2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #33343

Insights Gleaned from The GAIN Peer-Mentoring Program Pilot

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Insights gleaned from the GAIN peer-mentoring program pilot

Abstract

There is a growing collection of literature that documents the persistence problem in Science, Technology, Engineering, and Math (STEM) disciplines, which is especially significant for students who belong to minority groups. The GAIN (Guide, Advance, Interact, Network) peer-mentoring program was created for undergraduate students pursuing mechanical engineering at Loyola Marymount University, as one step forward in combating this issue. The intent of this in-person program was to increase students' motivation to persist towards their STEM degree primarily by strengthening their belongingness to engineering. In this study, initial data from the prematurely ended Spring 2020 pilot of the program (due to the COVID-19 pandemic) is analyzed with the intention of contributing to the body of knowledge on best practices in developing supportive resources for engineering students. In particular, qualitative and quantitative analyses are performed on the responses to highlighted questions from two surveys. These efforts uncover insights into what criteria students feel are most important in matching them with a mentee or mentor, what types of challenges they have faced in college, and what they hope to get out of the mentoring relationship. Demographic data was also collected to allow for the exploration of any differences in student responses based on personal information, such as ethnicity, gender, and academic class standing. These results are used to inform the improvement and redesign of GAIN to be effective in a virtual setting. Furthermore, this paper highlights the importance of building multidisciplinary teams to strengthen the recruitment and impact of out-of-class educational interventions.

Introduction and motivation

The college-level achievement gap between students who belong to majority and minority groups in Science, Technology, Engineering, and Mathematics (STEM) is a well-known issue in the United States [1, 2, 3]. In particular, the higher exit rates for women and underrepresented minority (URM) students are often highlighted [4, 5, 6]. In addition, the obstacles in the way of students' happiness and success in STEM fields may be experienced differently for students who belong to each minority group [7, 3, 8]. Furthermore, on top of any group- or individual-specific challenges, the overall national retention data show that the majority of all students who enter college as a STEM major do not persist in STEM until graduation [1, 3]. This trend is despite students having a similar level of aspiration to major in STEM across group differences, such as ethnicity [4].

While the existence of the retention issue in STEM is well known, the question remains of how to make STEM education truly diverse, equitable, and inclusive. The body of work on the trials and successes of testing out (partial) solutions to the retention issue is growing from the perspective of a variety of in-class and out-of-class angles [9, 10] and even to multi-level mentoring ecosystems [11]. Furthermore, there are many known benefits derived from peer-mentoring studies applied across both STEM and non-STEM fields [12, 13, 14, 15]. Moreover, the formation of a social group within engineering is important for student persistence [16], which could be bolstered by interacting with a peer-mentoring program.

As one humble step forward in counteracting the retention issue in STEM, the aim of the study presented here is to contribute to the growing body of work by improving the retention and success of mechanical engineering undergraduate students at Loyola Marymount University (LMU). In particular, the GAIN (Guide, Advance, Interact, Network) peer-mentoring program was developed as an out-of-class academic intervention and launched in Spring 2020 as a pilot. Despite LMU having a higher retention rate than the national average, 30% of freshman still exit the mechanical engineering department before their senior year [17]. In addition, the sample size for women and other underrepresented students within this LMU data is usually too small to be reported. The intent of this work is to support all mechanical engineering undergraduate students at LMU in the pursuit of their Bachelor's degrees via the GAIN peer-mentoring program, with the hope of also discovering more widely applicable insights that can extrapolated to battle systemic STEM retention issues at other universities as well.

The Spring 2020 in-person pilot of the GAIN peer-mentoring program was ended shortly after it began, due to the onset of the COVID-19 pandemic. At the time of closure, the recruitment phase had been completed and data from two initial surveys had been collected. The focus of this paper is on analyzing the partial data set from the prematurely ended GAIN pilot. The purpose of these efforts is twofold: (1) to inform the improvement and transformation of GAIN into a virtual program, and (2) to aid in the development of best practices in creating resources that support student persistence in engineering.

Methodology

Research questions

The GAIN peer-mentoring program and associated data collection instruments were created as one step forward in contributing to answering the broad research question of "What are the best practices in developing educational interventions that work to counteract the retention issue in STEM?" In particular, the scope of the GAIN peer-mentoring program is narrowed to mechanical engineering undergraduate students at a medium-sized, undergraduate-focused, private, Catholic, liberal arts university, as an accessible starting point in these ongoing efforts [18]. Furthermore, given the premature ending of the Spring 2020 GAIN pilot, the study presented here is focused on answering the following series of related research questions: "What particular challenges do mechanical engineering students face in college? What are they looking for in a peer mentor? In what ways are the experiences of students who belong to minority groups different from those who belong to majority groups?" In addition to contributing to the body of knowledge on these topics, another aim of this study is to utilize the information gathered from the canceled pilot to improve the effectiveness of the GAIN program for future iterations.

Eligibility and recruitment

The Spring 2020 GAIN pilot was open to any enrolled undergraduate students at LMU who were majoring in mechanical engineering or engineering undeclared (which refers to the general engineering program for up to the first three semesters). All students of age 18 and over who signed up for the GAIN pilot were also participants in the associated research study. This research study was approved by the Institutional Review Board (IRB) at LMU (protocol number: LMU IRB 2020 SP 24 R), and informed consent was obtained via a series of yes/no eligibility

and acknowledgment questions following a detailed consent form that was linked in the preamble of each online survey.

The recruitment of participants for the GAIN pilot and associated research study included a multifaceted approach: flyers posted in engineering buildings on campus, a GAIN website detailing the scope and benefits of the program, "elevator pitches" delivered by the student research team to select mechanical engineering and general engineering classes, and a blurb in the weekly mechanical engineering newsletter. In addition, all eligible students were invited to a casual "info session" with pizza, at which potential participants could ask questions, meet the team, and sign up for the GAIN pilot on their phones. All of these elements of the recruitment plan were successfully implemented before the pilot ended. The outcomes of this recruitment as well as the changes made to improve the recruitment for the second GAIN (virtual) pilot attempt are discussed in later sections of this paper.

Program structure

The GAIN peer-mentoring program was planned to primarily consist of flexible interactions between mentors and mentees. As participants were matched into mentoring pairs, there was planned to be a brief training session focused on how to connect with each other and to promote a worthwhile professional relationship. In addition to the one-on-one mentoring meet-ups, the program was planned to include GAIN-wide events, with VIP faculty or industry guests. At these events, all mentors and all mentees would be encouraged to network together and to work in small teams to perform structured hands-on design and problem-solving activities. The structure of this program was intended to support the goal of increasing students' motivation to persist by increasing their sense of belonging to engineering communities and their self-efficacy in relation to their engineering skills.

Surveys

The Spring 2020 GAIN pilot was planned to include a variety of surveys, each with a different practical or research purpose. Specifically, four separate surveys had been prepared using Qualtrics: the matching survey, baseline survey (as a pre/post survey), check-in survey, and feedback survey. Only the matching survey and the first iteration of the baseline survey had been implemented before the Spring 2020 pilot was canceled due to the COVID-19 pandemic.

To join the GAIN pilot, students were asked to fill out the matching survey and the baseline survey. The matching survey included a mixture of closed- and open-ended questions about students' identity, interests, and preferred style of interaction with the program. The purpose of this survey was to gather useful information for matching participants into successful peer-mentoring pairs. In contrast, the baseline survey included only closed-ended questions to collect data on the status of participants' sense of belonging, self-efficacy, and engineering identity, as well as some brief demographic information. Almost all of the questions were in the form of Likert-type scales, as this type of question is especially helpful in indicating the respondent's attitude. The baseline survey was planned to be administered at the start of the pilot (the pre-survey) and again at the end of the pilot (the post-survey), with the intention of tracking how participation in the GAIN pilot affected (and hopefully increased/strengthened) the main psychological constructs mentioned above. The baseline survey was also administered to a control group of students who were eligible for but who chose not to participate in the GAIN

pilot, allowing any "natural" changes due to the progression of the semester to be separated from the effect of the educational intervention. Students who filled out the baseline survey, whether as a GAIN member or not, were entered in a drawing to with $40 Amazon gift cards as a participation incentive.

The other two surveys were planned to be administered later in the pilot to provide practical information on how well the GAIN pilot was going. In particular, the check-in survey would have briefly asked participants about how often they were meeting with their mentee/mentor and generally how satisfied they were with their match, with the added benefit of providing context for the pre/post survey results. The feedback survey was also brief and would have prompted participants to provide their direct feedback on the strengths and weaknesses of the GAIN program to be used in future iterations.

Analysis approach

The analysis for this study is focused on the data from a subset of five questions across the two surveys that were administered before the Spring 2020 GAIN pilot was canceled: four from the matching survey and one from the baseline (pre-) survey. Table 1 serves to highlight and label these five survey questions.

Table 1: Main survey questions analyzed from the canceled GAIN pilot. The identifier "M" refers to the matching survey and "B" refers to the baseline survey

Topic, Style, and Source	**Highlighted Survey Question**
Question M1: Challenges faced (Open-ended, Matching survey)	Briefly describe the main challenge(s) you have faced in college so far. Examples academic struggles, personal struggles, time management, work-balance life, difficult roommates, acclimating to life on campus, etc.
Question M2: Mentor specialties (Open-ended, Matching survey)	As a mentor, please list the areas in which you feel especially comfortable guiding your mentee. Examples time management, retaking a course, finding a community on campus, etc.
Question M3: Relationship benefits (Multi-select, Matching survey)	What would you like to get out of the mentoring relationship?
Question M4: Matching similarities	Based on the information that you have provided, how important are the considerations below in matching

(Likert scale, Matching survey)	you with your mentor/mentee? Please indicate the level of importance to you.
Question B1: Unwelcoming climate (Likert scale, Baseline survey)	To what extent do you worry that people at LMU negatively judge you based on what they think about your race, gender, or social class?

As is discussed in the results section, the partial pilot data is analyzed using a mixed methods approach. In addition, NVivo software is employed to analyze the chosen open-ended questions. A process of "coding" was performed on the brief free-text responses from the participants using "inductive codes," which are labels generated and assigned to phrases or segments of the text that the researcher deems significant. "Inductive codes" are in contrast to "deductive codes," which would be pre-determined and only assigned upon reading the text [19]. The process of coding allows the raw data to be sorted, in an effort to illuminate patterns [19, 20].

Results

Recruitment outcomes

The recruitment from the research study associated with the Spring 2020 GAIN pilot yielded a total of 18 participants, including 15 participants who signed up for the GAIN peer-mentoring program by filling out the matching survey, and three participants who chose to serve as the control group by only completing the baseline survey (Figure 1).

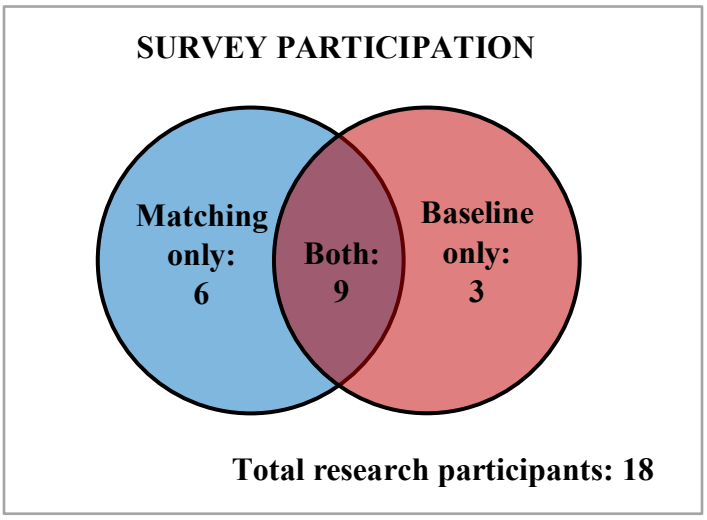

Figure 1: Survey participation breakdown

While all students who wanted to participate in the full program should have filled out both the matching and the baseline (pre-) survey, only 9 of the 15 participants had filled out both by the time of cancellation. Out of these 15 participants for the full program, 13 had declared a mechanical engineering major and 2 were still in the general track as engineering undeclared

majors. In addition, the 18 total research participants included 16 men and 2 women, and both women signed up for the full GAIN program.

As shown in Figure 2, the majority of students who enrolled in the full GAIN pilot in Spring 2020 by completing the matching survey were male juniors who signed up as mentors. Although the overall recruitment numbers are small, the current turnout of women is below the typical average percentage of women in mechanical engineering at LMU, which is usually around 20% [21]. One influencing factor in producing this outcome may be the high enrollment of juniors, as this cohort happens to have about half of the typical number of women. In addition, all participants in this study came from a pool of approximately 160 students in the mechanical engineering major at LMU plus an additional much smaller pool of engineering undeclared majors.

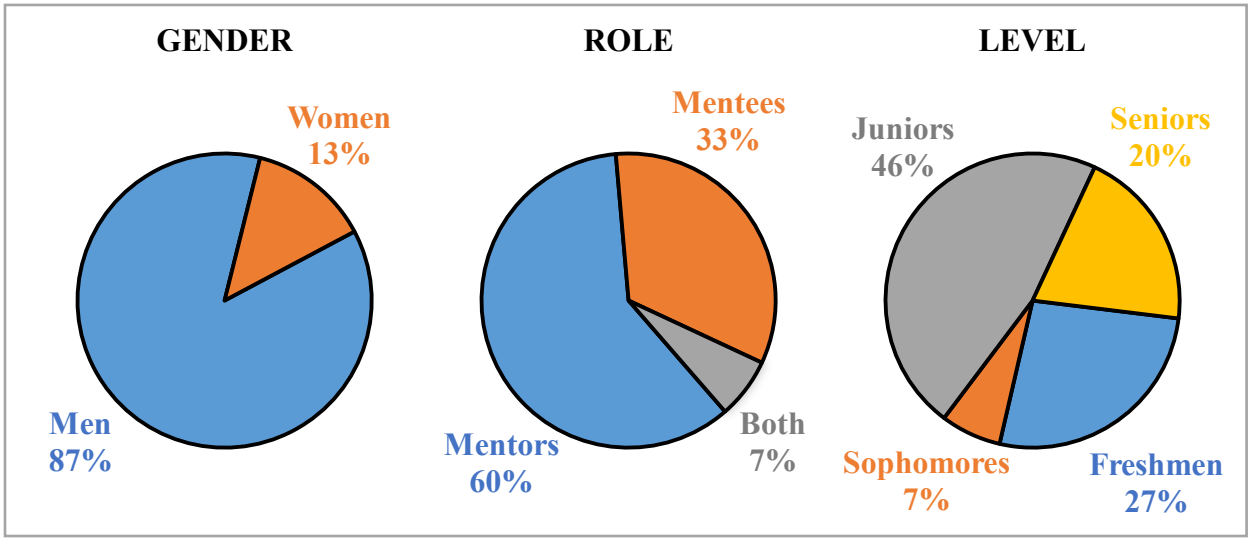

Figure 2: Demographic and role breakdown for the matching survey participants

In terms of the mentoring roles, all of the freshmen and sophomores signed up to be mentees, one junior signed up as both a mentee and mentor, and the rest of the juniors as well as all of the seniors declared their interest in being mentors. The research team suspects that this skewed outcome of having a higher proportion of mentors than mentees may stem from juniors naturally seeing themselves as mentors due to their classification as "upperclassmen." This result was despite the messaging during recruitment that juniors could be mentored by seniors too (and sophomores could mentor freshmen). Furthermore, the team suspects that the implied vulnerability in the title of "mentee" applied within a male-dominant pool and a peer-mentoring context may produce hesitation for juniors to volunteer as mentees. In planning for the next iteration of GAIN, changes were made to the marketing to improve the balance between groups as well as the recruitment yield overall, and these updates are presented in the discussion section.

Analysis of question M1: Challenges faced

The 15 free-text responses to question M1 (defined in Table 1) from the matching survey were analyzed using NVivo software. In an effort to create a visual summary of the keywords from students' responses to this question, a word cloud (Figure 3) was created by running a word frequency query. In doing so, 32 additional words were iteratively added to the default set of

excluded words in the query to streamline the results. Within the context of this study, these additional words were excluded because either they did not have significant meaning alone or they were misleading when displayed out of context. Examples include “also,” “took,” “affected,” “year,” and “love.” Of the remaining words, the most frequently occurring words that participants used to describe the challenges that they have faced in college were “time” and “struggles,” as shown in Figure 3, where larger word size indicates more frequent occurrence in the responses.

Figure 3: Word cloud visualization of the college-level challenges faced by the participants

In addition to a word frequency query, a coding analysis was performed on the responses to question M1 from the matching survey to distill this qualitative information. In doing so, four inductive codes were generated by the researcher while reading and sorting the data: academics, path uncertainty, personal and social struggles, and time balance. The “academics” code was used to label any struggles related to coursework, such as low grades, dropping courses, or poor study habits. The “path uncertainty” code broadly labels any lack of clarity in students’ academic or career trajectory in engineering, such as being unsure about their major or having trouble finding an internship. The “personal and social struggles” code includes a variety of individual or interpersonal challenges, such as mental health concerns, difficulty getting along with roommates or finding a fitting social group on campus, and being tired. Finally, the “time balance” code refers to challenges such as insufficient time management skills, difficulty finding time for extracurricular activities or relaxation due to the high academic workload, and juggling coursework with job responsibilities.

While the vast majority of coded excerpts from students’ responses fell distinctly into only one of the four coding categories, a small minority of the excerpts were coded into more than one category. In particular, segments related to lack of sleep were coded under both “personal and

social struggles" and "time balance," as the former title describes the psychological challenge of working while exhausted and the latter alludes to both the cause and remedy of this issue. In the end, the results of this analysis indicate that the most important codes are "time balance" and "personal and social struggles" in describing the challenges that this pool of students face while studying engineering at the college level (Figure 4).

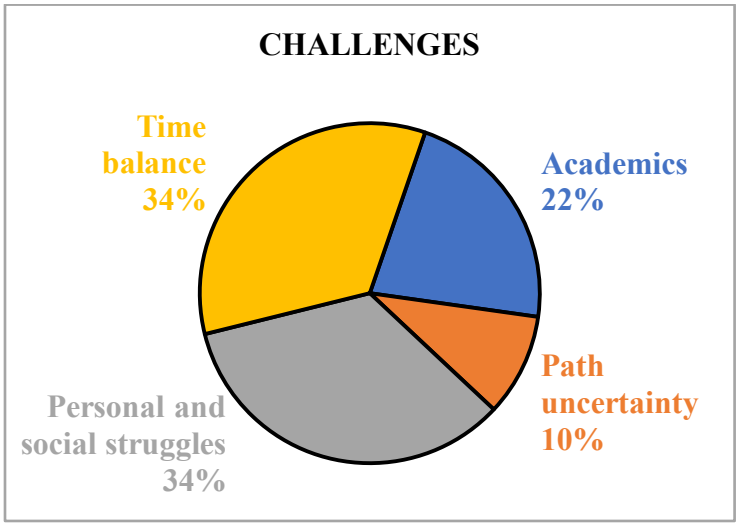

Figure 4: Relative occurrence frequency of the four inductive codes used to categorize the college-level challenges faced by the participants

Analysis of question M2: Mentor specialties

Utilizing the same approach as for question M1, a coding analysis was performed on the participants' free-text responses to question M2 (defined in Table 1). In doing so, five inductive codes were generated: community and networking, improving academics, time management, specific technical expertise, and general support (Figure 5). These codes encapsulate what the participants who signed up to be mentors listed as the topics about which they feel particularly comfortable assisting their mentee, assumedly from personal experience.

Here, "community and networking" refers to ways that students can find communities to which they are excited to belong, both within and outside of LMU, as well as how to network as a career tool. Examples of "improving academics" included developing better study habits and assistance with coursework. For the "time management" code, most of the included excerpts were exactly the same phrase as this title, but this category generally includes any approach to maximize the efficiency of students' time usage. The "specific technical expertise" category was only relevant to one excerpt, and refers to assisting the mentee with a specific technical task within the field of mechanical engineering. The final code, "general support" includes examples such as career advice, finding resources, and how to survive in engineering.

As with the coded excerpts from question M1, only a small minority of excerpts from question M2 were coded into more than one (exactly two) categories. For example, the topic of helping mentees connect with their professors was coded into both the "improving academics" and "community and networking" bins. Overall, the results from this analysis indicate that

"community and networking" was the most important code, with "time management" and "improving academics" in second place.

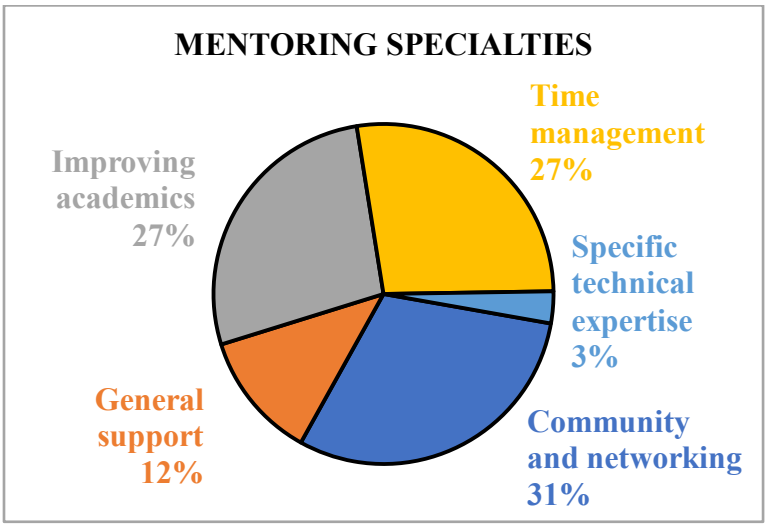

Figure 5: Relative occurrence frequency of the five inductive codes used to categorize the particular competencies of the participants who signed up to be mentors

Analysis of question M3: Relationship benefits

In contrast to the free-text style of questions M1 and M2, question M3 was formatted in a "select all that apply" fashion, asking mentees and mentors what benefits they hope to gain from their mentoring relationship. For this question, the relative importance of each of the nine options was determined by counting the number of participants who included it in their selection (Figure 6).

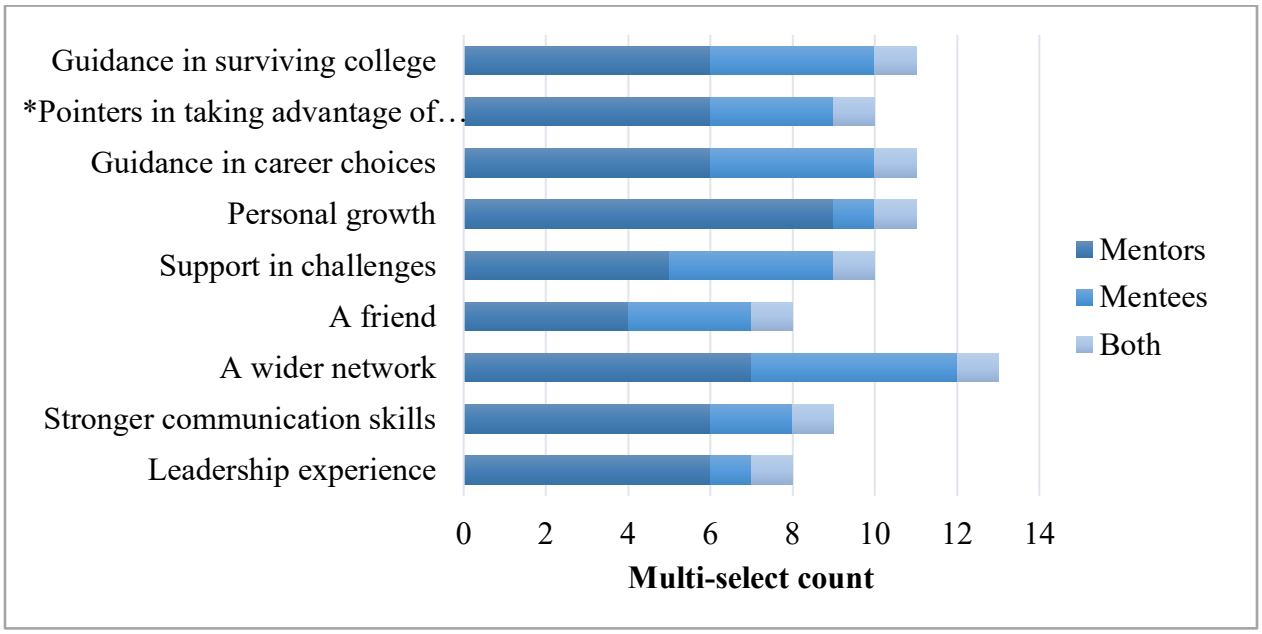

Figure 6: Aggregated selection counts for which benefits participants hoped to gain from their potential mentoring relationship. (* completes to "… what LMU has to offer")

From the 9 listed benefits, all participants happened to select 3 to 9 of the options with a median of 6. This result included 2 participants who selected all 9 (one was a freshman mentee, and the other was a junior who signed up as both a mentee and a mentor). While the pool of participants who answered this question included mentors and mentees, 6 out of 9 of the mentor subset included "leadership experience" in their selection. Overall, the clear top selection of the participants was "a wider network," which is unsurprising because of the innate connection between building mentoring relationships and networking. The second most popular choice resulted in a three-way tie between "guidance in surviving college," "guidance in career choices," and "personal growth."

Analysis of question M4: Matching similarities

As with question M3, question M4 is closed-ended and the analysis consists of counting up the number of participants who chose a particular selection (Figure 7). In this case, participants were asked to indicate the importance of the listed attributes in matching them with a mentee or mentor. This question was presented in a Likert-type format, with five options ranging from "not important" to "very important." A sixth option of "no opinion" was also included in case any participants were unsure of whether a given attribute would strengthen or have no effect on the success of their potential mentoring relationship.

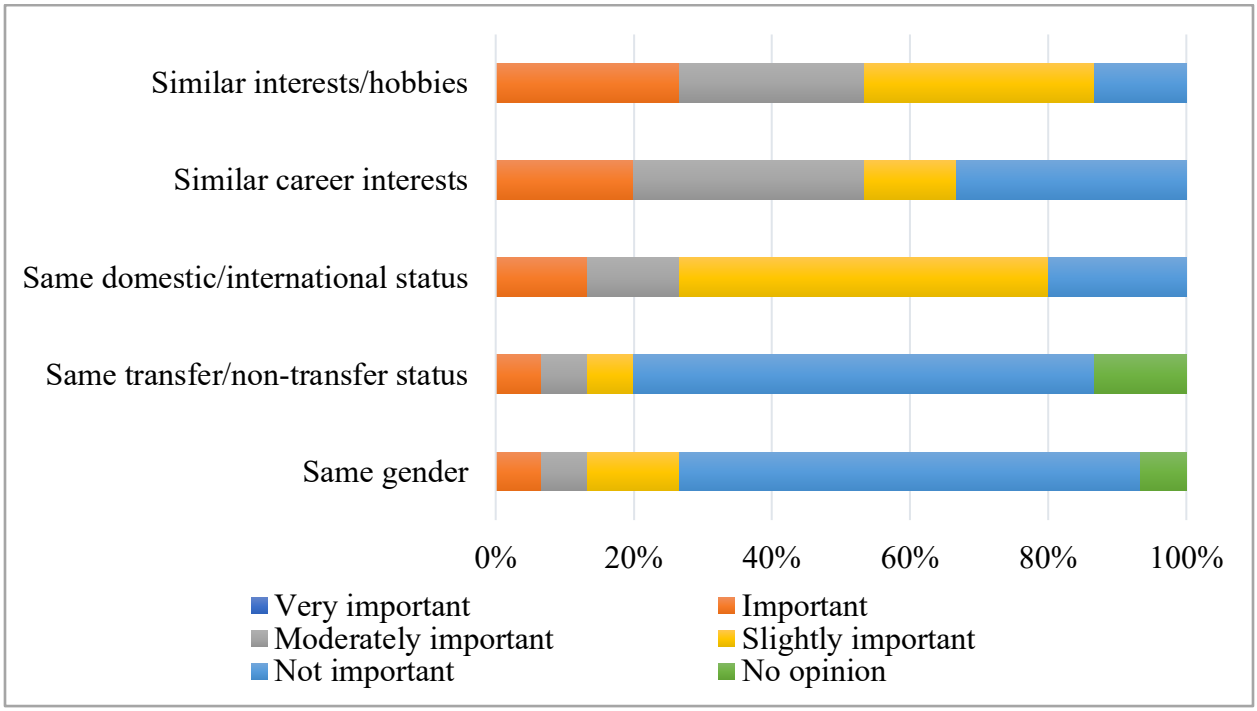

Figure 7: Level of importance in sharing similar attributes with participants' mentees or mentors

The results show that the most agreement between matching survey participants (indicated by the segment length within the bars in Figure 7) in response to question M4 occurs in deciding that having the same transfer/non-transfer status and same gender as their potential mentee or mentor are both not important factors. The research team suspects that the small portion of both transfer students and women included in the set of participants may be partially responsible for this result. Interestingly, the one and only transfer student who filled out the matching survey

selected “slightly important” in response to the transfer status prompt, and one of the two women in the participant set selected “important” in response to the gender prompt whereas the other woman selected “slightly important.” In the same vein, the next highest agreement level occurred when participants deemed having the same domestic/international status as “slightly important,” which is likely influenced in some way by the participant set including only domestic students. In addition, none of the participants ever chose “very important” in regards to any of the prompts within question M4.

For the remaining two prompts within question M4, the responses are more evenly split among the options, signaling that there is less agreement. The importance ratings in response to the similar interests/hobbies prompt is the most skewed towards the higher importance end of the scale, indicating that having similar interests or hobbies with their mentee or mentor is the attribute that participants find to be the most valuable (at least from the available options). Interestingly, a sort of splitting effect appears in the results from the similar career interests prompt, as one third of the participants chose “moderately important” and another third chose “not important.” The research team suspects that some of the participants’ uncertainty in their exact career path may be partially responsible for the low-end side of this split.

Analysis of question B1: Unwelcoming climate

The set of participants who completed the baseline survey is different from the set of participants who completed the matching survey, as 6 students from the matching set did not fill out the baseline survey, and an additional 3 students filled out only the baseline survey (Figure 1). The resulting set of 12 students who responded to the baseline survey included 2 women, and 0 engineering undeclared majors. The baseline set included a higher proportion of transfer students than the matching set, with a count of 3 out of 12, and the academic level breakdown included a majority of juniors along with no sophomores (Figure 8).

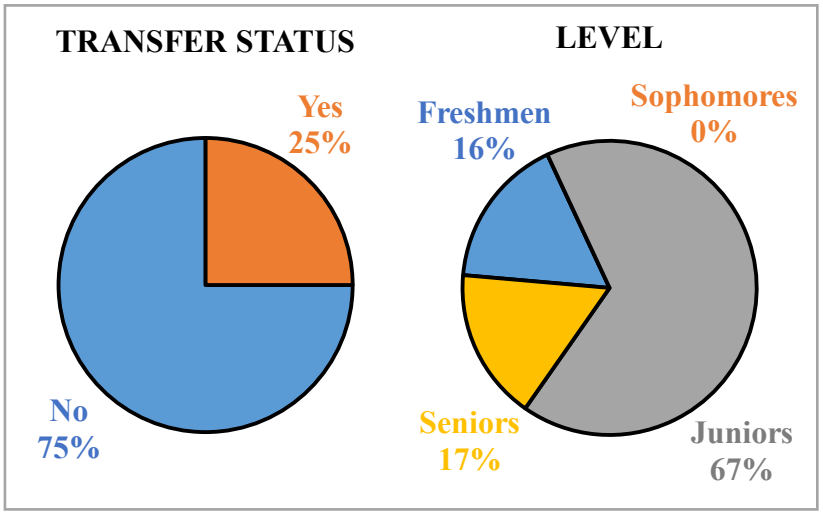

Figure 8: Demographic breakdown for the baseline survey participants

Question B1 from the baseline survey (defined in Table 1) prompted students to indicate the extent to which they feel negatively judged by people at LMU based on their race, gender, or social class. This closed-ended question was presented in a Likert-type format, with five

available choices: 1 – "none at all," 2 – "a little," 3 – "a moderate amount," 4 – "a lot," and 5 – "a great deal." This question assesses stereotype threat and its wording was taken directly from the literature [22, 23], with the associated scale modified to span 5 points (instead of 7 points). This question was included in the "belongingness" section of the baseline survey, and is intended to provide some indication of the climate of LMU, as perceived by engineering students. Question B1 was chosen to be highlighted here, out of all of the baseline survey questions, because the differences in the collected responses to this question seem to correlate with whether the participant identifies with a majority or minority group in engineering (Figure 9).

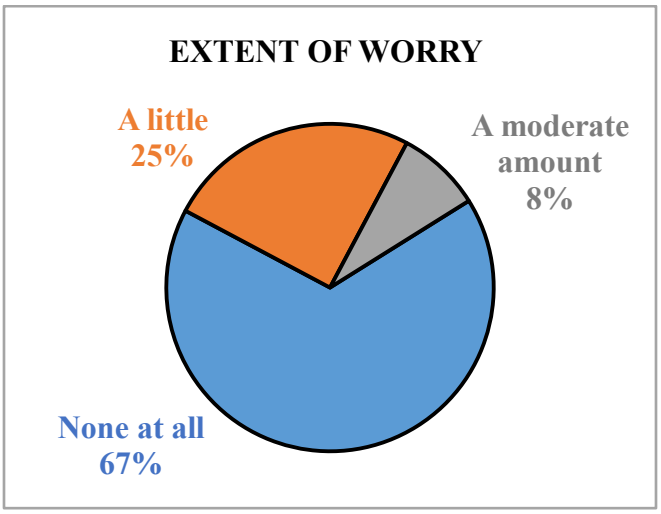

Figure 9: Extent to which participants worry about being negatively judged based on their race, gender, or social class, with included demographic analysis

In reference to question B1, the majority of participants (8 out of 12) selected "none at all," indicating that they are not worried about negative judgement with respect to the three identity elements listed. Of the remaining 4 participants, 3 selected "a little" and 1 selected "a moderate amount." All four of these students who selected anything other than "none at all" belong to a minority group in engineering with respect to their gender or ethnicity. In particular, two were women (as well as the only women in the data set) and the two men were both Hispanic or Latino.

Discussion and preliminary conclusions

Recruitment and marketing

In an effort to redesign the GAIN peer-mentoring program to be effective in a virtual setting and to improve the impact of the program overall, based on the results of this study, a variety of changes were made. Here, two of these changes in the area of marketing and recruitment are highlighted along with the supporting reasoning: (1) deemphasizing the structural aspects of the program and instead focusing on shared values, (2) promoting a mentoring community with an associated two-way mentoring culture. These improvements to the attractiveness and eventual overall effectiveness of this program by modifying the marketing aspects are due in large part to the joining of marketing expert, Dr. Julian Saint Clair, to the research team as well as advice provided by mentoring expert Dr. Ellen Ensher. Moreover, given the key role that recruitment plays in both the impact of any out-of-class educational intervention and the depth of research

analysis possible, there are many benefits to forming multidisciplinary teams to tackle the leaky pipeline issues in STEM.

In reference to the first highlighted area of change, the "GAIN peer-mentoring program" was renamed to simply be called "GAIN" (Guide, Advanced, Interact, Network) and a corresponding tagline was created: "Empowering all of us to thrive in engineering." In addition, the new GAIN includes a private Discord server to facilitate more opportunities for casual connections to be made between peers. While a formalized peer-mentoring program is still a core component of the new GAIN, deemphasizing this structure in the title and marketing materials helps to motivate students to join by connecting to what is important to them. Furthermore, one line from the new mission of GAIN reads, "We are dedicated to *paying it forward* and creating an open culture where the different parts of each of us are truly welcome." In addition to the concept of "paying it forward" generally being a desire that is easy to tap into, this is cited an important motivator for students to sign up as peer mentors [14, 24]. Given the relatively low turn out of students for the Spring 2020 GAIN pilot, these changes are in an effort to increase the overall participation numbers while also intending to help sustain participants' momentum in the program by focusing on shared values.

The preponderance of students signing up to be mentors rather than mentees raised questions as to how the benefits of being a mentee could be better positioned, which brought about the second highlighted area of change. Being a mentor may come with external benefits such as prestige or social capital [25], or with internal benefits such as esteem or efficacy needs [26]. Being a mentee may be perceived as a subordinate, vulnerable position that may be inconsistent with or threatening to a participant's sense of confidence, efficacy, or agency as related to their engineering identity (for reviews see [27, 28, 29]). Even in a peer-mentoring relationship, the terms "mentor" and "mentee" can produce resistance due to the implied hierarchy [15]. Thus, the next iteration of GAIN seeks to position getting mentored as a desirable position where participants can get inside information, which in-turn may be associated with social capital and seen as empowering [30]. Similarly, the new outreach materials focus on the phrasing "mentoring pairs" instead of mentee/mentor to further lower this boundary. In addition, the new advertisements use the slogan "get mentored" as both a call to action and a mentality. Furthermore, the associated promotion of a two-way mentoring culture is in line with the concept of a growth mindset, the encouragement of which can lead to further intelligence gains [31].

Surveys

Despite the limited data, it is encouraging to see that the top mentoring specialties (question M2) generally line up well with the challenges that students face (question M1). For example, the "time management" code from the specialties is very similar to the "time balance" code from the challenges, and the "community and networking" code from the specialties can be seen as a partial remedy to the "personal and social struggles" code from the challenges. This correlation implies that mentors are ready and willing to share the keys to success that they have won from overcoming some of the obstacles they have faced, and that their peers are struggling with similar obstacles. For the subsequent implementation of the matching survey, the research team has removed the clarifying examples of challenges and specialties that were included in the prompts, as they appear to have biased students' responses by limiting their word choice. However, assuming that the responses are still truthful to students' personal experiences, the

results can still be used to inform marketing materials and additional resources given to GAIN members. Furthermore, the observation that "time" arose as the most frequent word that students used in describing the main college-level challenges that they have faced implies that the high workload of engineering presents a particular obstacle to student success.

Results from the closed-ended questions provide additional information about students' experiences that complements the qualitative data. In particular, participants indicated that having similar interests or hobbies with the other half of their mentoring pair is the most important matching criteria (question M4) and that the most popular benefit from the mentoring relationship is expanding their network (question M3). In addition, some students indicated that they do worry somewhat about being judged by their peers based on their race, gender, or social class (question B1), which demonstrates that there are diversity-related climate issues to be addressed. All of these observations align well with the popular codes concerning community and personal struggles and further motivate the reframing of GAIN around more casual community building than the formal structure of peer mentoring. Establishing GAIN as a continuous and growing community of students connected by shared values of inclusion and helping each other succeed is intended as a change agent for improving engineering climate and propelling a diverse population of students forward towards their career goals.

Future directions

The previously discussed modifications to the marketing for the next iteration of GAIN are anticipated to lead to significantly improved recruitment, leading to a richer data set that can be analyzed in-depth as part of this ongoing work. In particular, having a larger set of participants along with updated data collection instruments will allow for a thorough analysis of the effectiveness of this academic intervention. In doing so, careful consideration will be given to assessing any differences that may arise in the overall impact from this program when correlated with aspects of the students' identity. This identity-linked information would allow for additional modifications to be made to GAIN, in an effort to ensure that all groups are being well served. In addition, the research team hopes that GAIN will become a well-established inclusive community that can be expanded to include students from other engineering disciplines and universities, all with the aim of creating a world where all engineers are confident in their belonging to the field.

References

[1] President's Council of Advisors on Science and Technology (PCAST), "Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics," Executive Office of the President, 2012.

[2] National Science Foundation, National Center for Science and Engineering Statistics, "Women, Minorities, and Persons with Disabilities in Science and Engineering: Special Report NSF 19-304," Alexandria, VA, 2019.

[3] E. Seymour, A.-B. Hunter and T. J. Weston, "Why We Are Still Talking About Leaving," in *Talking About Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education*, Springer, 2019, pp. 1-54.

[4] Higher Education Research Institute at UCLA, "Degrees of Success: Bachelor's Degree Completion Rates Among Initial STEM Majors," HERI Report Brief, 2010.

[5] Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, Expanding underrepresented minority participation: America's science and technology talent at the crossroads, Washington, DC: National Academies Press, 2011.

[6] M. J. Graham, J. Frederick, A. Byars-Winston, A.-B. Hunter and J. Handelsman, "Increasing Persistence of College Students in STEM," *Science Education,* vol. 341, no. 6153, pp. 1455-1456, 2013.

[7] M. M. Camacho and S. M. Lord, "Latinos and the exclusionary space of engineering education," *Latino Studies,* vol. 11, no. 1, pp. 103-112, 2013.

[8] M. Besterfield-Sacre, M. Moreno, L. J. Shuman and C. J. Atman, "Gender and ethnicity differences in freshmen engineering student attitudes: A cross-institutional study," *Journal of engineering Education,* vol. 90, no. 4, pp. 477-489, 2001.

[9] NSF INCLUDES National Network, "Broadening Participation in STEM: Evidence-based Strategies for Improving Equity and Inclusion of Individuals in Underrepresented Racial and Ethnic Groups," NSF INCLUDES Coordination Hub Research , 2020.

[10] H. Pon-Barry, B. W.-L. Packard and A. St. John, "Expanding capacity and promoting inclusion in introductory computer science: a focus on near-peer mentor preparation and code review," *Computer Science Education,* vol. 27, no. 1, pp. 54-77, 2017.

[11] J.-L. Mondisa, B. W.-L. Packard and B. Montogomery, "Understanding what STEM mentoring ecosystems need to thrive: A STEM-ME framework," *Mentoring & Tutoring: Partnership in Learning,* vol. 29, no. 1, pp. 110-135, 2021.

[12] 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,* vol. 114, no. 23, pp. 5964-5969, 2017.

[13] A. M. Zaniewski and D. Reinholz, "Increasing STEM success: a near-peer mentoring program in the physical sciences," *International Journal of STEM Education,* vol. 3, no. 1, pp. 1-12, 2016.

[14] P. Collier, "Why peer mentoring is an effective approach for promoting college student success," *Metropolitan Universities,* vol. 28, no. 3, pp. 9-19, 2017.

[15] J. W. Colvin and M. Ashman, "Roles, risks, and benefits of peer mentoring relationships in higher education," *Mentoring & Tutoring: Partnership in Learning,* vol. 18, no. 2, pp. 121-134, 2010.

[16] O. Pierrakos, T. K. Beam, J. Constantz, A. Johri and R. Anderson, "On the development of a professional identity: Engineering persisters vs engineering switchers," in *2009 39th IEEE Frontiers in Education Conference*, 2009.

[17] Institutional Research and Decision Support, "Undergraduate Freshmen Retention Rates Official Statistics," Loyola Marymount University, 2018. [Online]. Available: https://academics.lmu.edu/officeofinstitutionalresearch/officialstatisticsandotherreporting/officialstatistics/.

[18] N. Schaal, M. Richter and C. Tiong-Smith, "Student Persistence in STEM: An Ongoing Exploration of the Experiences of Mechanical Engineering Students at Loyola Marymount University," in *Proceedings of the 2021 Virtual American Society for Engineering Education Pacific Southwest Section Annual Conference*, (virtual), 2021.

[19] J. Saldana, "An Introduction to Codes and Coding," in *The Coding Manual for Qualitative Researchers*, SAGE Publications, 2009, pp. 1-31.

[20] J. M. Case and G. Light, "Framing Qualitative Methods in Engineering Education Research: Established and Emerging Methodologies," in *Cambridge Handbook of Engineering Education Research (CHEER)*, Cambridge University Press, 2014, pp. 535-549.

[21] Institutional Research and Decision Support, "Enrollments of Westchester Campus Official Statistics: Headcounts for Fall Term," Loyola Marymount University, 2018. [Online]. Available: https://academics.lmu.edu/officeofinstitutionalresearch/officialstatisticsandotherreporting/officialstatistics/.

[22] J. M. Holmes, N. A. Bowman, M. C. Murphy and E. Carter, "Envisioning college success: the role of student identity centrality," *Social Psychology of Education,* vol. 22, no. 5, pp. 1015-1034, 2019.

[23] G. L. Cohen and J. Garcia, "'I am us': negative stereotypes as collective threats," *Journal of personality and social psychology,* vol. 84, no. 4, pp. 566-582, 2005.

[24] B. Bunting, B. Dye, S. Pinnegar and K. Robinson, "Understanding the dynamics of peer mentor learning: A narrative study," *Journal of the First-Year Experience & Students in Transition,* vol. 24, no. 1, pp. 61-78, 2012.

[25] J. Savary, C. X. Li and G. E. Newman, "Exalted purchases or tainted donations? Self-signaling and the evaluation of charitable incentives," *Journal of Consumer Psychology,* vol. 30, no. 4, pp. 671-679, 2020.

[26] J. Lee and L. J. Shrum, "Conspicuous consumption versus charitable behavior in response to social exclusion: A differential needs explanation," *Journal of Consumer Research,* vol. 39, no. 3, pp. 530-544, 2012.

[27] M. Forehand, A. Reed and J. K. S. Clair, "Identity interplay: The importance and challenges of consumer research on multiple identities," *Consumer Psychology Review,* vol. 4, no. 1, pp. 100-120, 2021.

[28] J. L. Petriglieri, "Under threat: Responses to and the consequences of threats to individuals' identities," *Academy of Management Review,* vol. 36, no. 4, pp. 641-662, 2011.

[29] S. J. Spencer, C. Logel and P. G. Davies, "Stereotype Threat," *Annual Review of Psychology,* vol. 67, pp. 415-37, 2016.

[30] J. Berger, Contagious: Why things catch on, Simon and Schuster, 2016.

[31] C. S. Dweck, Mindset: The New Psychology of Success, New York, NY: Random House, 2016.