Making Meaning through Mentorship: A Student-Led Layered Peer Mentorship Program

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Abstract

This Complete Evidence-Based Paper presents research about a layered peer mentorship program for undergraduate engineering students at a public urban research university and ways that students have made meaning from their mentorship experiences. This mentorship program began in Fall 2019 and has grown to include the following layers: (a) first-year students who receive mentorship, (b) sophomore- and junior-level students who serve as mentors (all of whom received mentorship during their first year), (c) junior- and senior-level students who serve as lead mentors who design the program for that academic year (including content, group meetings, service projects, meeting schedules, etc.), (d) a graduate student who mentors and supervises the lead mentors, and (e) a faculty member who oversees the overall program, provides general guidance, and advises all the students. We will describe ways in which the participating students have made meaning of their experience in the program, highlighting three key areas: (1) the web of relationships formed, which cohere into a community; (2) students' transitions from receiving mentorship as first-year students to mentoring others in their sophomore and junior years; and (3) the feedback and iteration process by which the program has continuously developed, which forefronts student voice and agency. The paper will provide specific examples in each of the three key areas described, with a special focus on students' own descriptions of the meaning they have made through their participation in the mentorship program. Recommendations will also be shared for those interested in implementing similar programs on their campuses.

The mentorship program forms a complex web of relationships between and among students, and these relationships cohere into a felt community for students. These relationships are forged by various means in various contexts. First, each student who receives mentorship is a first-year student in the Engineering Learning Community (ELC). In the ELC, first-year students take a bundle of courses together, with specific sections of English composition, math, and a first-year design innovations course. Second, the students who receive mentorship are assigned peer mentors who are sophomore- and junior-level students who were previously in the ELC. Mentees and mentors meet regularly in both individual and group meetings, which affords both individual and group relationships to form. All these interplaying individual and group relationships form a rich, complex web which coheres into a community for students.

Additionally, students also find meaning through their transition from mentee in their first year to mentor in their sophomore and junior years. This meaning is forged through personal growth, as well as through a reification of engineering identity when they are viewed as legitimate members of the community of engineering majors. When students become mentors, they transition into a position where first-year students look to them for advice, support, and encouragement. Mentors enact their identity as someone with experience who has valuable perspective to share. Mentors can feel more confident in their classes knowing that their status as an engineering major is respected and has been legitimated. Lastly, serving as a mentor is something students look forward to listing on their resume as a demonstration of teamwork and people skills which engineering employers so highly value.

A third way students make meaning from the mentorship program is through the feedback and iteration process by which the program is continuously formed. At the end of each semester, students submit formal, anonymous, formative feedback on the program. The suggestions students make are implemented almost immediately, making this mentorship program responsive and adaptable. Students in the program know that their feedback is taken seriously, and that they have the power to create the mentorship program they find most helpful. Additionally, the lead mentors have nearly complete autonomy to organize, schedule, and run the program as they see fit. The upper layers of the program – the graduate student and the faculty member – provide support, advice, and resources, but the undergraduate students are the ones iterating and forming the program. Through these means, the program has evolved in several ways, including the introduction of group meetings and a semesterly service project, which were the direct implementations of student ideas. This focus on student voice and agency enables students to build self-efficacy and make meaning from their experiences with the mentorship program.

Introduction

This paper describes a mentorship program for undergraduate engineering students at a public urban research university, and it will focus on the aspects that make the program most meaningful for the students. This mentorship program is a concerted effort with an engineering learning community (ELC) for first-year students [1, 2], which was initially designed to increase student retention at the engineering college. Moreover, eligible students voluntarily take part in an NSF-funded Scholarships for STEM (S-STEM) program where participation in both ELC and the mentorship program is required. On the other hand, incoming students who are not eligible for the S-STEM program are encouraged to participate in the ELC and are offered mentorship.

There are a variety of mentorship programs at different institutions, created for engineering students, that have assorted but generally homogeneous intentions geared toward student success. Some of these programs focus on increasing undergraduate internships [3] or on understanding career options [4], while others aim to increase student success in first-year programs [5] and improve student retention [6, 7, 8, 9, 10]. All these categories have various levels of mentorship tailored to meet the primary needs of the respective program. For example, an industry mentor might provide career guidance while a faculty mentor could advise on degrees paths and options for graduate work. More recent programs have focused on peer mentoring, especially for first year programs concerned with increasing retention rates [11, 12], but which are also applied to higher level academics and teaching related mentoring [13].

The key feature of peer mentoring is that another student or colleague who is one layer above provides mentorship to the student or colleague who is one layer below. In this mode of mentorship, the information received comes from someone who is more like a friend or an older sibling; this approach changes the power dynamics completely. In this respect, it is believed that any flow of information will be better received and will naturally contain the fresh perspective of someone who has recently fulfilled the requirements of the previous layer. Moreover, some studies found in literature have provided evidence that being a mentor has its own benefits, such

as increased development of leadership, communication, and social skills, as well as a sense of community [14, 15], and in some cases, increased retention rates [16].

Layered Mentorship Program (LMP)

The mentorship style described here is a multi-layered near-peer mentorship program, that we term as Layered Mentorship Program (LMP), with a primary focus on the bottom layer, the incoming first-year students who join the engineering learning community (ELC). These students are offered a mentor, a sophomore student in engineering and a previous participant in the ELC. These mentors also received mentorship in the previous year and have transitioned into becoming one. Here we consider how this transition might contribute to, or validate, the student's self-efficacy and sense of belonging at the engineering college and with their engineering student peers. Moreover, the mentors in the second layer report to and obtain guidance from a third layer of mentors whom we term 'lead mentors.' Lead mentors are junior- or senior-level engineering students who served as mentors in the previous year(s) with continued involvement in the program. They help to guide the second layer for a smooth transition into becoming a mentor and maintain a unified program that they can adjust to better meet the needs of the first layer and maintain the general guidelines from the highest layer, the program faculty leaders and assisting graduate students. The LMP is currently a small program, averaging ten first-year students receiving mentorship, eight or nine sophomore- or junior-level students serving as mentors, and one or two junior- or senior-level students serving as lead mentors.

The interpersonal relationships that naturally form in the learning community are thus extended by means of the mentorship program and are carried through the various layers over many years, which form a complex web of associations that are thought to contribute to a robust disposition toward engineering education and STEM in general. We believe these relationships contribute to the student identity in such a way that validates their decision to study engineering in multiple ways, which can generally be described under the communication theory of identity, discussed in [17]. The first is that the formation of a strong community of peers, who are all engineering majors, contributes to a sense of belonging at the engineering college and provides a platform where students can communicate their identity, or express themselves as engineers, to a body of like-minded peers.

Next, receiving mentorship is thought to help keep students engaged with their community and pushes them to realize best practices for success. In this interaction, it is believed that first year students begin to form a stronger sense of being an engineering or STEM major, and this identity is co-constructed with their mentor. Then, the transition to becoming a mentor in their sophomore year acts like a promotion where these students provide help rather than receive it. This transition is thought to also help mentors maintain best practices because they are faced with giving good advice and feeling as if they need to follow it themselves.

At the end of each semester, participating students give feedback on the program and can make changes that allow the bottom layer to receive support more aligned with what they need. Such changes could relate to frequency of mentoring meetings, the topics discussed, group related mentoring meeting activities, and the feedback mechanism itself. As a result, participation

becomes more meaningful, and students feel valued by and connected to the layers above. Moreover, such iterations are thought to further form student identity at the college in terms of a larger social context since these changes affect future participants as well.

To establish the value of this mentoring approach beyond unstructured observations and further understand students meaning-making, a survey was conducted. What follows is an explanation of the methods used to explore the additional meaning that students may take from this program. Next, the survey results and qualitative discussion are presented. And lastly, a conclusion that contains recommendations to anyone wanting to implement a similar program.

Methods and Materials

This study examined qualitative data from an end-of-year survey given to mentors at the end of the Spring 2021 semester. That academic year (Fall 2020-Spring 2021), there were ten mentors who mentored one or two first-year students each. Of these ten mentors, eight responded to the survey. This survey included the following open-ended items:

- What skills did you obtain in order to become a more effective mentor?
- What behavioral changes did you make to become a more effective mentor?
- What resources/people helped you become a more effective mentor?
- Did being a mentor change how you approached your own academics? If so, how?
- After being a mentor, do you feel more connected to the STEM community on campus? Please elaborate.
- In your own words, explain how the transition to becoming a mentor has allowed you to build confidence and leadership skills. Did this trend continue into the second semester of mentoring?

A classical content analysis [18] using the constant comparison method [19] was conducted on these open-ended items. Using this method, codes which represented the essence or main idea(s) of the qualitative content were assigned to each response. Each response was compared with existing codes to determine if there was a match; if there was a not a match, a new code was created for that response. Each response received as many or as few codes as matched the ideas expressed in the response since some responses contained multiple ideas. Two coders independently coded all data, and then met to discuss and reconcile coding discrepancies until 100% agreement was reached on each response for each item.

Results and Discussion

The next sections describe qualitative evidence for each of the main ideas expressed in this study: the complex web of relationships that cohere into a felt community for students, the transition from receiving mentorship to providing mentorship, and the student feedback and program iteration process.

Complex Web of Relationships

There were two open-ended items on the end-of-year mentor survey that demonstrated the complex web of relationships within the layered mentorship program. The first relevant item was, “What resources/people helped you to become a more effective mentor?” The second relevant item was, “After being a mentor, do you feel more connected to the STEM community on campus? Please elaborate.”

For the first relevant item, “What resources/people helped you to become a more effective mentor?”, three of the eight participants (37.5%) mentioned their mentor from the previous year. This represents a social tie from mentor to mentee that began as a formalized relationship within the mentorship program and then continued informally after the official mentor-mentee relationship ended. Six of the eight participants (75%) mentioned the lead mentor. This represents a social tie between middle layers of the mentorship program. As one participant stated, “Knowing that our lead mentor was available was a big comfort.” Lastly, three of eight participants (37.5%) mentioned others who were also serving as mentors currently. This represents a social tie that, unlike the other ties mentioned so far, is lateral in nature rather than hierarchical. As one participant stated, “Other mentors…helped me to become a more effective mentor,” and as another stated, “Having a group chat with other mentors was helpful.”

For the second relevant item, “After being a mentor, do you feel more connected to the STEM community on campus? Please elaborate.”, six of eight participants (75%) reported feeling more connected. For the two who did not report feeling more connected due to being a mentor, one student stated that remote learning (due to COVID-19) was a barrier to feeling connected, and the other student shared that they felt more connected to the STEM community on campus due to the larger ELC program and not necessarily because of serving as a mentor. Two students (25%) expressed that serving as a mentor offered them connection during a time of remote learning (due to COVID-19). Two students (25%) stated that they enjoyed connecting with students outside their major through the layered mentorship program. Lastly, three of the eight participants (37.5%) stated they had forged lasting friendships through the mentorship program. As one participant stated, “Being a mentor makes me feel more connected to my peers in the ELC. We bond over the ELC and these are some of my best friends from college.”

Transition from Receiving Mentorship to Providing Mentorship

There were four open-ended items on the end-of-year mentor survey that addressed how students changed as their roles changed. The first relevant item was, “What skills did you obtain in order to become a more effective mentor?” The second relevant item was, “What behavioral changes did you make to become a more effective mentor?” The third relevant item was, “Did being a mentor change how you approached your own academics? If so, how?” The fourth relevant item was, “In your own words, explain how the transition to becoming a mentor has allowed you to build confidence and leadership skills. Did this trend continue into the second semester of mentoring?”

For the first relevant item, “What skills did you obtain in order to become a more effective mentor?”, students mentioned growing skills in communication (five students, 62.5%),

organization (two students, 25%), time management (two students, 25%), empathy (three students, 37.5%), giving good advice (two students, 25%), providing responsive and individualized mentorship (three students 37.5%), and being available and approachable to their mentees (two students, 25%). As one participant stated, "I better understood how to lead conversations with mentees and how to make myself more approachable as opposed to the first time around. As an effective mentor, I offered more than just academic support and learned how to better view situations from my mentees perspective than my own." This variety of soft skills described by students as a result of becoming a mentor demonstrate meaningful growth in both interpersonal and leadership arenas.

For the second relevant item, "What behavioral changes did you make to become a more effective mentor?", students reported increasing in the following areas: patience (three students, 37.5%), organization (one student, 12.5%), openness and approachability (two students, 25%), confidence (one student, 12.5%), and knowledge (one student, 12.5%). Again, this shows development in a variety of positive interpersonal and leadership behavioral arenas.

For the third relevant item, "Did being a mentor change how you approach your own academics? If so, how?", students reported increased organization (three students, 37.5%), feeling convicted to take their own advice (three students, 37.5%), increased consistency (one student, 12.5%), and trying to do better (two students, 25%). As one student stated, "Being a mentor instilled this idea in me that I am an example and need to act like one. I somewhat stayed more organized and timely because it's something I would talk about with my mentee." This type of development, leadership, and maturation is reported as a direct result of transitioning from mentee to mentor. Another student stated, "In giving advice to the mentees, I felt more motivated to take that advice for myself." These students who transitioned from receiving mentorship to providing mentorship reported closing a gap between the advice they provided and their own behavior.

Finally, the fourth relevant item was "In your own words, explain how the transition to becoming a mentor has allowed you to build confidence and leadership skills. Did this trend continue into the second semester of mentoring?" Five participants (62.5%) reported that they got better at helping. As one student stated, "It helped me improve my skills in assisting others." Additionally, three students (37.5%) reported an increase in confidence and three students (37.5%) reported an increase in their leadership skills. As one student stated:

> "In giving advice and leading students when you're told to, it sort of leads into realizing that your advice is worth giving. In the first semester, I was unsure about how I would do as a mentor because I had never done something like it before. I learned over the course of the semester that the advice I had was worthwhile to the mentees receiving it and became more confident in giving it out."

Finally, two students (25%) expressed that they were pushed to become role models. One student stated it this way: "As a mentor, I became an example and I became a focal point for another student which forced me to have to be better. I had to be consistent and deliver each time, so as a leader I practiced important skills." This growth described by students who transitioned from

receiving mentorship to providing mentorship provides evidence of the meaning they made through the layered mentorship program.

Student Feedback and Program Iteration Process

Finally, the layered mentorship program employed a unique process of student feedback and program iteration that forefronts student voice. At the end of each semester, both mentees and mentors fill out a feedback survey on the program, and changes to the program in response to this feedback are implemented in the next semester's programming.

The first semester of the layered mentorship program, mentors and mentees met weekly throughout the semester, and mentor/mentee pairs were switched midway through the semester in order to give students a wider variety of perspectives. However, through student feedback, the program evolved to include a mix of one-on-one mentor/mentee meetings, group mentorship meetings, and off weeks during academically busy times of the semester (e.g., during mid-term exams week). Also, through student feedback, mentor/mentee pairs stayed consistent throughout the semester with the option to stay consistent for the whole academic year.

In addition to the introduction of group meetings, students within the layered mentorship program also asked for specific programming during group meetings. At the request of students, one semester's group meetings focused on the development of SMART (specific, measurable, achievable, relevant, and time-bound) goals, with regular progress check-ins in a group setting. Also at the suggestion of a student, one group meeting each semester is now dedicated to a service project, such as running a food drive or volunteering at a local non-profit organization. Additionally, students have also organized resume and internship workshops to be a part of the layered mentorship program. The highly responsive and adaptable nature of the layered mentorship program empowers students to feel ownership over the layered mentorship program and its co-creation.

Conclusion and Recommendations

The strength of the layered mentorship program described in this paper resides, as student survey responses emphasize, in its unique traits that foster self-efficacy and empowerment through community. First, by having multiple layers from first year students up through faculty, there is an emphasis on the interpersonal relationships among and between students to form a felt community. Second, in the act of growing from mentee to mentor, mentors experience the increase in responsibility that arises when students transition from receiving mentorship to providing it. Because of this emphasis on community and growing responsibility, the layered peer mentorship program could augment other programs to improve STEM education. Those efforts often center on active learning techniques that also emphasize peer interactions, reinforcing the sense of empowerment-through-community as the LMP. (For a brief introduction to some of these methods, we recommend Ericson [20].) Moreover, we believe the program iteration process through which the program is continuously formed and reformed through student feedback enhances student self-efficacy and empowerment. While our current program is small, making our conclusions difficult to generalize to larger populations, the evidence provided

here provides a step toward understanding and developing best practices for peer mentorship programs. We recommend that institutions who may wish to implement similar programs with their STEM students involve the participants in the planning and implementation of similar mentorship programs so that students feel a sense of ownership over the program and are provided an opportunity to exercise creativity and leadership skills in a low-stakes, high-encouragement, community environment.

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References

[1] M. Howland Cummings, M. Darbeheshti, G. E. Simon, W. T. Schupbach, M. S. Jacobson, T. Altman and K. Goodman, "Comparing Student Outcomes From Four Iterations of an Engineering Learning Community," in *ASEE Annual Conference*, Virtual, 2021, July.

[2] M. Darbeheshti and D. R. Edmonds, "A Creative First-Year Program to Improve Student Retention," in *ASEE Annual Conference & Exposition*, Salt Lake City, UT, 2018, June.

[3] T. Dallas, H. Greenhalgh-Spencer and K. M. Frias, The Role of Mentorship in Student Preparation for Impactful Internships, Minneapolis, MN: ASEE Annual Conference & Exposition, 2022, August.

[4] E. Marquez and S. Garcia, "Quality Mentorship Matters: An Innovative Approach to Support Sutdnets Success in Engineering Undergraduate Research," in *ASEE Virtual Annual Conference*, Virtual, 2021, July.

[5] C. M. de Vries and J. Johnson, "Development of a Mentorship Program between Upper-class and First Year Engineering Students through 3D Printing," in *ASEE Virtual Conference*, Virtual, 2020, June.

[6] J. I. Clark, S. L. Codd, A. C. Des Jardins, C. M. Foreman, B. W. Gunnink, C. Plumb and K. R. Stocker, "Peer Mentoring Program: Providing early intervention and support to improve retention and success of women in engineering, computer science, and physics," in *ASEE Annual Conference & Exposition*, Seattle, 2015, June.

[7] A. D. Niemi, M. G. Green and M. Roudkovski, "Evaluation of a First-Year Retention Project: Findings at Halftime," in *ASEE Annual Conference & Exposition*, Atlanta, GA, 2013, June.

[8] J. Johnson, A. D. Nieme, M. G. Green and L. E. Gentry, "Management and Assessment of a Successful Peer Mentor Program for Increasing Freshmen Retention," in *ASEE Annual Conference & Exposition*, Indianapolis, IN, 2014, June.

[9] C. Gattis, B. Hill and A. Lachowsky, "A Successful Engineering Peer Mentorship Program," in *ASEE Annual Conference & Exposition*, Honolulu, HI, 2007, June.

[10] M. Darbeheshti, W. Schupbach, A. C. Lafuente, T. Altman, K. Goodman, M. S. Jacobson and S. O'Brien, "Learning Communities: Impact on Retention of first-year students," in *ASEE Virtual Conference*, 2020, June.

[11] G. E. Simon, M. Darbeheshti, M. Howland Cummings, W. T. Schupbach, T. Altman, M. S. Jacobson and K. Goodman, "WIP: A Layered Mentorship Program (LMP) for Engineering Student Success and Retention," in *ASEE Annual Conference*, Virtual, 2021, July.

[12] N. Brown, J. Velarde and D. J. Mascaro, "Using Peer Mentoring to Enhance Student Experience and Increase Retention in Mechanical Engineering," in *ASEE Conference & Exposition*, New Orleans, LA, 2016, June.

[13] S. C. Mac Namara, A. E. Rauh, M. M. Blum, N. Russo, M. A. Green and S. Nangia, "Peer Mentoring for Women in STEM," in *ASEE Virtual Conference*, 2020, June.

[14] E. C. Voyles, R. K. Kowalchuk, J. W. Nicklow and R. Ricks, "Residential Peer Mentoring Benefits Mentees: What about Mentors?," in *ASEE Annual Conference & Exposition*, Vancouver, BC, 2011, June.

[15] A. Steele, W. N. Waggenspack and J. L. Odenwald, "Unanticipated Outcomes: Social and Academic Benefits for STEM Peer Mentors," in *ASEE Annual Conference*, Virtual Meeting, 2021.

[16] A. Monte, K. A. Sleeman and G. L. Hein, "Does Peer Mentoring Increase Retention of the Mentor?," in *ASEE/IEEE Frontiers in Education Conference*, Milwaukee, WI, 2007.

[17] C. O. Stewart, "STEM Identities: A Communication Theory of Identity Approach," *Journal of Language and Social Psychology,* vol. 41, no. 2, pp. 148-170, 2022.

[18] B. Berelson, Content analysis in communication research, Free Press, 1952.

[19] A. L. Strauss and J. M. Corbin, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, Sage Publications, Inc, 1998.

[20] B. Ericson, "Four Ways to Add Active Learning to Computing Courses," *CACM,* vol. 66, no. 2, pp. 26-29, 2023.