WIP: Closing the Opportunity Gap Through Industry Career Mentoring in Science and Engineering Education

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***Abstract*—This innovative practice WIP paper describes the implementation of a five-year mentoring initiative for science and engineering programs at an urban, private institution with the goals of providing holistic programming and opportunities for early career preparation for all first-year students. In partnership with Mentor Collective, peer mentor programming was designed to include data collection from mentees to better understand their needs and to support their academic training with meaningful experiences that support career readiness. Data over a five-year period from mentees demonstrate the following: (1) expectations from program participants vary significantly from learning how to maintain healthy work-life balance to succeeding in classes and participation in co-curricular activities, (2) graduation rates at and above 80% are achievable and sustainable, which is significantly higher than the national average and (3) closing of the opportunity gap can be accomplished for populations that have traditionally low graduation rates. Feedback from the mentors (industry professionals) reveal very high interest in their willingness to continue participation, which suggests that mentoring initiatives are mutually beneficial, sustainable, and scalable across institutions. Additional data from this report also demonstrate that the impact of linking first-year students with industry professionals can serve as a scalable mentoring solution.**

Keywords—peer mentoring, opportunity gap, student success

I. Introduction

Closing the opportunity gap in science and engineering education is key to an inclusive STEM workforce (See the inclusive engineering education framework in Figure 1[1]). The opportunity gap describes how factors like ethnicity/race, economic status, culture, language, and family situations influence opportunities afforded to students. Despite the efforts from higher education institutions to achieve equity and equal access, the graduate rates as measured for specific demographics (ethnic minorities and first generation) illustrate the existence of systemic issues, particularly in STEM education. STEM students have varying levels of awareness of the curriculum, and as a result, this leads to large variances in academic performance and participation in experiential learning. Moreover, students who lack access to social capital (either participatory or network-based) [2] are also less likely to persist to degree attainment. Fortunately, there are untapped resources on college campuses that demonstrate potential as a promising practice. We intend to supplement existing bodies of work by leveraging the willingness of peer mentors (currently enrolled in higher education and in industry) to help STEM students navigate through the educational experience, thus impacting members from all communities. We aim to improve the experiences for diverse populations using the framework below so that all students can gain access to community building opportunities, networking, effective strategies for success, and an engagement continuum to realize the potential of a STEM degree. One critical aspect of this framework is the focus on the opportunity gap.

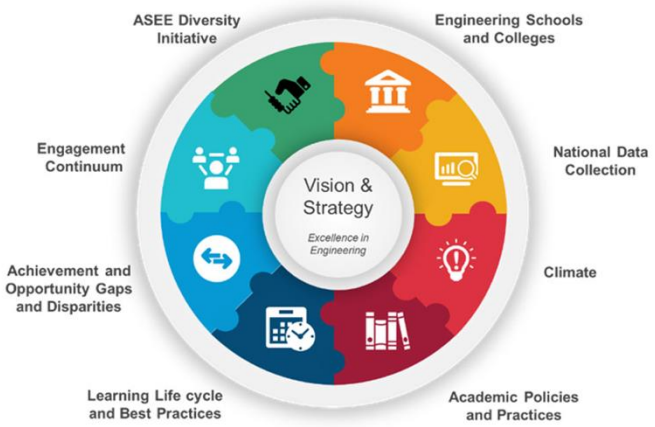

Figure 1. An inclusive engineering education framework

While the opportunity gap in STEM remains a challenge for many higher education institutions (regardless of size, location, and type), successful examples of programs that successfully address the opportunity gap in science and engineering usually include isolated efforts [3-5], whereas the pathway to national improvement involves adaptation of 'promising and scalable practices'. We learned through faculty-student relationships that many students were not aware of their career options until later in their academic career. Consistent with the practices at many STEM institutions, we monitor student migration in- and out- of STEM programs and realize that many students leave STEM programs before they enroll in major courses offered later in the curriculum. These students were predominantly from populations traditionally and historically underserved. To improve broadening participation, we partnered with the Mentor

Collective to (1) better understand the needs of STEM students and (2) enhance academic training in STEM that support career readiness. We leveraged Mentor Collective's research-based mentee-mentor matching design to offer quality relationships especially to our most vulnerable student populations. We are motivated to provide practical solutions to overcome disparities in STEM education by exploring assets that are available at all higher education institutions. This study reports the adaptation of a peer mentoring approach for achieving inclusivity in STEM education through holistic programming and increased access to early career preparation for all first-year students.

II. Background

A. Mentoring Program Description and Design

A private, Jesuit university in a mid-size city, where this study took place, emphasizes mentoring and educating the whole person, which aligns with the Jesuit mission. In the STEM college specifically, both science and engineering programs reside under the same leadership structure, which provides unique opportunities to focus on science (Physics, Chemistry, and Earth Sciences), computer science, and engineering programs with broad access to interdisciplinary activities. Therea are six active mentoring programs resourced by the STEM college. Two of the mentoring programs are reported here and include the following: (i) the First year Mentor Collective and (ii) Mentor Collective Alumni Network. The mentoring program design includes peer-to-peer mentorships supporting approximately 100-200 mentees with an average opt-in rate of 50-60% from invited students. Student-to-industry professional/alumni mentorships support up to 100-200 mentees with an average 30-40% opt-in rate from invited students. Peer-to-peer mentorships are intended to foster sense of belonging, while student to industry professional and alumni mentorships are primarily focused on career readiness and preparation for a career in engineering.

In the First Year Mentor Collective, first year students are paired with a peer mentor who wants to invest in their success, for example, a person ready to listen, inspire, help navigate challenges in- and out- of the classroom, and recognize opportunities for gaining meaningful experiences. The program was designed to help students learn what to expect in school, how to approach challenges, gain career advice and valuable insights, while mentors build their networks and develop skills to become better professionals and leaders. First year students (or students new to the school) were eligible to participate, whereas mentors were required to have sophomore, junior, or senior level status and at least one semester of attendance. In the Mentor Collective Alumni Network, mentees are sophomores, juniors, or seniors, and mentors are alumni and friends of the university.

A Mentor Collective proprietary matching algorithm was used to connect mentees and mentors using mentee/mentor self-reported data. Mentees and mentors complete a matching survey when they sign up for the program. The standard questions on the matching survey were based on research about which criteria are essential to fostering engaged mentorships. These criteria were then weighted according to priority in the matching process, with additional weight given to the mentee's top matching criterion (i.e., their response to the question: "Out of the preferences you just shared, which is the most important to you?"). For example, if a student specifies that it's most important to them to be matched with someone with the same career interests, this was given top priority in the weighting. Generally, these were the standard criteria for matching (ranked from highest to lowest weight): mentee's top matching criterion, desired mentor's major, career interests, desired mentoring frequency, academic interests, tell us about yourself, challenges, hobbies, requested age, languages and unique aspects of the institutional program. Principles that guide Mentor Collective's matching surveys and matching algorithm include the following: (i) mentees have agency in their match, (ii) mentors control their commitment level, and (iii) mentorship looks different for everyone. For our mentoring programs, we leveraged Mentor Collective's standard matching survey customizations and design for making strong matches between mentors and mentees.

B. Theoretical Framework

The peer mentoring approach pursued in this study is not an innovation domain. In fact, it is grounded on principles commonly adopted in the literature: (i) definition of the mentoring approach, (ii) making known essential functions of the role of mentor, (iii) well-defined activities for mentoring relationships, and (iv) qualities the mentors should exhibit in order to carry out mentoring activities [6]. Moreover, there is a body of literature on peer mentoring that this study leverages. For example, the institution where this study took place, at a fundamental level, prioritizes caring for the whole person. Similar to the study by Cramer, et al. [7], our peer mentors exemplify a list of traits necessary for achieving excellence in mentorship (available, knowledgeable, passionate, personable, encouraging, empathic, educated in diversity issues). Our goal for this effort was to tap into the benefits of peer mentoring by providing access to all students, especially those students traditionally underrepresented in STEM fields.

C. Participation by the Numbers

A comprehensive approach to mentee and mentor recruitment was employed. This included targeted marketing to prospective students and their families during campus visits and summer orientation programs. For recruiting mentors, we utilized alumni networks and local industries in the surrounding metropolitan area. After expressing interest in the mentoring program, each participant completed an online survey (designed by Mentor Collective), and this data was used to assess personalities and interests for mentor-mentee matching. Over a five-year period, there were approximately 560 registered and matched mentees from the STEM college (35% women, 15% underrepresented minorities), where 250 were first-year students and another 300 participants were registered mentors (40% women, 10% underrepresented minorities). Among the STEM student mentees, 32% reported as first generation or non-reporting. In regards to mentor recruitment, approximately 3,100 candidates were either invited, unmatched, or exited the program following on-boarding and registration, resulting in a 9% recruiting yield.

III. Evidence of the Impact of Peer Mentoring

To assess whether mentoring programs were meeting the needs of participants, additional data was collected before,

during, and after the program year. Data included survey request completion date, demographic information, mentoring program status, roles, career interests, measure of academic self-efficacy, number of conversations, conversation details, challenges, hobbies, top academic interests, and mentee goals. Initial and end-of-year assessment instruments were employed to collect data from participants that include questions such as *(i) I feel comfortable at my school, (ii) I feel like I am an important member of my school's community, (iii) I feel supported at my school, (iv) I am confident that I will achieve the goals that I set for myself, (v) I can learn what is being taught in class this year, (vi) Once I've decided to accomplish something that's important to me, and (vii) I keep trying to accomplish it, even if it is harder than I thought.* All of this information was paired with academic performance, student success data, and demographic data provided by the university's office of institutional research to gather insights into program effectiveness.

While the mentoring program partnership with Mentor Collective has completed only one cohort (initially enrollment to graduation), the combined data analysis over the first five years reveals promising trends for long term impact. For example, the six-year graduation rate increased 5% (from 76% for the 2013 entering class (n=279) to 81% for the 2016 entering class, (n=294)). The peak graduation rate was 81% during the same period. The perceived reputation of the mentoring program is enhancing due to the significant increase in the number of unique mentees and mentors. Program details are now articulated in marketing materials at both the college and university levels. The number of women mentees enrolled in the program increased substantially since program initiation in 2019 (12 students to 47 students), and participation from men also increased (from 21students to 42 students). The number of women mentors also increased (from 4 to 22) along with the number of men mentors (from 3 to 18).

We attempted to measure academic self-efficacy from program participants, given the goals of the program to improve academic experiences, graduation rates, and career readiness. As reported by Bandura [8] and Bandura & Locke [9], self-efficacy positively predicts performance beyond prior performance and ability. Using self-efficacy prompts with a 5-point Likert-scale (strongly disagree to strongly agree), the average recent self-efficacy measure for program participants was 4.16 (n=361), which is on par with reported national averages in STEM. In our case, females students report slightly higher academic self-efficacy (+0.13), while first generation reported negligible difference. We also searched for evidence of opportunity gaps across demographics including factors such as first generation, ethnicity, and gender. By leveraging institutional data for program participants, we find differences in grade point average to be negligible between men and women (0.03 with an average of 3.37). Using race and ethnicity as a factor, we also find negligible differences (Black/African American: 3.34, Hispanic/Latino: 3.36, and White: 3.40). These are also promising results. However, when comparing mentees identified as first generation, we find a significantly higher grade point average (3.57) compared to those identified as non-first generation (3.30) and did not answer (3.42).

IV. Discussion

This study reports on the first five years of a partnership between a STEM college at a Jesuit institution in an urban setting and the Mentor Collective for the purpose of enhancing student experiences, graduation rates in STEM, and career readiness. We utilized a cascaded mentoring approach that offers peer mentoring to first year STEM students and industry mentoring to sophomore, junior and senior level STEM students. The initial results suggests that the opportunity gap (which describes how factors like ethnicity/race, economic status, and family situations influence opportunities afforded to students) can be overcome with the implementation of a research-based design for mentee-mentor matching. This early analysis compares factors such as gender, ethnicity, and first generation and reveal positive trends towards equity and equal access.

While this study will benefit from data from additional graduated cohorts, the early trends are promising and imply new opportunities for sustainability and scalability across STEM institutions. There are several critical pieces of information that would provide greater insight into the effectiveness of the mentoring program. For example, it is important to study long term career success. This would include first destination data (position, salary, and sector) and as well as data five years post-graduation to assess the role of mentoring in retention in the field. Fortunately, salary studies from first destination surveys for the past two years (containing all graduates from programs in the current STEM college) demonstrate comparable salaries within each discipline regardless of gender and ethnicity.

The means for financing education remains an important aspect and should be incorporated in future analysis. While the current financial aid package (at this institution) provides tremendous value, the listed tuition rate prevents many potential students from even exploring the academic program options. Therefore, it remains an open question if enrolled students enter freshmen year with high self-efficacy. This potentially impacts the efficacy of aforementioned mentoring programs

Migration data (in and out of STEM programs) must be examined more closely to better understand the changes in student interests and whether mentoring can provide additional value to students who change majors. This requires an analysis prior to the initiation of the mentoring programs; however data collection were missing critical pieces of information such as first generation status.

Lastly, it is important to envelope data from the entire academic experience from each student, including research experiences, co-ops and internships, and study abroad. The motivation of this work was to explore whether the opportunity gap could be effectively addressed with a mentoring approach that does not target specifical populations, but is aligned with the university's value system.

References

[1] G. E. Triplett, J. D. Leonard, and R. Wasilewski, "Digging for Bedrock: Grounded Strategies for Broadening Participation in Engineering," in *2023 IEEE Frontiers in Education Conference (FIE)*, 2023: IEEE, pp. 1-5.

[2] V. Hunt, S. Prince, S. Dixon-Fyle, and K. Dolan, "Diversity wins," McKinsey, 2020.

[3] D. E. Chubin and W. E. Ward, "Building on the BEST principles and evidence: A framework for broadening participation," *Broadening participation in undergraduate research: Fostering excellence and enhancing the impact*, pp. 21-30, 2009.

[4] T. Holloman, W. C. Lee, J. London, A. Halkiyo, G. Jew, and B. Watford, "A historical and policy perspective on broadening participation in STEM: Insights from national reports (1974-2016)," in *2018 CoNECD-The Collaborative Network for Engineering and Computing Diversity Conference*, 2018.

[5] Z. Wilson-Kennedy, G. S. Byrd, E. Kennedy, and H. T. Frierson, *Broadening participation in STEM: Effective methods, practices, and programs*. Emerald Group Publishing, 2019.

[6] E. M. Anderson and A. L. Shannon, "Toward a conceptualization of mentoring," *Journal of Teacher education*, vol. 39, no. 1, pp. 38-42, 1988.

[7] R. J. Cramer and S. Prentice-Dunn, "Caring for the whole person: Guidelines for advancing undergraduate mentorship," *College Student Journal*, vol. 41, no. 4, p. 771, 2007.

[8] A. Bandura, "Self-efficacy: The exercise of control," *Freeman google schola*, vol. 2, pp. 143-154, 1997.

[9] A. Bandura and E. A. Locke, "Negative self-efficacy and goal effects revisited," *Journal of applied psychology*, vol. 88, no. 1, p. 87, 2003.