

Implementation of intergenerational architectural engineering peer mentoring program and impact on institutional retention and connectedness

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Abstract

An intergenerational peer mentoring program was established at an architectural engineering program in the Midwest with the intent of improving student retention and fostering feelings of connectedness. The program unites students across all years of the undergraduate program and 5th year masters' students in groups mentored by professional engineers practicing in industry. The program was implemented within the curriculum of a required zero-credit hour seminar course and has expanded to include activities outside of class time. Prior retention theory and interventions were considered to develop a robust assessment method with the goal of evaluating the impact of the mentoring program on student retention and connectedness in the classroom. Impact on retention was examined through term-to-term mentor group rosters within the seminar course and through seven items from two subscales from the College Persistence Questionnaire. Community and camaraderie among students were measured by adapting a version of the Feelings of Connectedness subscale of the Classroom Community Scale. Initial results from the program's operation over the first three years of operation illustrate an increase in the retention of first-year students and awareness of industry professionals, though the effects of the program alone cannot be easily parsed apart from other institutional factors. Feelings of community significantly differed across channel groups, indicating that within-group behaviors may need to be further assessed. From the assessment of the program's operation to date, a framework for future implementation is outlined for use at other institutions.

Background

Many post-secondary educational institutions are confronted with the difficult task of minimizing student attrition rates despite a variety of retention factors that may weigh on a given student's commitment to their institution. This challenge is readily apparent among U.S. engineering programs where annual rates of degree attainment within four to six years have lingered around 50% [1].

In order to understand how to retain engineering students, it is first critical to understand what causes students to leave. One survey of fifty engineering student retention studies found that common attrition factors included "the unwelcoming academic climate found in many engineering programs, conceptual difficulties with core courses, a lack of self-efficacy or self-confidence, inadequate high school preparation, insufficient interest in or commitment to the field of engineering or a change in career goals, and racism and/or sexism" [2]. Retention programs that directly address these attritional factors may be more successful.

Common interventions have included faculty development, support programs, remedial/developmental course work, learning communities, and intervention programs tailored to individual students [3]. Of a survey of twenty-five studies that related to improving student retention, many potential actions with evidence of success were identified—among which learning communities, support groups or networks, and student-faculty interaction were identified as potentially addressing the most attrition factors at once [2]. Among these

interventions, social integration is a common thread. The importance of social integration into university life has been long considered in Tinto's conceptual model of retention [4], and "a statistically significant relationship has been found between social integration and retention" [5]. Engineering students can be socially integrated with their peers, their instructors, or with practicing professionals in the industry community.

On a student level, near-peer mentoring models establish a link between students of different experience levels (mentor and mentee) through face-to-face contact to foster peer guidance regarding issues that the mentee may be facing. A study of one such near-peer program implemented in a physical science program concluded that mentors helped to normalize their mentees experience through empathy, and that future mentoring programs should consider monitoring relationships for concerns, building programs in the context of a larger community, promoting informal meetings through the presence of food, and giving participants a choice in their pairing [6].

Although many institutions have implemented retention programs, methods of assessing the impact of such programs on retention are not always well-documented. To determine if a retention program is worth the time and effort that it takes to operate, a comprehensive assessment procedure must be developed.

Previous work by Davidson, Beck, and Milligan generated a College Persistence Questionnaire (CPQ) to assist in identifying at-risk students. Students' responses to the CPQ could be tabulated to determine scores of commitment to the educational program. Once at-risk students had been identified, the variables that influence retention could also be identified through evaluation of bivariate correlation with retention. However, as the authors have noted, applying these findings to an entire student body may not be successful since "variables that prominently influence the persistence decision of one student or one group of students may be weakly related or unrelated to the persistence of other undergraduates" [7]. This can also be said of applying findings across different institutions. So, institutions seeking to implement their own retention program should first examine the variables that influence student commitment within their own institutions.

The purpose of this paper is to describe the peer mentoring program instituted in one architectural engineering program, and report on the assessment of that program over a three-year period. The assessment of the program was designed to gauge the extent to which the program was meeting its objectives related to improving retention, building community, and strengthening connections with alumni. We next describe the AE program involved, key courses, and the mentorship program, followed by the method and results of the program assessment. We end with conclusions and recommendations for those interested in creating a similar program.

Program Structure

The architectural engineering (AE) program at the University of Nebraska–Lincoln offers the following four degrees: a Bachelor of Science in AE (BSAE); a fifth-year ABET-accredited master's degree following the BSAE (or equivalent); a Master of Science in AE (MSAE); and a Doctor of Philosophy in AE (PhD-AE). The BSAE and the fifth-year master's degree combine to create a 4+1, five-year accredited degree.

AE Seminar Course

The AE Seminar course was first introduced in the fall semester of 2016 to present undergraduate students with professional problems and practices by students, faculty, and professionals in the field of architectural engineering. At first, the course was only required for students across all years of the undergraduate AE program, and students were only required to enroll in the AE Seminar course for a minimum of 6 semesters during the undergraduate AE program. Through its first two years of implementation, the course invited practicing professionals to present unique projects in building design that excited students about their future careers. Since then, the AE Seminar course has also served as a gathering place to address the undergraduate AE student body with important announcements, reminders, and opportunities. Often, instructors also recognize recipients of student and design competition awards to help foster a student culture of achievement, excellence, and celebration of others. The course meets three times each semester for 50 minutes and is offered in both the fall and spring semesters.

AE Student Leadership Committee and AE Mentor Program

The AE Student Leadership and Advisory Committee (AESLAC) is a group of student leaders within the University of Nebraska–Lincoln AE program across all grade levels that develops, organizes, and implements several AE events and programs that encourage camaraderie, mentorship, and industry networking.

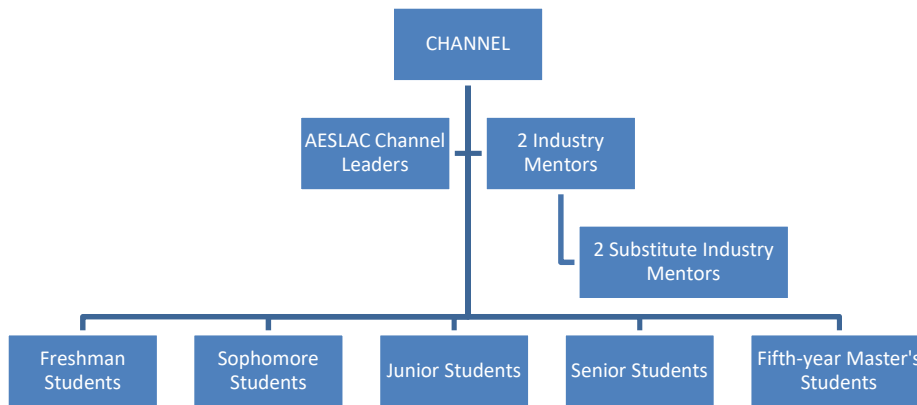
In the fall semester of 2010, the AESLAC launched the AE Mentoring Program through the Introduction to Architectural Engineering course—a required course typically taken in the first year of the program. As a part of this program, the AESLAC recruited sophomore level and above students to serve as student mentors for groups of five to six first year students. The AESLAC also recruits practicing industry professionals to serve as industry mentors for these student groups. Program activities throughout the semester include an icebreaker scavenger hunt, a tour of the industry mentor’s office, and an introduction to navigating building plans. Previous analysis found that this AE Mentoring Program appeared to be “most beneficial to improving retention of marginal students who were initially not as committed to completing the AE program,” however it could not be concluded that the program was the sole influence on retention numbers [8].

AE Seminar Channel Program

In the fall semester of 2018, a new AE mentoring program, called the Channel Program, was initiated under the direction of the AESLAC in addition to the existing AE Mentoring Program. This new program was inspired by student leaders who perceived that the existing AE Mentoring Program did not successfully facilitate student-to-industry relationships in the long term beyond the completion of the first-year course. In response to this, students in the AESLAC developed a plan to break out the students of the AE Seminar course into eight mentorship “channels.” Each channel was comprised of approximately equal amounts of students from each year in the undergraduate AE program. The AESLAC appointed two student peer leaders (sophomore level and above) to each channel to facilitate the program. Volunteers from the local AE professional community were recruited to serve as industry mentors to each channel. Typical channel structure is depicted in Figure 1.

Throughout the AE Seminar course, channels were tasked with both in-class and after-class activities that sought to utilize the opportunity to interface with students across all years of the program together in the same room. Program content was intended to achieve three key objectives: (1) Improve student retention through industry and upperclassmen mentorship, (2) strengthen camaraderie amongst AE students in common channels, and (3) connect practicing professionals/alumni with AE students consistently throughout their education.

Figure 1 – Typical Channel Structure



In the fall semester of 2021, several modifications were made to the Channel Program and the AE Seminar course. First, the curriculum was modified to require students to enroll in the AE Seminar course in all semesters of the 4+1 AE program. Second, the number of industry mentors for each channel was increased to two industry mentors per channel. Rather than renewing commitments annually, each industry mentor was asked to commit to a three-year appointment. This was intended to improve the consistency of industry participants within each channel from year to year. Lastly, the process of assigning incoming students to channel groups was modified to align groups between the Intro to AE course and the AE Seminar course. This ensured that a first-year student in the AE program would regularly interact with the same cohort of students and mentors in the Intro to AE course and the AE Seminar course, and they would continue to interact with those same students and mentors as they progressed through the 4+1 program within that same channel.

Channel Program Events and Activities

Programming is primarily focused on balancing activities that foster camaraderie within channels while also creating opportunities for students to learn from their professional mentors. Some activities are catered specifically toward professional development (e.g., learning how to read building plans with their industry mentor, hosting mock job interviews), while others are purely social (e.g., AE BBQ, Coffee Social). Some activities aim to encourage engineering skills like teamwork and problem solving in a friendly competitive format (e.g., Egg Drop Competition, Balloon Car Competition). Activities of all types occur both in-class and after-class. Some programming is repeated annually, while others are scheduled to only repeat on a four-year cycle. A four-year activity cycle was specified to ensure that fifth-year master's students will re-experience an activity from their first year. The intent is that such students will use their prior

experience to reminisce with fellow students while also mentoring the less experienced students in their own channel. A summary of Channel Program activities and events is provided in Table 1.

Table 1 - Summary of Frequently Hosted Events and Activities

Programming Repeated Annually		
During Seminar (September)	Program Kickoff	New students receive their channel assignments, are introduced to their channel groups, and complete icebreaker activities.
During Seminar (Varies)	Professional Presentations	Channels observe a presentation from an industry presenter. Topics have spanned specific projects, case studies, or present-day concerns in architectural engineering.
During Seminar (April)	Words of Wisdom	Fifth-year master's students collaborate to prepare a video collage of advice for undergraduate students in the program. Students discuss advice with their peers and industry mentors.
Post-Seminar (September)	AE BBQ	Students, mentors, and faculty gather outdoors for free food and yard games.
Post-Seminar (November)	Cans-giving	Channel groups compete to collect the most donations of canned goods from the university and their industry mentors' workplaces. The canned goods are arranged into an artistic sculpture by the AESLAC and entered into the AEI "Canstruction" competition. Following the competition, the goods are donated to a food pantry on-campus.
Programming Repeated in Four Year Cycle		
During-Seminar	Review of Building Plans	Industry mentor brings a physical set of building plans to review with students.
During-Seminar	Reverse Interview Activity	Industry mentors roleplay as a recent graduate interviewing for an entry-level position at an AE firm. Students roleplay as interviewers, generating questions to ask their mentors.

Programming Repeated in Four Year Cycle		
Post-Seminar	Egg-Drop Competition	Students and mentors work together to design a vessel to protect an egg from a one-story fall. The channel with the most cost-efficient successful design wins free pizza after the next seminar.
Post-Seminar	Balloon Car Competition	Students and mentors work together to design a balloon-powered car. The channel with the car that travels the furthest wins a prize.
During-Seminar	Paper Airplane Competition	Students and mentors compete within their channel to build a paper airplane that travels the furthest. Winners from each channel then compete against one another to declare a winning channel.
During-Seminar	Balloon Tower Competition	Students and mentors compete across channels to build the highest tower using only balloons and tape.
Post-Seminar	Coffee Social	Free coffee and snacks are provided for students and mentors to gather and socialize.
During-Seminar	Architect-Engineer-Builder Telephone	Channels split into two small groups, each led by an industry mentor. Participants are assigned role of Architect, Engineer, or Builder. Architects view a completed image of a LEGO structure and communicate what they see to an Engineer (who cannot see the source image). Engineers draw what the Architect describes and prepare instructions to be executed by the Builder.
Post-Seminar	Channel Scavenger Hunt	Each channel is given a “scavenger hunt scorecard” with suggestions for outside of class activities/events. Channels score points for completing items such as “take a tour of your industry mentor’s office” or “arrange a construction site tour with your industry mentor.” The channel with the most points wins a prize.

The spring 2020 semester of the AE Seminar course was interrupted by campus closure in response to the Coronavirus (COVID-19) pandemic. Since in-person interaction was disallowed, a remote teleconferencing class session was held. During the session, graduating fifth-year master's students provided their “words of wisdom” to undergraduate students in the form of a pre-prepared video compilation. This has since persisted as a program tradition to the present day. In the subsequent academic year during the COVID-19 pandemic channel activities were completed using virtual break-out rooms. Most often, channels met in the virtual break-out rooms to discuss the project presentation they had observed in the seminar session.

Methods

Survey data and program records were used to assess the extent to which the program's three objectives were being met. The impact of the Channel Program on retention was examined through term-to-term channel assignment data in the AE Seminar course. To assess the connection of alumni to the program, records were kept tracking the channel each alumni participant led and the years each alumnus participated. Students were also surveyed about their familiarity and knowledge of the program alumni. The impacts on social and psychological factors were assessed through a series of short, electronically delivered surveys.

Related to retention, seven items from two subscales from the College Persistence Questionnaire [7] were adapted and used to measure psychological commitment to students' degree program and the institution. Items were adapted to refer specifically to the institution and to earning any engineering degree or an AE degree. Items in these subscales have a 5-point response scale, with options that vary with the item's wording. Based on exploratory factor analysis (EFA), one item was dropped and the remaining items from these scales were combined into a single Persistence scale. Across all survey administrations, coefficient alpha estimates ranged from .582 to .828. The only term in which coefficient alpha was below .7 was a spring semester when the pool of participants had proportionally more students who were seniors or students in the fifth, MAE year, which appears to have contributed to the lower internal consistency.

Community and camaraderie among students were measured by adapting a version of the Feelings of Connectedness subscale of the Classroom Community Scale [9]. The 10 items were adapted to refer to the students' mentorship channels rather than a "classroom." This subscale has a 5-point agree/disagree response scale. Across all survey administrations, coefficient alpha estimates ranged from .855 to .901. Community was also less directly assessed by examining reports of participation in Channel Program non-compulsory events that take place outside of the classroom.

Four questions asked about students' familiarity and connections with program alumni (other than their channel mentor) and AE professionals. The two questions about program alumni were asked during each term, and the questions about non-alumni AE professionals were asked starting in the second academic year of the study (from Fall 2021 forward). Participants were asked to estimate the number of alumni or non-alumni AE professionals they were "aware of, in terms of who they are, what their jobs are, etc." and that they had met personally. Response options were 0, 1-2, 3-5, 6-10, and 11+.

Auxiliary demographic data were also collected to analyze group differences and impact at the individual and channel level. This included students' gender, race/ethnicity, year in the AE program, status as a first-generation student, status as an international student, and students' channel membership. These demographic questions were distributed across the surveys (1-3 per survey) to keep each survey as short as possible.

Participants and Procedures

Recruitment for the study occurred during the first AE Seminar course meeting each term. The invitation to complete the surveys was always presented at the start of each in-class meeting, and

it was only open to students attending class on that day. Participants completed the surveys electronically on personal devices, and each survey took less than five minutes. See Table 2 for the number of participants who took each survey during each term.

Table 2 - Sample Sizes for Each Survey Administration

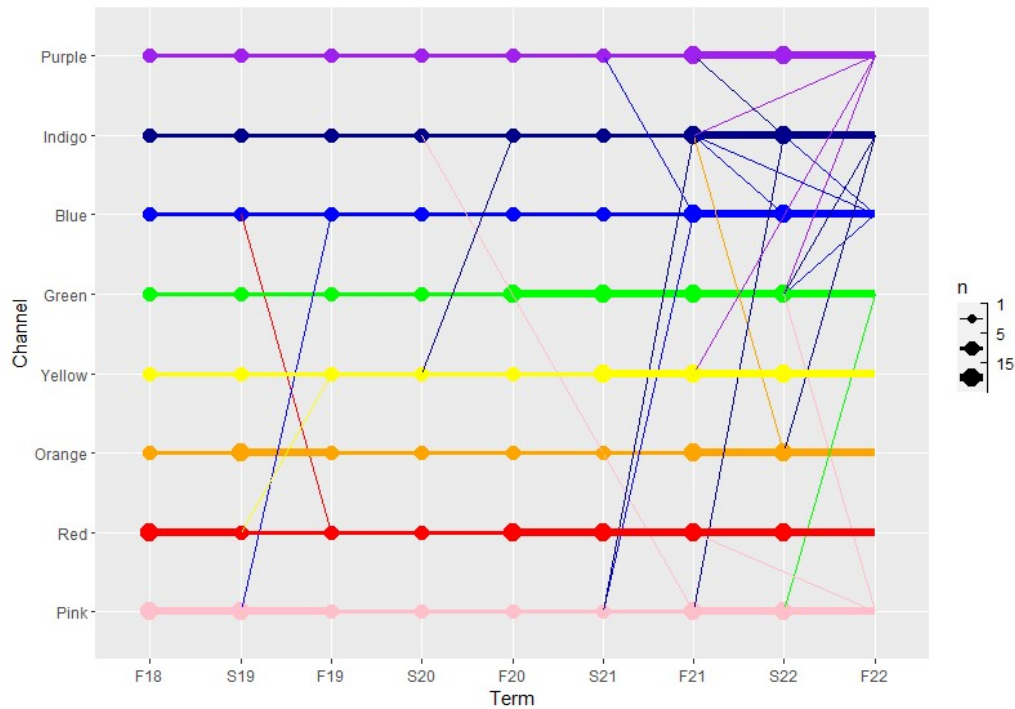
Term	Pre-survey	Mid-survey	Post-survey
Fall 2020	n = 115	n = 61	n = 64
Spring 2021	n = 54	n = 34	n = 35
Fall 2021	n = 121	n = 74	n = 56
Spring 2022	n = 66	n = 44	n = 40
Fall 2022	n = 54	n = 29	n = 20

Results

Retention of students

Channel roster data were available for each fall and spring term from Fall 2018 through Fall 2022, except for the Spring 2020 semester. From Fall 2018 through Spring 2021, channel roster data only contained channel membership for students also enrolled in the AE Seminar for the term. Starting in the Fall 2021 semester, the records contained all students in each channel, not just students enrolled in the course. As a result, the number of students in each channel ranged from 13-23 students per channel in the earlier terms, but it increased to 23-36 in later terms. See Figure 2 for a visualization of the number of students per channel per term as well as the degree to which students' channel membership changed over the terms.

Figure 2 – Channel size and reassignments across each term



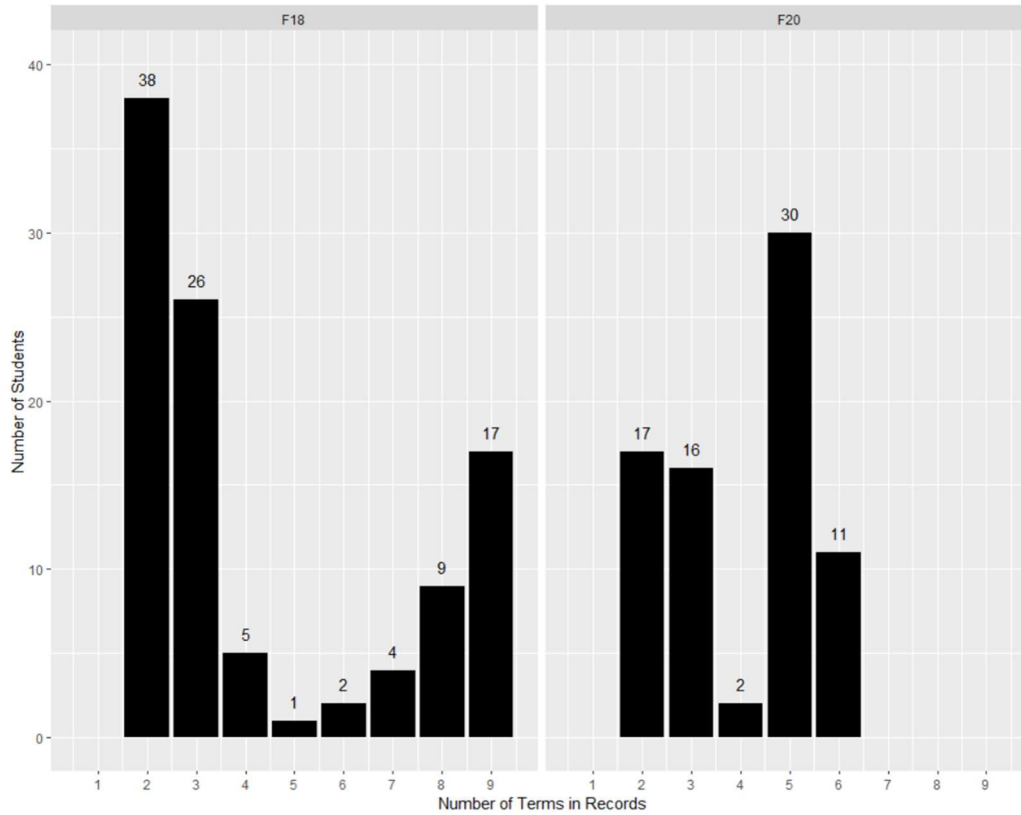
Note: Dot size represents the number of students in a channel in each semester. Line width represents the number of students whose channel membership spanned consecutive semesters. Diagonal lines represent students whose channel membership changed, with the line color showing their new channel assignment.

From the 2018-2019 academic year through the 2022-2023 academic year, a total of 464 students appeared in the Channel Program administrative records of channel assignments. There were 89 students who appeared in the channel records during a single term, and 73 students who appeared in the records for the first time in the fall semester of 2022.

For students starting in the program prior to the 2022 fall semester ($n = 391$), 4.1% appeared in the records for one semester, 25.6% appeared in the records for two semesters, 29.2% appeared in the records for three semesters, 12.3% appeared in the records for four semesters, 10.2% appeared in the records for five semesters, and 18.7% appeared in the records for six or more semesters (students are required to take the course six semesters).

Figure 3 compares the students who were freshmen in the AE program in the 2018 fall semester, the first term of the program, and the 2020 fall semester. We chose the 2020 fall semester as the comparison semester because it is a point where the channels had existed for multiple years and most of the students in channel leadership positions had started in the program as freshmen, but also enough time has passed that we can look at students' appearances in the records across several years. For most students who were freshmen during the 2020 fall semester, Fall 2022 (the latest semester for which data are available) is the fifth semester. Students from the fall of 2020 who appeared in the channel records six times began in the program in the spring of 2020 and still had freshmen standing during the fall 2020 semester. As is shown in Figure 3, a larger proportion of students from Fall 2020 (54%) remained in the channel records for five or more semesters than did the students from Fall 2018 (32%).

Figure 3 – Student retention measured from 2018 to 2020 term experience



Retention of mentors

From the 2018-2019 academic year through the 2022-2023 academic year, a total of 40 alumni served as mentors. Three mentors (7.5%) joined the program in the fall semester of 2022. Of the 37 who served as mentors prior to 2022, 34 (91.9%) were mentors for at least two academic years, and 6 (16.2%) were mentors for at least four academic years.

Community

Students' feelings of community were measured with the adapted Classroom Community Scale (described above). Analysis of Variance (ANOVA) was used to test for group differences in community related channel membership, gender, belonging to an underrepresented minority (URM) group, first-generation status, and year in the program. Differences in degrees of freedom reflect differences in the number of students who completed surveys and gave responses to individual questions.

Feelings of community were not the same for all channels, $F(7,230) = 2.21, p < .05$, partial $\eta^2 = .063$. Post-hoc comparisons revealed that the mean community score for the Yellow channel ($M = 3.15, SD = 0.46$) was significantly lower than the mean community score for the Indigo

channel ($M = 3.76$, $SD = 0.53$). No other pairwise differences were significant. The overall mean for the entire sample was $M = 3.39$, $SD = 0.56$.

There were no significant differences in feelings of community related to gender ($F(1,247) = 0.10$, $p > .05$), belonging to a URM group ($F(1,173) = 2.32$, $p > .05$), first-generation student status ($F(1,240) = 1.74$, $p > .05$), or year in the program ($F(1,244) = 1.13$, $p > .05$). The lack of differences related to these factors suggests that even though not all channels created the same feelings of community, students across different demographic groups had similar feelings.

Familiarity with Alumni and Other Industry Professionals

Because of the ordinal nature of the questions related to familiarity with alumni and industry professionals, these data were analyzed using the Kruskal-Wallis test to detect differences related to channel membership, term of data collection, year in the program, gender, belonging to an URM group, first-generation status. Table 3 contains results for all Kruskal-Wallis tests. For all tests with a significant difference ($p < .05$), the group difference is described; “---” indicates no significant difference. The most consistent trend was that more advanced students reported being familiar with a higher number of alumni and non-alumni industry professionals.

Table 3 - Summary of Kruskal Wallis Test Findings

Item	Channel	Term	Year in the Program	Gender	URM Status	First-gen Status
Not counting your mentorship channel leader, how many alumni of the Architectural Engineering program are you aware of, in terms of who they are, what their jobs are, etc.?	---	S22 > S21	MAE year students > all other groups, seniors higher than first-year students	---	---	---
Not counting your mentorship channel leader, how many alumni of the Architectural Engineering program have you met personally?	Indigo > blue, pink, purple, and red	S22 > S21	All groups different except for with adjacent years (e.g., FY different from all but Sophomores), positive correlation	---	---	---
How many non-alumni Architectural Engineering professionals are you aware of, in terms of who they are, what their jobs are, etc.?	---	---	MAE year students > first-year students, sophomores, and juniors.	---	---	---

Item	Channel	Term	Year in the Program	Gender	URM Status	First-gen Status
How many non-alumni Architectural Engineering professionals have you met personally?	---	---	MAE year students > first-year students, sophomores, and juniors, seniors higher than first-year students.	---	---	---

Discussion

In studying the effectiveness of the intergenerational peer mentoring program, an increase in the retention of first-year students was observed. However, it should not be asserted that this effect was achieved solely from the efforts of the mentoring program. Variation in recruitment, admission requirements, curriculum, course delivery options, university-sponsored events, student organization activities, availability of scholarship funding, and other confounding institutional factors may influence a given student’s likelihood to persist in the program to varying degrees. Even still, analysis has illustrated that familiarity with alumni and non-alumni industry professionals has increased throughout the program’s operation. The positive effects of this on retention, along with feelings of community, are supported by theory. In a similar manner, it was observed that the channel group with the highest mean score for feelings of community (Indigo) also reported having met the most alumni.

Another observation of interest was that not all channel groups created the same feelings of community. In such cases, additional consideration may need to be given to within-group feelings and behaviors. Industry mentors are only administered an annual orientation, and thus are not currently trained to address all attritional factors that may arise within their groups. In the future, a more extensive mentor training protocol could be developed along with a regularly administered questionnaire to monitor channel activities, attendance, and identify potential attritional factors before they manifest into more significant barriers to degree completion.

Differences in feeling of community were not significantly different across gender, belonging to a URM group, or year in program. Differences across these factors or others may vary across institutions.

As student enrollment increases, the creation of additional channel groups may be necessary to preserve reasonable mentor-to-student ratios. The presence of multiple industry mentors in each channel group has allowed channels to break out into smaller groups for activities where large group work is not feasible.

Implementing an intergenerational peer mentoring program requires collaborative work between instructors, student leaders, and industry volunteers. To minimize the burden on industry volunteers, it is suggested that instructors and/or student leaders bear the primary responsibility for planning program structure and events. The following steps have been completed each year to implement the mentor program defined in this paper:

1. Schedule monthly zero-credit hour seminar course
2. Coordinate with AE Seminar instructors (*completed annually during the Spring semester and throughout the summer*)
 - a. Determine which sessions will contain in-class Channel Program content.
 - b. Meet with instructors to gather feedback on prior year's program.
3. Obtain class roster to update channel assignments (*completed within the first week of classes, at least 1 week prior to the first seminar session*)
 - a. Class rosters should be compared to the running channel rosters to ensure that any new students are accounted for and assigned to a new channel.
 - b. New students are assigned equally to channels at random, but groups for the first-year mentoring activities are sampled from common channels.
 - c. A channel roster should be available at the first session of the semester to accommodate any last-minute additions to the class.
4. Prepare channel mentors (*completed annually during the summer*)
 - a. Recruit industry mentors via e-mail list to fill any open mentor positions (two per channel). Mentors need not be from the same company.
 - b. Each industry mentor shall name a substitute mentor from their place of employment to serve as a back-up as needed.
5. Reassign AESLAC facilitators (*completed after recruitment of student leaders in AE student council or similar student leadership organization*).
 - a. Reassignments should be made when necessary to ensure equal coverage of AESLAC facilitators across channels (prioritize movement of newly added AESLAC members).
6. Host informational meeting (*held during the first week of classes in the Fall or at least two weeks before the first seminar session*)
 - a. Hold an informational meeting with AESLAC and industry mentors to cover schedule and tentative mentorship activities.
7. Prepare channel activities (*completed at least 1 month before each session*)
 - a. Send reminders to AESLAC leaders and industry mentors the week of each seminar session.
 - b. Send reminder to volunteers about Channel Program activity a few days before each seminar session.
 - c. Administer Assessment Plan to gather program feedback at each session.
8. Review program feedback at end of academic year using Assessment Plan.

Conclusion

A new framework for the implementation of an intergenerational peer mentoring program within a zero-credit hour seminar course has been developed with intent of improving student retention and fostering feelings of connectedness. Initial results from the program's operation over the first

three years of operation do illustrate an increase in the retention of first-year students and awareness of industry professionals, though the effects of the program alone cannot be easily parsed apart from other institutional factors. Feelings of community did significantly differ across channel groups, indicating that within-group behaviors may need to be further assessed. No significant differences in feelings of community were found related to gender, belonging to a URM group, or year in the program. Despite this, educational institutions should give careful consideration to the attritional factors that may be most prominent within their programs. While this specific framework has emphasized development of social interactions between students and industry professionals, it cannot be said that this is a panacea to retention for all programs. Rather, it is suggested that this framework may serve as a useful component within an institution's broader retention efforts. Moreover, certain aspects of the program or its activities may be concentrated towards addressing other attritional factors.

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