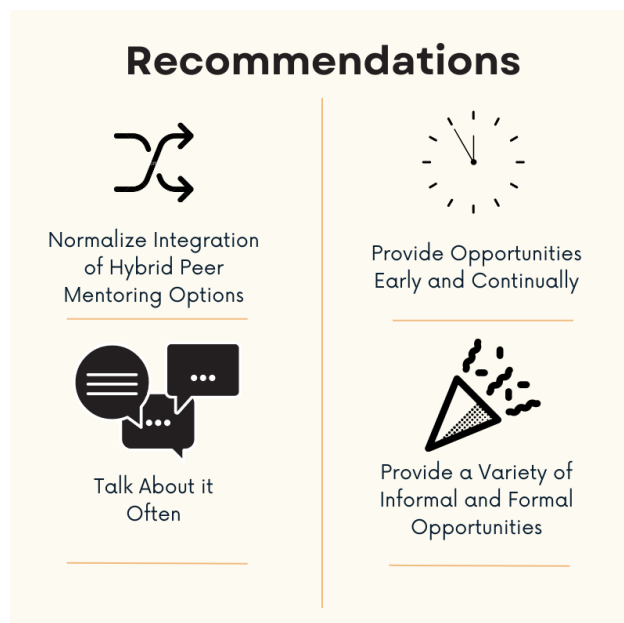
While face-to-face may seem ideal, virtual mentoring can provide a more flexible way to give students access to communicate with a diverse set of peer mentors, regardless of distance, offering a different and broader set of perspectives than those that may be available in only an in-person setting [53]–[56]. As we more fully understand student needs and take into consideration the results above with regard virtual peer mentorship, the goal toward providing the beneficial outcomes (e.g., retention, persistence, positive student experience [7], [9], [11]–[16]) of peer mentorship equitably [52] between in-person and distance learners seems feasible. As such, four recommendations have been developed to support the employment of hybrid or fully online peer mentoring efforts:

- **Normalize Integration of Hybrid Peer Mentoring Options:** As regularly as possible, provide both in-person and virtual connection opportunities, regardless of primary coursework delivery method.
- **Provide Opportunities Early and Continually:** The first two years in an undergraduate degree are a critical time for students to build relationships and garner much needed

support [1], [19], but those needs don't necessarily go away when students transition to upper division courses.

- **Talk about it Often:** Help students define what mentorship is and clarify that all forms of mentorship, both formal (e.g., assigned, programmatic peer mentors, etc.) and informal (e.g., friends, study groups, etc.) are important and beneficial.
- **Provide a Variety of Informal and Formal Opportunities:** Provide a variety of formal and informal opportunities both virtually and in-person to build peer mentorship. This may look like setting up a formal program that assigns a peer mentor to student or it could look like a casual social with students mingling freely or through icebreaker activities.

A visual of the recommendations is provided in Figure 3.

Recommendations

Normalize Integration of Hybrid Peer Mentoring Options

Provide Opportunities Early and Continually

Talk About it Often

Provide a Variety of Informal and Formal Opportunities

Figure 3. Recommendations for more fully implementing peer mentorship in EHL and general distance learning scenarios.

Limitations & Future Work

The biggest limitation in the survey is that the students were asked to provide the current barriers to peer mentorship and suggestions for support from the College of Engineering in general, not specifically with consideration of the EHL situation going on during the administration of the survey. This limited the amount of specific information garnered about peer mentorship in fully or hybrid online learning situations. Since students were under unique, stressful pandemic conditions at the time of taking the survey, the limitations of extending recommendations to non-pandemic conditions are recognized. Barriers and difficulties considered may have been more apparent under pandemic circumstances than typically may be present. Another limitation also arose because of the nature of self-reported short-answer survey questions, especially when answered anonymously. This type of question does not allow for follow-up from the research

team in gaining clarification. As such, future work will include additional qualitative methods based on interviewing to allow for deeper discoveries connected to students' responses.

Future work will also include more fully exploring the needs and perceptions of those who are in fully or hybrid virtual situation regularly, not just because of the COVID-19 EHL circumstances. Further exploration outside pandemic circumstances is warranted for validation and extension as this will give an opportunity to learn more about unique situations and considerations that need to be addressed to provide equivalence in peer mentorship. Furthermore, it will also be important to explore nuances in peer mentoring connected to gender and race. While this work did not emphasize on these differences given the homogenous population of the study (Table 1, [31]).

Conclusion

While exploratory and introductory in nature, the recommendations garnered from student responses are valuable to the future of equity for students in virtual peer mentoring situations. Based on participant responses to common barriers and suggestions on what the college can do, this help can and should come through integrating both typical face-to-face and virtual opportunities to all students, providing opportunities early and continually throughout the undergraduate engineering years, talking about peer mentorship often, and planning a variety of opportunities, both formal and informal, for facilitating student interactions. While many of these recommendations may also apply in a typical face-to-face situation, taking special effort to apply these things intentionally and uniquely in fully or hybrid virtual learning situations can provide the equivalence students need in experiencing peer mentorship when they are distanced from their campus and peers. As stated by Simonson [52], it isn't about doing things exactly the same in face-to-face and online scenarios but providing equivalence in learning experiences so the benefits can be reaped in all situations.

Acknowledgement

References

[1]   National Academies of Sciences Engineering and Medicine, *The science of effective mentorship in STEMM*. Washington, DC: The National Academies Press, 2019. doi: 10.17226/25568.

[2]   L. Gelles, I. Villanueva, and M. di Stefano, "'Mentoring is ethical, right?': Women graduate students and faculty in science and engineering speak out," *International Journal of Gender, Science and Technology; Vol 11, No 1 (2019)*, vol. 11, no. 1, pp. 108–133,

2019, [Online]. Available:
http://genderandset.open.ac.uk/index.php/genderandset/article/view/578/1041

[3] L. B. Limeri *et al.*, ""Where's my mentor?!" characterizing negative mentoring experiences in undergraduate life science research," *CBE Life Sciences Education*, vol. 18, no. 4, pp. 1–13, 2019, doi: 10.1187/cbe.19-02-0036.

[4] C. Palmer, "How to mentor ethically," *Monitor on Psychology*, vol. 50, no. 4, p. 70, 2019, [Online]. Available: https://www.apa.org/monitor/2019/04/mentor-ethically

[5] K. E. Kram and L. A. Isabella, "Mentoring alternatives: the role of peer relationships in career development," *The Academy of Management Journal*, vol. 28, no. 1, pp. 110–132, 1985, doi: 10.2307/256064.

[6] P. J. Collier, *Developing effective student peer mentoring programs: A practitioner's guide to program design, delivery, evaluation and training*. Sterling, VA: Stylus Publishing, LLC, 2015. [Online]. Available: https://books.google.com/books?hl=en&lr=&id=tqypCwAAQBAJ&oi=fnd&pg=PT13&dq=what+students+expect+from+peer+mentoring+programs&ots=8BL6yovNfZ&sig=wuKSJdmKZ8gQ_Ek1OjS3ZcI869Y#v=onepage&q=what students expect from peer mentoring programs&f=false

[7] P. J. Collier, "Why peer mentoring is an effective approach for promoting college student success," *Metropolitan Universities*, vol. 28, no. 3, 2017, doi: 10.18060/21539.

[8] E. A. Ensher, C. Thomas, and S. E. Murphy, "Comparison of traditional, step-ahead, and peer mentoring on protégés' support, satisfaction, and perceptions of career success: A social exchange perspective," *Journal of Business and Psychology*, vol. 15, no. 3, pp. 419–438, 2001, doi: 157.242.198.117.

[9] S. Allen, J. Lloyd-Hazlett, H. Cornelius, and D. Hunt, "Bridging the Gap: Implementing peer-mentoring programs for counselors-in-training," *Counseling & Wellness: A Professional Counseling Journal*, no. 6, 2017, doi: 10.1017/CBO9781107415324.004.

[10] NOVA SHRM and Dulles SHRM, "Mentoring program toolkit: Establishing a mentoring program in your local SHRM chapter," 2012.

[11] J. W. Colvin and M. Ashman, "Roles, risks, and benefits of peer mentoring relationships in higher education," *Mentoring and Tutoring: Partnership in Learning*, vol. 18, no. 2, pp. 121–134, 2010, doi: 10.1080/13611261003678879.

[12] D. L. Haggard, T. W. Dougherty, D. B. Turban, and J. E. Wilbanks, "Who is a mentor? a review of evolving definitions and implications for research," *Journal of Management*, vol. 37, no. 1, pp. 280–304, 2011, doi: 10.1177/0149206310386227.

[13] K. L. Meyers, S. E. Silliman, N. L. Gedde, and M. W. Ohland, "A comparison of engineering students' reflections on their first-year experiences," *Journal of Engineering Education*, vol. 99, no. 2, pp. 169–178, 2010, doi: 10.1002/j.2168-9830.2010.tb01053.x.

[14] J. marquez Kiyama and S. G. Luca, "Structured opportunities: Exploring the social and academic benefits for peer mentors in retention programs," *Journal of College Student Retention: Research, Theory, & Practice*, vol. 15, pp. 489–514, 2014.

[15] R. Ghosh and T. G. Reio, "Career benefits associated with mentoring for mentors: A meta-analysis," *Journal of Vocational Behavior*, vol. 83, pp. 106–116, 2013, doi: 10.1016/j.jvb.2013.03.011.

[16] C. L. Andersen and R. E. West, "Improving mentoring in higher education in undergraduate education and exploring implications for online learning," *Revista de Educacion a Distancia*, vol. 20, no. 64, Sep. 2020, doi: 10.6018/RED.408671.

[17] P. George and D. Peace, "Mentoring New Faculty," *Education Week*, Nov. 19, 1997. [Online]. Available: https://www.edweek.org/ew/articles/1997/11/19/13george.h17.html?print=1

[18] E. L. Dolan and D. Johnson, "The undergraduate-postgraduate-faculty triad: Unique functions and tensions associated with undergraduate research experiences at research universities," *CBE - Life Sciences Education*, vol. 9, no. 4, pp. 543–553, 2010, doi: 10.1187/cbe.10.

[19] American Society for Engineering Education, "Retention range: The wide variation among 2007 freshmen," *American Society for Engineering Education (ASEE) Newsletter*, 2016. http://createsend.com/t/y-45B6B3EF48CE7A3C#databyte (accessed Sep. 09, 2020).

[20] T. C. Dennehy and N. Dasgupta, "Female peer mentors early in college increase women's positive academic experiences and retention in engineering," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 114, no. 23, pp. 5964–5969, 2017, doi: 10.1073/pnas.1613117114.

[21] C. Gattis, B. Hill, and A. Lachowsky, "A successful engineering peer mentoring program," *ASEE Annual Conference and Exposition, Conference Proceedings*, 2007.

[22] R. J. Sanchez, T. N. Bauer, and M. E. Paronto, "Peer-mentoring freshmen: Implications for satisfaction, commitment and retention to graduation," *Academy of Management Learning and Education*, vol. 5, no. 1, pp. 25–37, 2006, doi: 10.5465/AMLE.2006.20388382.

[23] C. Faber, C. Smith-Orr, W. Lee, C. Bodnar, and A. Strong, "Best Practices for Developing a Virtual Peer Mentoring Community," 2017. [Online]. Available: https://rdw.rowan.edu/engineering_facpub/20

[24] A. Rockinson-Szapkiw, J. L. Wendt, and J. S. Stephen, "Outcomes for Mentors and Mentees 1 The Efficacy of a Blended Peer Mentoring Experience for Racial and Ethnic Minority 2 Women in STEM Pilot Study: Academic, Professional, and Psychosocial Outcomes for 3 Mentors and Mentees 4 Acknowledgements 13," *Journal for STEM Education Research*, vol. 4, pp. 173–193, 2021.

[25] J. J. Gish-Lieberman, A. Rockinson-Szapkiw, A. A. Tawfik, and T. M. Theiling, "Designing for Self-Efficacy: E-Mentoring Training for White and BIOPC Women in STEM," *International Journal of Designs for Learning*, vol. 12, no. 3, pp. 71–85, Nov. 2021, doi: 10.14434/ijdl.v12i3.31433.

[26] J. M. McInnerney and T. S. Roberts, "Online Learning: Social Interaction and the Creation of a Sense of Community," *Educational Technology & Society*, vol. 7, no. 3, pp. 73–81, 2004, Accessed: Dec. 20, 2021. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.126.3225&rep=rep1&type=pdf#page=78

[27] A. Serna, "How Our Near-Peer Mentoring Model Is Addressing Pandemic Isolation," *EdSurge*, May 18, 2021.

[28] J. E. Seaman, I. E. Allen, and J. Seaman, "Grade Increase: Tracking Distance Education in the United States.," 2018.

[29] R. M. Bernard, E. Borokhovski, R. F. Schmid, R. M. Tamim, and P. C. Abrami, "A Meta-Analysis of Blended Learning and Technology Use in Higher Education: From the General to the Applied," *Journal of Computing in Higher Education*, vol. 26, no. 1, pp. 87–122, 2014.

[30] U.S. Department of Education, "Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies," 2009.

[31] D. Christensen, "A Mixed-Methods Approach to Explore Student Perceived Needs for Peer Mentorship in a College of Engineering," *All Graduate Theses and Dissertations*, 2021, doi: 10.26076/ee04-a10e.

[32] G. Crisp and I. Cruz, "Mentoring college students: A critical review of the literature between 1990 and 2007," *Research in Higher Education*, vol. 50, no. 6, pp. 525–545, 2009, doi: 10.1007/s11162-009-9130-2.

[33] S. Gershenfeld, "A review of undergraduate mentoring programs," *Review of Educational Research*, vol. 84, no. 3, pp. 365–391, 2014, doi: 10.3102/0034654313520512.

[34] M. Jacobi, "Mentoring and undergraduate academic success : A Literature review," *Review of Educational Research*, vol. 61, no. 4, pp. 505–532, 1991, [Online]. Available: http://www.jstor.org/stable/1170575?seq=1&cid=pdf-reference#references_tab_contents

[35] A. Kaplan and M. L. Maehr, "The contributions and prospects of goal orientation theory," *Educational Psychology Review*, vol. 19, pp. 141–184, 2006, doi: 10.1007/s10648-006-9012-5.

[36] D. T. A. M. Kooij, R. Kanfer, M. Betts, and C. W. Rudolph, "Future Time Perspective: A systematic review and meta-analysis," *Journal of Applied Psychology*, vol. 103, no. 8, pp. 867–893, 2018, doi: 10.1037/apl0000306.

[37] F. R. Lang and L. L. Carstensen, "Time counts: Future time perspective, goals, and social relationships," *Psychology and Aging*, vol. 17, no. 1, pp. 125–139, 2002, doi: 10.1037/0882-7974.17.1.125.

[38] F. D. Kentli, "Comparison of hidden curriculum theories," *European Journal of Educational Studies*, vol. 1, no. 2, pp. 83–88, 2009, [Online]. Available: http://www.ozelacademy.com/EJES_v1n2_Kentli.pdf

[39] I. Villanueva, M. di Stefano, L. Gelles, K. Youmans, and A. Hunt, "Development and assessment of a vignette survey instrument to identify responses due to hidden curriculum among engineering students and faculty," *International Journal of Engineering Education*, vol. 36, no. 5, pp. 1549–1569, 2020.

[40] I. Villanueva, L. Gelles, K. Youmans, and M. di Stefano, "Hidden curriculum awareness: A comparison of engineering faculty, graduate students, and undergraduates," in *World Engineering Education Forum*, 2018, pp. 1–6. [Online]. Available: https://digitalcommons.usu.edu/ete_facpub/242/

[41] K. Herr and G. L. Anderson, *The action research dissertation: A guide for students and faculty*, 2nd ed. Thousand Oaks, CA: Sage Publications, Inc., 2015.

[42] P. Thomson and H. Gunter, "Inside, outside, upside down: The fluidity of academic researcher 'identity' in working with/in school," *International Journal of Research and Method in Education*, vol. 34, no. 1, pp. 17–30, 2011, doi: 10.1080/1743727X.2011.552309.

[43] D. Coghlan and A. B. Shani, "Developing the practice of leading change through insider action research: A dynamic capability perspective," in *The SAGE Handbook of Action*

Research, 3rd ed., H. Bradbury, Ed. London: Sage Publications Ltd, 2015, pp. 47–54. doi: 10.4135/9781473921290.n5.

[44] C. Moustakas, "Methods and procedures for conducting human science research," in *Phenomenological research methods*, Thousand Oaks, CA: Sage Publications, Inc., 2011, pp. 103–119. doi: 10.4135/9781412995658.

[45] C. Moustakas, *Phenomenological research: Analyses and examples*. 2011. doi: 10.4135/9781412995658.d9.

[46] H. Starks and S. B. Trinidad, "Choose your method: A comparison of phenomenology, discourse analysis, and grounded theory," *Qualitative Health Research*, vol. 17, no. 10, pp. 1372–1380, 2007, doi: 10.1177/1049732307307031.

[47] B. E. Neubauer, C. T. Witkop, and L. Varpio, "How phenomenology can help us learn from the experiences of others," *Perspectives on Medical Education*, vol. 8, pp. 90–97, 2019, doi: 10.1007/s40037-019-0509-2.

[48] C. Adams and M. van Manen, "Phenomenology," in *The SAGE Encyclopedia of Qualitative Research Methods*, L. M. Given, Ed. Thousand Oaks, CA: Sage Publications, Inc., 2012, pp. 615–619. doi: 10.4135/9781412963909.

[49] J. Saldaña, *The coding manual for qualitative researchers*. London: Sage Publications Ltd, 2009.

[50] J. T. DeCuir-Gunby, P. L. Marshall, and A. W. McCulloch, "Developing and using a codebook for the analysis of interview data: An example from a professional development research project," *Field Methods*, vol. 23, no. 2, pp. 135–155, 2011.

[51] J. C. Leary, E. G. Schainker, and J. A. K. Leyenaar, "The Unwritten Rules of Mentorship: Facilitators of and Barriers to Effective Mentorship in Pediatric Hospital Medicine," *Hospital pediatrics*, vol. 6, no. 4, pp. 219–225, Apr. 2016, doi: 10.1542/hpeds.2015-0108.

[52] M. Simonson, "Equivalency theory and distance education," *TechTrends*, vol. 43, no. 5, pp. 5–8, 1999.

[53] S. B. Knouse, "Virtual mentors: Mentoring on the internet," *Journal of Employment Counseling*, vol. 38, pp. 162–169, 2001, doi: 10.1002/j.2161-1920.2001.tb00498.x.

[54] J. Y. Chong *et al.*, "Enhancing mentoring experiences through e-mentoring: a systematic scoping review of e-mentoring programs between 2000 and 2017," *Advances in Health Sciences Education*, vol. 25, no. 1. Springer, pp. 195–226, Mar. 01, 2020. doi: 10.1007/s10459-019-09883-8.

[55] S. An and R. Lipscomb, "Instant Mentoring: Sharing Wisdom and Getting Advice Online with E-Mentoring," *Journal of the American Dietetic Association*, vol. 110, no. 8, pp. 1148–1155, Aug. 2010, doi: 10.1016/j.jada.2010.06.019.

[56] N. Sochacka, J. Walther, and S. Miller, "Fostering Empathy in Engineering Education." Accessed: Jan. 28, 2022. [Online]. Available: https://www.scientia.global/wp-content/uploads/Sochacka_Walther_Miller/Sochacka_Walther_Miller.pdf