Connections between a layered mentorship program and STEM identity for engineering students at an urban research university

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Abstract

This Complete Evidence-based Practice paper explores the connection between a mentorship program and STEM identity of the engineering students at the College of Engineering at University of Colorado Denver. Research shows that a meaningful mentorship program, with several layers of support for students, contributes to the overall success of students. In this paper, we study the positive impact of a Layered Mentorship Program (LMP) on the development of STEM identity for engineering students. This impact becomes more evident in urban universities with many commuting students. In such circumstances, the students have less opportunities for community building and development of STEM identity. As a result, the significance of mentorship programs becomes more obvious. The main objective of this research study is to understand the relationship between participation in LMP and student success through the development of STEM identity and peer-mentoring.

In the previous work by the research team, a theoretical framework was proposed to examine the relationships between mentorship programs, student success, and STEM identity. Here, we study how the mentorship program affects STEM identity using qualitative methods involving semi-structured interviews and surveys. Five students (mentors and mentees) were interviewed, and twenty-two students completed the survey. The qualitative analysis of the results shows that students who participated in LMP derived significant benefits, not only towards the enhancement of their STEM identity, but also through better academic achievements and stronger sense of community and belonging.

Introduction

An innovative Layered Mentorship Program (LMP) was designed and implemented in the College of Engineering at University of Colorado Denver. The main objective of this program is to promote STEM identity development and improve student success. LMP consists of a peer mentorship component where sophomore students meet regularly with freshman students, sometimes referred to as near-peer mentoring, and helping them navigate through their first year as engineering students. Additionally, the mentors meet regularly with one or two junior level engineering students who act as “lead mentors” and help to guide the mentoring process and facilitate group events with all the members. Then, those lead mentors are closely connected to graduate student assistants and the faculty leadership of the program thus, with several layers of support, we term this as the Layered Mentorship Program (LMP).

The motivation for this study derived from a previous work which examined the impact of the LMP on student retention rate. The results from a chi-square test show that there was a statistically significant improvement in retention with students who participated in the LMP as

mentees, compared to those who did not participate. A *t*-test shows a positive association between students' participation in the LMP and their GPA. In the current study, the survey and interview results indicate a shift of behavior towards the development of STEM identity for students who participated in the LMP.

The research questions for this study are:

1. How does participation in the LMP influence the development of STEM identity among the mentees?
2. What specific factors within the mentorship program contribute to the academic success and persistence of first-year student mentees?
3. In what ways do second-year student mentors perceive their leadership roles as impacting their own STEM identity and sense of belonging within the engineering community?

Background

In 2017, the faculty at the College of Engineering at University of Colorado Denver, started a learning community for its first-year students, the Engineering Learning Community (ELC). The primary goal of this program was to increase student retention and academic success through intervention-based initiatives aimed at keeping students engaged during their first year. One such feature was the introduction of a first-year interdisciplinary design course. In addition, learning community students also took combined coursework in math and English composition alongside their engineering peers. This helped to build community and engage students during the first year. Then in 2019, the Layered Mentorship Program was introduced as one of the distinguishing features of the learning community. In this, second year engineering students who participated in the learning community acted as mentors for the incoming first year students and helped them to traverse through their first year. In-house studies coming from this program, as well as external studies, highlight the importance of community building and sense of belonging as it relates to student success and persistence in engineering and in STEM.

A brief literature review, and common knowledge, indicates that most engineering students have similar experiences during their first year. Students quickly need to enroll in classes, arrange student housing, account for their cost of living, maintain their jobs, life and work in balance, and more [1]. While all these experiences are occurring, another important component of the student journey is matriculation. Often during the first few weeks of school, identity and community begin to form and resonate for many students. They begin to create and maintain a sense of belonging for themselves while attending their university [2]. As such, the program leadership holds that helping incoming students to develop a community of like-minded peers up front is important for student success.

The term "*belonging*" can be described as "the subjective feeling of deep connection with social groups, physical places, and individual and collective experiences – is a fundamental human need that predicts numerous mental, physical, social, economic, and behavioral outcomes" [3].

Reference [4] discusses sense of belonging in higher education, however the ideas and principles presented here transcend across various education subsectors as well as underrepresented communities. Reference [4] defined belonging as "a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment together". Reference [5] describes this phenomenon from the student perspective, specifically stating that "Believing in one's ability to successfully complete a particular course of action, though essential to persistence, does not in itself ensure persistence. What is also required is that students come to see themselves as a member of a community of faculty, staff, and other students who value their participation, that they matter and belong."

The importance of having a community and sense of belonging, as engineering students, is not a new concept, however it was certainly critical during the COVID-19 pandemic. Engineering students, and students in general, at universities were not immune to the effects that the pandemic had on their sense of community and belonging as students were sent away from campus, isolating themselves from their professors and peers. Despite these changes, most colleges remained open virtually, however many struggled with engagement and creating a sense of belonging. For example, in a study about belonging during the pandemic, one student said, "I feel like I don't have a good sense of bonding with people or a sense of belonging because we don't see each other face to face or talk with the professors in-depth" [6]. On the other hand, programs like the Learning Community and the Layered Mentorship program managed to alleviate these effects and promoted community building and peer engagement by employing virtual communal activities [7].

Mentorship programs are growing in popularity in academia because of the positive impacts they have on undergraduate students [8]. Higher Education administrators understand the benefits that mentorship programs can have, especially as it relates to academic success, student persistence, and leadership training that helps their students establish practical skill sets vital to engineering careers. Peer mentoring is defined as "a form of peer education where students serve as role models to fellow students and provide them with support and guidance" [9]. Peer mentoring has been shown to provide a variety of benefits for the mentees and mentors alike [10]. The mentees can see first-hand how upper classmates balance their academic, work, and home life [10]. Peer mentoring helped to promote academic achievement and community building, and in turn, to form a sense of belonging, to build self-efficacy skills, as well as leadership development [11]. In our program, incoming first year students that self-select into the learning community receive mentorship for one year, and some of them continue and serve as mentors in their sophomore year. Moreover, since the program has been in effect for 5 years, we invited the participating students from all five cohorts to be involved in our study, although only some of them responded. An important aspect was being able to include students from previous years which provided a unique perspective having participated as both mentee and mentor, while other students provided feedback only having been a mentee. Analysis of the data identified key findings: peer mentorship improves assessment performance for both mentee and mentor, reduces stress and anxiety, enhances participation and engagement in the academic community, and adds value to student outcomes. Similar outcomes are discussed in [12] and [13]. While our work generally focuses on the short term benefits that being mentored and being a mentor can

have on engineering students during their first and second year in College, another study indicated that being a mentor can have long lasting objective and subjective career benefits [14].

Experimental Methods/Materials/Project Approach

The primary goal of the layered mentorship program is to improve success rates for first-year students, while also recognizing the benefits that second-year student mentors gain from their leadership roles. To understand the efficacy of this program and how it might better achieve this goal, we utilize a mixed methods-based research approach [15]. Analysis indicated that both mentees and mentors experienced significant benefits from the program, enhancing their STEM identities, positively influencing academic performance, and fostering a stronger sense of belonging with their peers, staff, and faculty in the program.

Survey: Participants and Data Collection

The engineering learning community students who participated in the Layered Mentorship Program, from the current cohort and all previous cohorts, a total of 62 students from diverse backgrounds were invited to take this survey. The survey was designed to highlight how the LMP might affect mentees and mentors differently. In this regard, we asked the students to think about their participation in the program from the perspective of being mentored as well as from the perspective of being a mentor and respond to the same set of questions from each perspective. Thus, in what follows are the results presented side by side for cross comparison. Moreover, we wanted to know, at least qualitatively, how the LMP might affect student success, STEM identity, and sense of belonging. This is sometimes difficult information to measure, so we included questions and statements that are believed to be relevant to achieving student success, to enhance STEM identity, and highlight a sense of belonging. Given this back door approach, we also include interview data with students and provide firsthand perspectives from our students. It should be noted that some students taking the survey did not answer all the questions and the number of student responses is indicated on each figure of results. The questions from the survey are given in Appendix A.

Semi-Structured Interviews: Participants and Data Collection

Six students from the LMP participated in semi-structured interviews. This qualitative study utilized non-probability convenience sampling. These participants acted as both mentees and mentors of the LMP. The goal was to provide a comprehensive viewpoint from students who participated on both sides of the program. Interviews were conducted online and recorded for transcription and coding analysis. Interviews varied in length from 30 to 60 minutes, and included questions about the LMP, academic standing and achievement, STEM identity, self-efficacy skills, and sense of belonging. The traditional practice of using two individuals to independently validate the coding results was not used here, but rather a collaborative approach via regular discussions with our research team was used, all of whom contributed their perspective on the transcribed interviews regarding each code. This collaborative effort was used to mitigate individual biases and maintain the integrity of our coding framework.

Results and Analysis

Analysis of survey results included reviewing descriptive statistics from the data set. Moreover, we included both thematic and coding analysis for open-ended responses. In addition, a segment analysis was utilized as the survey included sections for both mentees and mentors. Of the 62 students who were invited to participate in the online survey, 22 responded (39% response rate). Standard demographic subsets were not considered in this study, but rather all participating members in the program were included equally. The questions were written to establish the perspective of how the layered mentorship program can be associated with academic success, STEM Identity, and sense of belonging from the mentee's perspective as well as the mentor's perspective. In addition, we included questions looking at the transition from mentee to mentor. The first set of questions focused on mentees whereas the second set of questions focused on the mentor's perspective; here we present them side by side for cross comparison. Although there were a different number of respondents from each group, we attribute differences in results to an effect stemming from the transition to becoming a mentor. Mentees and mentors were asked the same questions except for one additional question for the mentors. In the results and discussion section, figures where questions are labeled with the letter "a" represent the question beginning with "Being mentored ..." while those labeled with "b" represent the same question beginning with "Being a mentor ... ".

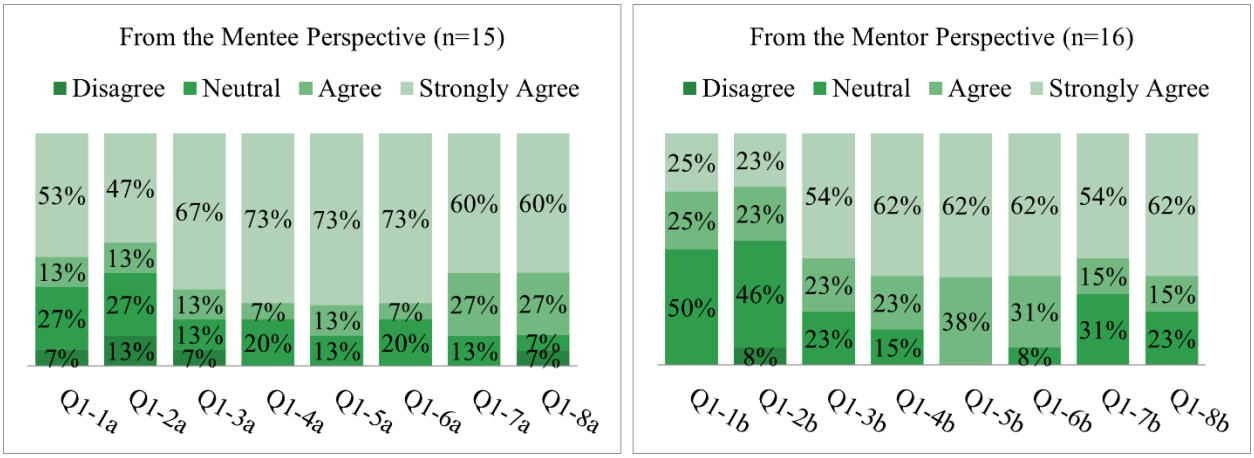

Figure 1: Results from survey Question 1; a Likert scale. Results indicate the percentage of participants, from the perspective of a mentee (left) and from the perspective of the mentor (right), that agree with each statement. The statements are listed below.

Q1: Think back to your experience (participation) being mentored/ being a mentor in your first year of the ELC. Choose an answer to the following questions for each case:

1. Participation helped me improve academically.
2. Participation helped me improve my GPA.
3. Participation helped me decide to continue as an Engineering student at the College of Engineering.
4. Participation reinforced my identity as a STEM student.

5. Participation helped me to build interpersonal bonds with other STEM students.
6. Participation gave me a sense of community and belonging among other STEM students.
7. Participation helped me to build confidence and self-efficacy.
8. Participation has helped me to develop professional and authentic skills.

The Engineering Learning Community's goal is to increase student success as well as enhance student experience overall, especially regarding their sense of belonging at the college and their STEM identity. Here, we want to know if participation in the LMP has benefits for mentees and mentors alike and by how much. In this regard, we asked the student participants, from the current cohort and previous cohorts, to think about their experiences participating in the program as a mentee and as a mentor. Then we asked them to select from a Likert scale their agreement with a series of statements, listed above under Question 1, that are related to these themes. What we noted is that, on both sides, many of the participants agreed or agreed strongly that their participation in the program improved their student success and sense of belonging in the college, see Figure 1 for the percentages.

However, we also noticed that the students agreed with the statements more from the perspective of the mentee compared to that of the mentor. This generally indicates that students going through the different layers of the mentorship program felt more strongly about these benefits when participating as a mentee. For example, 53% of the mentees strongly agreed with statement one regarding improvement in student success, while only 25% of mentors strongly agreed with the same statement. On the other hand, we also note that some of the participants did not agree with these statements in general, indicating that the program did not have the same effect for all students.

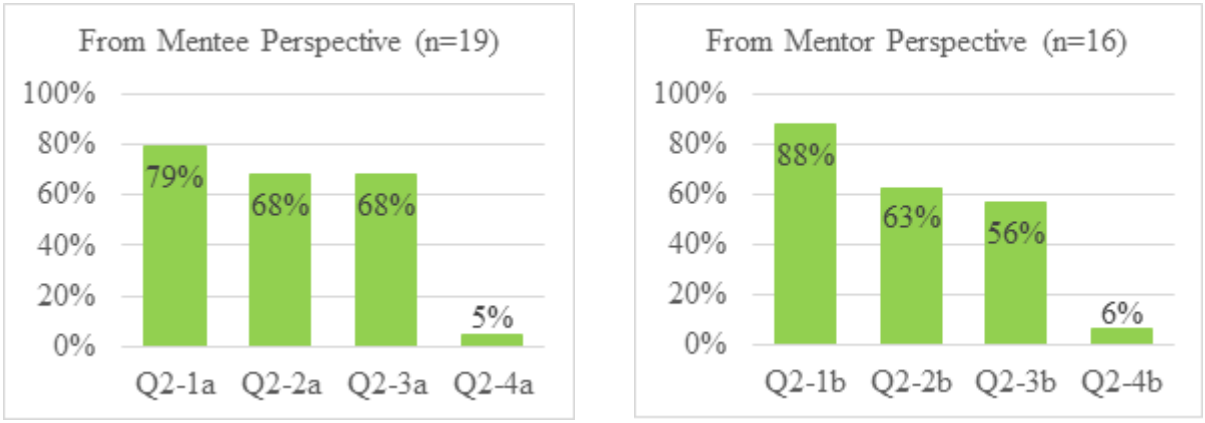

Figure 2: Results from survey Question 2; a select all that apply type under the category of the behaviors related to academic success. Results indicate the percentage of participants, from the perspective of a mentee (left) and from the perspective of the mentor (right), that agree with each statement.

Q2: How has being mentored during your first year in the ELC affected your academic success? Please select any that apply and/or fill your own statement?

1. Being mentored/Being a mentor helped me to hold myself accountable.
2. Being mentored/Being a mentor helped me to stay organized and stay on track.
3. Being mentored/Being a mentor helped me to manage my time and assignments.
4. Other.

The second question was aimed at the behaviors related to academic success. In this regard, we asked the students to select all those statements that they feel apply to them. The statements include common practices that are believed to lead to academic success and use this as a measure of how the LMP might improve their academic success. More than half of the students, 68%, reported being mentored helped them manage their time and assignments, and with staying organized and on track. Mentees agreed at 79% that the mentoring program helped them stay accountable with their academic pursuits. We find it interesting that the mentors felt they had to hold themselves accountable more than the mentees. This attribute was also noted in [16].

Sixty-three percent of the mentors stated being mentored helped them to stay organized and on track, and with managing their time as well as assignments at 56%. Many students at 88% agreed that being a mentor in the program helped them stay accountable with their academic pursuits. One individual (6%) selected "Other," however only provided a "N/A" for additional comments.

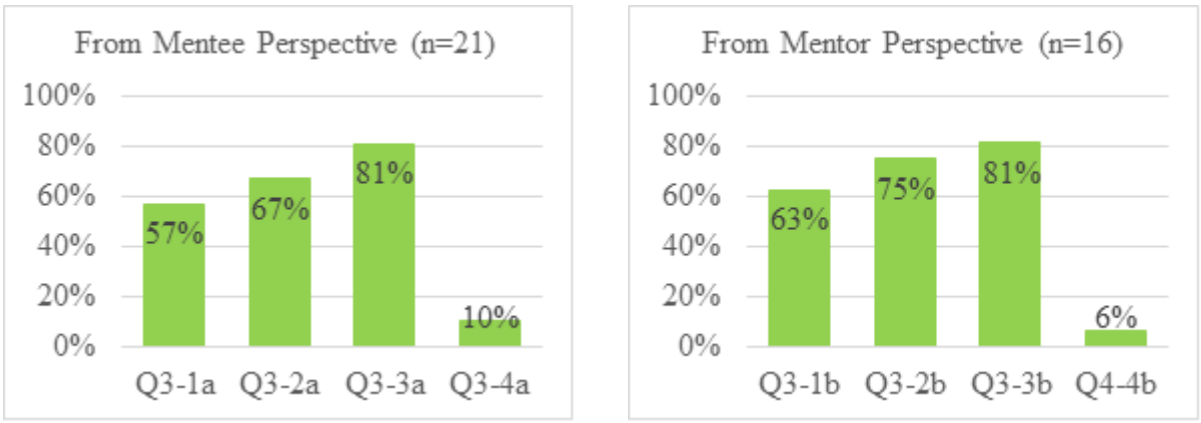

Figure 3: Results from survey Question 3; a select all that apply type under the category of STEM Identity and Belonging. Results indicate the percentage of participants, from the perspective of a mentee (left) and from the perspective of the mentor (right), that agree with each statement.

Q3: How has being mentored during your first year in the ELC affected your identity as a STEM student? Please select any that apply and/or fill in your own statement.

1. Being mentored/Being a mentor helped reinforce my decision to study at the Engineering College

2. Being mentored/Being a mentor helped me to feel like I belong at the Engineering College.
3. Being mentored/Being a mentor helped me to see myself as an Engineer.
4. Other.

In Question 3, mentees were asked about STEM identity and belonging, see Figure 3. Then, 81% of students indicated that being mentored helped see themselves as Engineers. More than half of students at 67% mentioned being mentored made them feel like they belong. One student supported this with an open-ended response*, "It helped me realize that I could overcome difficult classes if others could too."* Many students, 57%, stated that being mentored reinforced their pursuit to study at the Engineering College. Like the previous question, some students selected "Other." One student much preferred the community gatherings as opposed to the mentorship, *"I very much preferred group meetings over mentoring however I feel like I would maybe enjoy being a mentor."* This quote sheds light on the positive experience in community or group settings when participating in this mentorship program.

In turn, student mentors were asked to select all that apply for the same set of statements regarding STEM identity and belonging. Results in Figure 3 indicate that 75% of student mentors felt that being a mentor helped them feel like they belonged. Then, 81% of them stated that directly being a mentor helped them to themselves as an Engineer. While 63% of students said that being a mentor helped reinforce their decision to study Engineering. Again, we highlight the difference in percentages for the first two statements, indicating that mentoring may have had a stronger impact on STEM identity and sense of belonging than being mentored did.

Student mentors were asked an additional question that included several statements that students were asked to "select all that apply" as they transitioned from a mentee student to a mentor student (Please see figure 4 below). Sixty-five percent of students expressed that being a mentor prompted these students to do their best and become role models for younger students as well as these students seeing themselves as a successful Engineering student. Several of them (57%) chose the statement that being a mentor prompted them to follow their own advice, since they were sharing advice and suggestions to mentee students even if mentee students were older in age than the mentor students who were in their second year. One student stated the following, *"My mentee was older than me, they joined after and switched majors. I can say I feel proud to be able to guide and help my mentee when he needed it."* We did have "Other" responses, but these were removed through data cleaning due to these students being mentee students as the time of this survey.

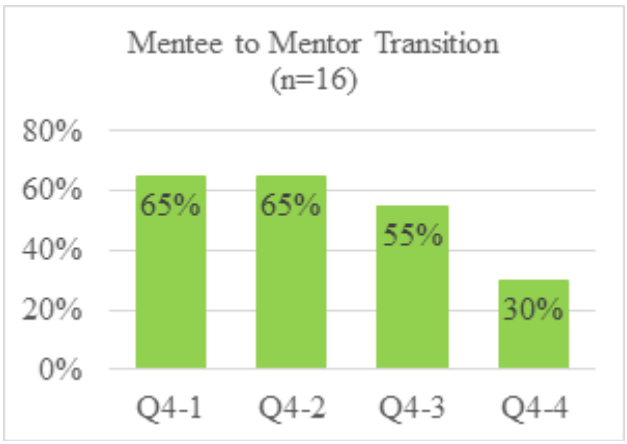

Figure 4: Results from survey Question 4; a select all that apply type under the category of Mentee to Mentor Transition. Results indicate the percentage of participants, from the perspective of a mentee transitioning into the role of a mentor.

Q4: How has the transition from being mentored to becoming a mentor during your second year in the ELC affected your identity as a STEM student. Please select any that apply and/or fill in your own statement (question only asked to student mentors).

1. Becoming a mentor prompted me to do my best and become a role model for younger students.
2. Becoming a mentor prompted me to see myself as a successful Engineering student.
3. Becoming a mentor prompted me to follow my own advice.
4. Other.

Q5: How can the mentorship program better meet your needs as a STEM student? Please elaborate.

Question 5 asked mentees and mentors to provide any additional insights about the LMP by answering an open-ended question. Most students were satisfied with the mentorship program; however, three areas of improvement were identified by these students. Mentee and mentor students want more opportunities to build community and socialize. They suggested providing more events in the LMP and ELC respectively. Students also advocated making this program available to more students within their program to have more students utilize this benefit. Lastly, students indicated more formal training for mentor students to better support the mentee students.

Researchers were curious about these differences for mentees and mentors and wanted to further investigate this change, since there were some fluctuations in the percentage with mentees. What accounted for these differences, regardless of negative or positive change? To further understand these differences, the researchers decided to conduct semi-structured interviews from student mentors.

Semi-Structured Interviews

The results from the interview were coded through thematic analysis. Interpretive validity was ensured by providing thorough, rich, and thick description of the participants' experiences as well as checking participant responses to confirm validity. Triangulation was a key strategy to study the findings with different collection methods (interviews, surveys, academic information provided by the college, observations from staff connected to the LMP. Coding and analysis consisted of reading the data thoroughly to understand the experiences of all interviewees and assessing the thematic themes discovered during interviewing as well as any sub-themes. Our main themes include mentorship to achieve academically, mentorship to develop and maintain STEM identity, mentorship to access STEM community and create a sense of belonging. All students who were both mentors and mentees were invited to participate in the interviews. The following section will explore these themes and provide examples from student mentors.

Academic Achievement

Academic achievement was a major finding with the mentors. Many mentors described the struggle of starting an academic journey in higher education. However, these same students encountered their initial years in the Engineering college as a global pandemic occurred simultaneously. Every student interviewed described this struggle to find a balance with academics during this time.

> *"My first year entering school, I was having a hard time, and I was getting pretty low grades like Cs, which was passing."*

Education during the pandemic shifted tremendously from a traditional in-person activity to online. Students described this as well.

> *"I think I had a really difficult time just adjusting as a STEM student like taking all these science classes in the math classes online. I think that was pretty difficult."*

The mentorship provided guidance from a mentor as well as support to understand a work life balance especially during the pandemic.

> *"During the pandemic, it was really hard for me to adjust to online school. I couldn't really motivate myself, I would say to study independently because everything was over Zoom and it was so easy to just not go to class. My mentor really motivated me through it. She told me how she kept motivated and I think that was pretty inspiring."*

These students were also able to use their experience in the mentorship to help guide their mentees.

"I think, as I became a mentor, and then a lead mentor, I realized that I needed to work harder in school, so I could motivate others to do the same. And I was able to graduate with honors."

Overall, these students benefited academically from the positive experience both as mentee and mentor, even though for many students there were some initial struggles from the shift from high school to college as well as an urban, commuter college. Students describe receiving practical help with academics such as tutoring, but also as a support to vent and gain advice to make better academic decisions.

Social skills

Mentors discussed that socializing is sometimes not easy for engineering students at a commuter campus. Mentor students stated that many mentees were introverted. This was especially hard for students who were forced to take courses during the pandemic. Socializing with fellow mentees and mentors reinforced comradeship with students.

"Going back in person, I feel like being social was also very hard. And I think it kind of was a little bit of a, like a learning curve for me as a mentor as well, because now I have to be an example and then bring back my social skills that I wasn't really using for a year because I was at home. That's, that's what really was a big adjustment for me."

Leadership

Mentor students articulated how the LMP changed their overall identity to feel more confident and see themselves as a leader. The Layered Mentorship also springboarded other leadership opportunities.

"I think you kind of start to own your identity. Like I guess you become more I would say like more involved with the STEM community and it's almost like a leadership position. I feel like I think they helped me become more outgoing and more. Right now, I'm part of a club called the Society of Hispanic Professional Engineers and this year I am the vice president."

"I think, because I learned leadership skills, I was able to, I guess, be more confident and more outspoken and more sociable. As my capstone project, I was the client relations manager for my team. I was in charge of communicating with an external client and just being that face for the group. And I felt comfortable doing that, because I was already in a leadership position where I was the face of the ELC for a while. And I was very, as a lead mentor, I think I had to schedule a lot of meetings, communicate with different people. And I felt very comfortable from that experience, and work to pass it on to my experience as a client relations manager. I think italso helps me as a medical assistant, it helps me just be more sociable towards patients."

Time Management

Mentor students highlight a work-life balance challenge that many mentor and mentee students faced. During interviews students described time management as a struggle to achieve.

> *"My biggest hurdle was even though I had that those people behind me were time management."*

STEM Identity

Mentor students described the LMP in their experiences initially starting in the Engineering College and how to be vulnerable.

> *"I think when I became a lead mentor, I think this role really pushed me into more of a leader, like I became a better leader through this position. I missed as a mentor, I was just an example for one student, but as a lead mentor, I was an example for all the students in the ELC. And I feel like that really helped identify my identity as a stem student, because it really gave me the confidence to take more risks. In my education, as well, I felt like I was able to go out and ask for research opportunities, because I felt like I needed to be a leader and like, show my students what it is to be a successful student in STEM."*

Community and belonging

Mentor students discussed the impact and importance of community and belonging in the LMP. Students described having individuals who think as they do with academic and career goals, but also how these individuals help each other.

> *"I'm meeting other people that have the same mindset as me. Being around those people, and seeing, hey, can they help me study? Can they help me learn this topic because there's computer science majors like electric engineers, civil engineers, so you can go to the left bunch, mechanicals had to take circuits class, could go to the electrical where that's their bread and butter. Maybe they could teach you, they can help you out."*

Mentor students experienced the pandemic together and made ways to further connect during an isolated time.

> *"Let's start discord with the ELC and play games like I'm still we're still on the discord. It hasn't been texted recently, but there's a Discord server, an old Discord server that we play games on. I actually met my now fiancé at the ELC."*

Mentors described building campus partners to further community building with external organizations.

> *"We did interact with other staff members, like we got to go down to the Career Center and like, that's actually where we got our resume workshop done through, and our interview workshop done through. So we get to find and explore different resources within the school, but we also got to talk to, like a lot of professors, and like the people invested in the ELC community."*

Students often reflected on the role of community building and mentorship.

> *"I feel like getting to interact with people that are upperclassmen is probably the most valuable thing. Um, just because, they're already established with their STEM identity, so they get to pass that on. For me, it's really about mentorship. I found that to be the most valuable part."*

Discussion

To answer our research questions, the results illustrate 1) that participation in the LMP has positively influenced the development of STEM identity among the mentees in a variety of ways, 2) an array of specific factors within the mentorship program contribute to the academic success and persistence of first-year engineering students, and 3) second-year student mentors perceive their leadership roles as meaningfully impacting their own STEM identity and sense of belonging within the engineering community.

How does participation in the LMP influence the development of STEM identity among the mentees?

Participation in the mentorship program positively supported mentees to form a STEM identity. These students' overall self-perception changed during the mentorship program. According to the survey results 81% of mentees stated being mentored supported the shift in seeing themselves as engineers. Further investigation through interviews showed that mentored students who were mentees described their mentoring experiences as a catalyst to change this view in themselves especially with the one-on-one peer mentoring with an upper-class student in the same program.

Another key finding that influenced the development of STEM identity for mentee students is developing and maintaining a sense of belonging. Approximately 67% of mentees made them feel a sense of belonging towards the Engineering College. Feeling welcome and a sense of belonging often reinforces their STEM identity. Interviews from mentor students described even during the pandemic how they created environments online such as typical programming you would have with in-person experience or creating a server on Discord to connect with each other.

Mentees also described the overall support they felt from the LMP. This supportive environment allowed students to have failures and successes in a space for growth. Mentee students specifically call out their encouragement and confidence shift to support overcoming challenges

not only academically, but personally and professionally. This continued to promote STEM identity for these mentee students.

What specific factors within the mentorship program contribute to the academic success and persistence of first-year engineering students?

Many factors within the LMP contributed to the academic success and persistence of first-year engineering students. 68% of mentees during their first year described being mentored made them hold themselves accountable for academic pursuits. Accountability was named one of the major factors that students learned through mentoring, especially during that transition from high school to college. Mentor students also described how they needed to hold themselves accountable to be good role models for their mentees.

Time management was another factor expressed by mentee students to aid in success during their first year. The LMP readied students for the direction to successfully managing assignments, time, and any additional endeavors being pursued. Time management skills are impertinent for academic achievement.

Similar factors contributing to STEM identity, community building or having a sense of community were vital to students' academic success and persistence for first-year engineering students. 80% of mentees concurred that this community building between mentee and mentor students helped create important interpersonal relationships with fellow STEM students and ultimately nurturing that growing community.

Lastly, self-efficacy and confidence increased for mentee students. In both the survey and reflecting on mentors' experience as mentees, the first year for these students was crucial and developed confidence. Students mentioned foundational classes that provide the building blocks of their engineering career. These students also expressed how these classes, projects in these courses and developing self-efficacy skills supported their understanding and success as they continue their studies in engineering.

In what ways do second-year student mentors perceive their leadership roles as impacting their own STEM identity and sense of belonging within the engineering community?

Second-year student mentors perceive their leadership roles as substantially impacting their sense of belonging as well as STEM identity. Mentors in both the survey and interviews communicated developing leadership qualities and confidence being in the mentors to mentees. Mentor students expressed that doing their best with their academic studies, professionally, and personally to be role models for their mentee students. This in turn helped these mentors with their overall confidence. Students named the increase in their socializing with peers, upper classmen and staff and faculty of the Engineering College. These two factors positively impacted the mentor students' sense of belonging and STEM identity.

Academic achievement from the mentors was a vital component to their success as leaders. The mentors walked the same path that the mentees did. These students understood the importance of getting and maintaining high academic standards. The mentors know the responsibility of

leading and motivating their mentees. This required the mentors to strive for the highest academic marks, with the goal of setting a positive example for mentees while simultaneously holding themselves accountable to achieve academically.

Sense of belonging was one of the greatest findings mentors and mentees experienced. 75% of mentors stated that being a mentor helped them feel like they belonged to the Engineering College and the community of engineers. Interpersonal bonds created between mentors, mentees, staff, and faculty were significant in creating a space where mentors and mentees alike could thrive. Mentors spearheaded this initiative. They developed their leadership skills and were able to create a community, sense of belonging, and pride for their mentees in engineering.

Limitations

Survey: Some limitations that this study may highlight include that this study is centered on an urban commuter campus and may not have similar results in different academic settings. Another limitation of this study might be that we did not have a large enough sample size.

Semi-Structured Interviews: The reliance on different interviews necessitates extensive analysis time for each session, which may impact the overall efficiency of the research process. Additionally, there is the potential for bias, particularly in the interpretation of the different interviews, which could influence the findings.

Conclusion

The findings from the survey and semi-structured interviews indicate an overall positive impact of the Layered Mentorship Program. The analysis performed here highlighted several characteristics that contributed to the behaviors related to academic achievement, STEM and engineering identity, community building and a sense of belonging, and professional as well as personal skills. These findings confirm, qualitatively, the authors belief that learning communities and mentorship programs can have a meaningful impact on student success for engineering students. We highlight the idea that mentorship has a strong and positive impact on the mentors themselves, which has not been discussed in detail in previous works in the field. More specifically, the mentors describe their increased sense of community, their increased confidence from being in a leadership role, and in turn a need to hold themselves accountable to the advice they pass down to mentees. We believe these behaviors contribute to student success and provide evidence that the Layered Mentorship Program encourages these behaviors.

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Appendix A – Survey Questions

Q1: Think back to your experience (participation) being Mentored your first year of the ELC. Choose an answer to the following questions for each case

1. Participation helped me improve academically
2. Participation helped me improve my GPA
3. Participation helped me decide to continue as an Engineering student at the College of Engineering
4. Participation reinforced my identity as a STEM student
5. Participation helped me to build interpersonal bonds with other STEM students
6. Participation gave me a sense of community and belonging among other STEM students
7. Participation helped me to build confidence and self-efficacy
8. Participation has helped me to develop professional and authentic skills

Q2: How has being mentored during your first year in the ELC affected your academic success? Please select any that apply and/or fill your own statement?

1. Being mentored helped me to hold myself accountable.
2. Being mentored helped me to stay organized and stay on track.
3. Being mentored helped me to manage my time and assignments.
4. Other

Q3: How has being mentored during your first year in the ELC affected your identity as a STEM student? Please select any that apply and/or fill in your own statement.

1. Being mentored helped reinforce my decision to study at the Engineering College.
2. Being mentored helped me to feel like I belong at Engineering College.
3. Being mentored helped me to see myself as an Engineer.
4. Other

Q4: How has the transition from being mentored to becoming a mentor during your second year in the ELC affected your identity as a STEM student. Please select any that apply and/or fill in your own statement. (Question only asked to student mentors)

1. Becoming a mentor prompted me to do my best and become a role model for younger students.
2. Becoming a mentor prompted me to see myself as a successful Engineering student.
3. Becoming a mentor prompted me to follow my own advice.
4. Other

Q5: How can the mentorship program better meet your needs as a STEM student? Please elaborate.

Appendix B – Semi-Structured Interview Questions

1. Tell me about yourself (year, what are you studying, culture? First gen? Etc.)
2. How long have you been a lead mentor?
3. How did you get involved in this program? What has caused you to want to stay involved?
4. Thinking back on your experiences in this program, can you talk to me about your time as a mentee? How did you identify as a STEM student? What needs did you have as a student?
5. Thinking back on your experiences in this program, can you talk to me about your time as a mentor? How did you identify as a STEM student? What needs did you have as a student?
6. Thinking back on your experiences in this program, can you talk to me about your time as a lead mentor? How did you identify as a STEM student? What needs did you have as a student?
7. How has the ELC/ mentor program support your needs as a student?
8. How has it not supported those needs?
9. What did you like about the mentor program?
10. What did you not like about the mentor program?
11. How was this program affected by the COVID pandemic? Do you think the pandemic negatively or positively affected your experiences as a mentee and mentor?
12. Does a change in student identity correspond with a change in needs that can be supported by the Layered Mentorship Program? CORE QUESTION
13. Do you think a change in your student identity correspond with a change in needs that was supported in this program? As a mentor, did you see this with students? Did you experience this?
14. Is there anything you would like to add that I may have missed in this conversation?
15. How do you identify STEM? What does STEM mean to you? How do you think others describe STEM?