# Board 420: Urban STEM Collaboratory: 5 Years of Lessons Learned

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Mengyuan (Alice) Zhao is the Associate Director of Research and Development at IUPUI CyberLab. Her team works on designing, developing, and implementing innovative educational technology tools. Their current project is CourseNetworking (or CN), an academic social networking and learning platform, which has been used by the NSF Urban STEM Collaboratory project to connect student scholars from three urban universities and facilitate their STEM identity development through ePortfolio building and digital badges. Mengyuan has an EdD in Instructional Systems Technology with a research focus on social learning and innovative learning technology.

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# Urban STEM Collaboratory: 5 Years of Lessons Learned


## Abstract

The Urban STEM Collaboratory is an NSF-funded S-STEM project featuring partnership across three urban universities to develop effective interventions, in combination with financial support, for improving academic outcomes for engineering students. The Urban STEM project was designed to address challenges faced at the three urban institutions collaborating for the project, and in particular the need for many of the engineering students to work a significant number of hours each week, resulting in them taking fewer course hours each semester and being disconnected from their peers, faculty, and campus. These factors are especially concerning for students who are underrepresented in engineering majors, as they already leave engineering majors and careers at higher rates. Thus, the Urban STEM Collaboratory was designed to support students both financially and in the development of a stronger STEM identity and sense of 'fit' and connection to their academic program and career pathway. This paper outlines the Urban STEM Collaboratory model, describes the student cohorts, and highlights findings from student engagement in the project.


## Introduction

The NSF S-STEM program provides scholarship support for students who are academically talented but have demonstrated financial need. The Urban STEM Collaboratory project, engaging three urban universities, was designed to help alleviate financial stress and enhance students' sense of belonging within their engineering major and their STEM identity, as these aspects are critical for engineering students' success and retention in the majors and careers. The interventions deployed include common math courses, peer-led team learning and mentoring, a STEM Ambassador program, and use of the CourseNetworking (CN) platform to foster cross-campus networking, and academic, psychosocial, and professional development workshops.

This paper describes our scholar population and discusses the findings and lessons learned since project inception. Our five-year effort (four student cohorts) has engaged over 150 engineering students across our three campuses. We have tracked demographic and academic achievement data for our scholars as well as for eligible engineering students (those meeting GPA and financial need requirements) who were not part of the project. In general, scholars across all three institutions demonstrated better academic performance and markedly higher retention rates than their S-STEM eligible peers.

## Background and Model

The Urban STEM project was designed to address challenges faced at the three urban institutions collaborating for the project – namely the significant fraction of students at each institution with high levels of unmet financial need resulting in students needing to work long hours to pay for school. The number of work hours that students take on reduces their ability to be successful in school in a variety of ways. One challenge is the fact that work schedules limit students' abilities to take a full course load, thus extending the time to degree completion. The second is the fact that at the three campuses which each have large commuter populations, having to work while in school also reduces the amount of time that students can spend engaged in other activities, such as networking with peers, attending student organization meetings, or studying in student groups.

These campus interactions, whether academic in nature or social, are very important for establishing community and helping students develop STEM identity and sense of belonging. In fact, networking activities can prove to be more impactful on student success than academic interventions [1]. Developing a sense of belonging and community within the major is crucial for retention and academic success, in part because students that are connected to a network of peers and faculty are more likely to take advantage of resources available to them that support their academic success [2-5]. And, development of STEM identity and community is especially important for underrepresented students, including women and racial or ethnic minorities in STEM disciplines, who leave STEM programs at higher rates than do students from more represented demographics in part because they do not feel they belong within the major and career [6].

The three urban campuses collaborating for this project face similar challenges in terms of impediments to student success but have different campus contexts and infrastructure enabling examination of tailored interventions to support engineering student success. All three institutions have a population of students with significant financial need that requires them to work extensive hours, slowing progress toward engineering degree completion. Additionally, many of these students are also first-generation college students and students from underrepresented demographics which can further impede development of a STEM identity and sense of belonging within their engineering discipline.

With this background in mind, the Urban STEM Collaboratory project is designed to:

1. Increase the retention, success, and graduation rates of academically talented and financially needy undergraduate engineering majors;
2. Implement sustainable interventions that support academic success, STEM identity, and workforce readiness of engineering students;
3. Incentivize student participation in project activities through a special Badge system in the online Course Networking (CN) platform;
4. Develop an evidence-based understanding of factors influencing development of STEM identity and the resulting impact on student success, attitudes, workforce readiness, and STEM self-efficacy.

The project-wide interventions included NSF-funded scholarships (up to $10,000 per academic year, based on unmet financial need as determined by the FAFSA), a summer bridge program, academic year activities (academic support and career readiness workshops, networking and mentoring events) and cross-institutional interaction on the CN platform common to all campuses [7]. Scholarship support for students through the project has been significant, typically ranging from $5,000-$10,000 per year per student. Each campus has also deployed different cohort models for their scholars and studied special interventions unique to their institution as well. Unique interventions included a Learning Community (University of Colorado Denver, UCD), Peer-led Team Learning (Indiana University Purdue University Indianapolis, IUPUI), and a STEM Ambassador program (University of Memphis, UofM). All interventions were specifically deployed with the intent of positively impacting student success, STEM identity, sense of belonging, and workforce readiness.

**Collaboratory Outcomes**

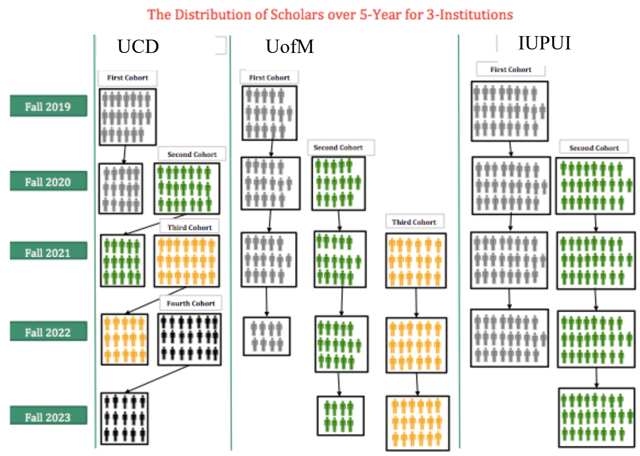



Figure 1. Urban STEM Scholar Cohort Models.

Over the course of the project, data has been collected each year at each institution related to demographics, academic performance, and progress toward degree completion. The data is collected for the scholar cohorts as well as for a comparison group of students who were eligible for the program, in terms of entering GPA and unmet financial need, but who are not participating. While each university had a goal of including a total of 50 scholars in its cohort, the cohort models for each institution were different, as described in Figure 1, with different colors indicating introduction of a new group of scholars. This Collaboratory-wide data is presented first, with outcomes reported for individual interventions at the collaborating campuses in subsequent sections.

Scholar Demographics

For the four academic years completed to date (2019-2020 through 2022-2023), a total of 151 students were engaged in the program (49 at UCD, 56 at UofM, 46 at IUPUI) and awarded S-STEM scholarships. The student scholars are diverse, with 32% female, 39% from underrepresented minority groups (URM), and approximately 30% first-generation students across the Collaboratory. Demographic breakdowns are presented by university in Tables 1-3, as compared to the demographics of students at each institution who were eligible for the Urban STEM program but did not participate (engineering majors, met minimum GPA requirement, and had demonstrated unmet financial need) and those of the university as a whole.

In general, Urban STEM Scholars are more diverse than the population of S-STEM eligible peers, indicating the programs were successful in attracting diverse applicants. UofM and IUPUI have more representation of female students in the scholar cohorts than in the general S-STEM eligible population, while UCD scholars had lower representation of women. All scholar cohorts had representation of female students at much lower levels than for the institution, which is to be expected for engineering programs. For underrepresented minority (URM) students, both UCD and UofM became more successful over time in attracting URM students to the program, with each having scholar cohorts with more representation of URM students than the general S-STEM eligible or the institution populations. IUPUI, with only two cohorts of students, had URM representation similar to or above that of the S-STEM eligible and institution populations for both cohorts. UCD and IUPUI had less representation of first-generation students in their scholar cohort than in the general S-STEM eligible and institution populations for all years, while

UofM's scholar cohorts included greater representation of first-generation students than either the general S-STEM eligible or institution populations in all years.

Table 1. Gender Representation for University, Students Eligible for S-STEM, Scholars by Institution

| Year (based on Fall) | UofM | | | UCD | | | IUPUI | | |
|---|---|---|---|---|---|---|---|---|---|
| | University | S-STEM Eligible | Scholars | University | S-STEM Eligible | Scholars | University | S-STEM Eligible | Scholars |
| 2019 | 60% | 22% | 50% | 53% | 24% | 22% | 58% | 16% | 32% |
| 2020 | 61% | 24% | 38% | 54% | 25% | 17% | 58% | 17% | 29% |
| 2021 | 61% | 26% | 46% | 55% | 26% | 19% | 57% | 17% | 23% |
| 2022 | 59% | 22% | 47% | 56% | 24% | 13% | 58% | 20% | 21% |

Table 2. URM (African American, Hispanic, Two or More Races) Representation for University, Students Eligible for S-STEM, Scholars by Institution

| Year (based on Fall) | UofM | | | UCD | | | IUPUI | | |
|---|---|---|---|---|---|---|---|---|---|
| | University | S-STEM Eligible | Scholars | University | S-STEM Eligible | Scholars | University | S-STEM Eligible | Scholars |
| **2019** | 44% | 34% | 29% | 38% | 46% | 30% | 25% | 28% | 36% |
| **2020** | 54% | 64% | 54% | 38% | 48% | 26% | 27% | 31% | 32% |
| **2021** | 47% | 38% | 56% | 39% | 50% | 52% | 28% | 33% | 28% |
| **2022** | 50% | 41% | 64% | 41% | 49% | 73% | 31% | 35% | 32% |

Table 3. First Generation Student Representation for University, Students Eligible for S-STEM, Scholars by Institution

| Year (based on Fall) | UofM | | | UCD | | | IUPUI | | |
|---|---|---|---|---|---|---|---|---|---|
| | University | S-STEM Eligible | Scholars | University | S-STEM Eligible | Scholars | University | S-STEM Eligible | Scholars |
| **2019** | 30% | 26% | 47% | 48% | 63% | 56% | 28% | 29% | 20% |
| **2020** | 30% | 28% | 35% | 47% | 58% | 24% | 28% | 28% | 22% |
| **2021** | 27% | 23% | 33% | 47% | 62% | 46% | 28% | 30% | 21% |
| **2022** | 27% | 24% | 43% | 47% | 67% | 40% | 29% | 34% | 24% |

Academic Performance and Progress

S-STEM scholars' academic performance, compared to the students who were eligible to apply to the S-STEM but were not part of the program was measured each year. In general, scholars earned higher GPAs and more credits than their program-eligible peers. Tables 4-6 shows data for scholar cohorts at each institution as compared to peers who met program requirements in terms of entering GPA and financial need but who were not part of the Urban STEM program.

Table 4. Overall GPA Earned by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2019 | 2.9 | 3.09 | 2.99 | 3.45 | 2.73 | 3.09 |
| 2020 | 2.95 | 3.35 | 3.12 | 3.14 | 2.79 | 3.17 |
| 2021 | 2.98 | 3.48 | 2.94 | 2.97 | 2.82 | 3.13 |
| 2022 | 3.02 | 3.27 | 2.92 | 2.97 | 2.82 | 3.08 |

Table 5. Overall Math Course GPA Earned by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2019 | 2.06 | 2.52 | 2.21 | 3.33 | 2.27 | 2.90 |
| 2020 | 2.48 | 2.92 | 2.61 | 3.05 | 2.44 | 2.74 |
| 2021 | 2.09 | 3.01 | 2.55 | 2.74 | 2.12 | 2.40 |
| 2022 | 2.29 | 2.83 | 2.14 | 2.65 | 2.22 | N/A |

Table 6. Overall Major GPA Earned by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2019 | 2.18 | 1.93 | 2.92 | 3.54 | 2.76 | 3.09 |
| 2020 | 2.74 | 3.16 | 3.15 | 3.31 | 2.85 | 3.21 |
| 2021 | 2.63 | 3.25 | 2.96 | 2.65 | 2.82 | 3.13 |
| 2022 | 2.63 | 3.05 | 2.76 | 3.07 | 2.82 | 3.08 |

Since the project inception, we have also collected data for each institution for retention rates at the freshman to sophomore and sophomore to junior years for both our scholar cohorts and their Urban STEM eligible peers who are not participating in the program. In terms of progress toward degree completion, students engaged in the Urban STEM program are being retained at higher rates than their program-eligible peers, both in the original major and in STEM. This data is presented in Tables 7-10.

Table 7. Retention Rates Freshman to Sophomore in Major by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible (Major) | Scholars (Major) | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2020 | 61% | 86% | 47% | 100% | N/A | 84% |
| 2021 | 49% | 80% | 50% | 100% | N/A | 71% |
| 2022 | 63% | 75% | 49% | 86% | N/A | N/A |

Table 8. Retention Rates Freshman to Sophomore in STEM by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible (STEM) | Scholars (STEM) | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2020 | 70% | 86% | 62% | 100% | N/A | 92% |
| 2021 | 59% | 80% | 65% | 100% | N/A | 90% |
| 2022 | 71% | 100% | 63% | 86% | N/A | N/A |

Table 9. Retention Rates Sophomore to Junior in Major by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible (Major) | Scholars (Major) | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2020 | 74% | 100% | 15% | n/a | N/A | N/A |
| 2021 | 71% | 67% | 29% | 100% | N/A | 92% |
| 2022 | 80% | 86% | 22% | 52% | N/A | 84% |

Table 10. Retention Rates Sophomore to Junior in STEM by Students Eligible for S-STEM vs. Scholars by Institution

| Year (based on Fall) | UofM | | UCD | | IUPUI | |
|---|---|---|---|---|---|---|
| | S-STEM Eligible (STEM) | Scholars (STEM) | S-STEM Eligible | Scholars | S-STEM Eligible | Scholars |
| 2020 | 78% | 100% | 47% | n/a | N/A | N/A |
| 2021 | 76% | 78% | 42% | 100% | N/A | 96% |
| 2022 | 86% | 100% | 46% | 65% | N/A | 100% |

## Sense of Belonging/Community Building

To foster interaction among scholars across campuses and create a sense of belonging within the Urban STEM community, the program adopted CourseNetworking (CN), an academic social networking platform developed at IUPUI. Using social media to engage college students is not a novel approach and its positive impacts have been well-documented by numerous scholars [8-12]. The reason we chose to implement CN was its unique combination of social networking features, a gamification engine (Anar Seeds) that tracks and incentivizes participation, a digital badging system, and a robust ePortfolio tool. We leveraged these tools to orchestrate a series of activities aligned with the program's goals.

As of January 2024, over 2,500 posts have been created in the CN Network by student scholars on a wide range of topics, such as STEM study tips, career preparation, mental health, hobbies, and local events. A couple of examples of posts can be found below. In addition to posts, 730 program badges have been awarded. The two most earned badges are "STEM Collaboratory Participant" and "STEM Collaboratory Bridge Scholar," followed by "Learning Continuity" (a badge that recognizes sharing online learning tips during the COVID-19 pandemic), "Community Service Scholar," and "Urban STEM Research Contributor." While posting and documenting badge evidence, some scholars have created comprehensive ePortfolios. Three examples are provided below:

- https://www.thecn.com/YK256 (UCD scholar)
- https://www.thecn.com/JF734 (IUPUI scholar)
- https://www.thecn.com/FJ155 (UofM scholar)

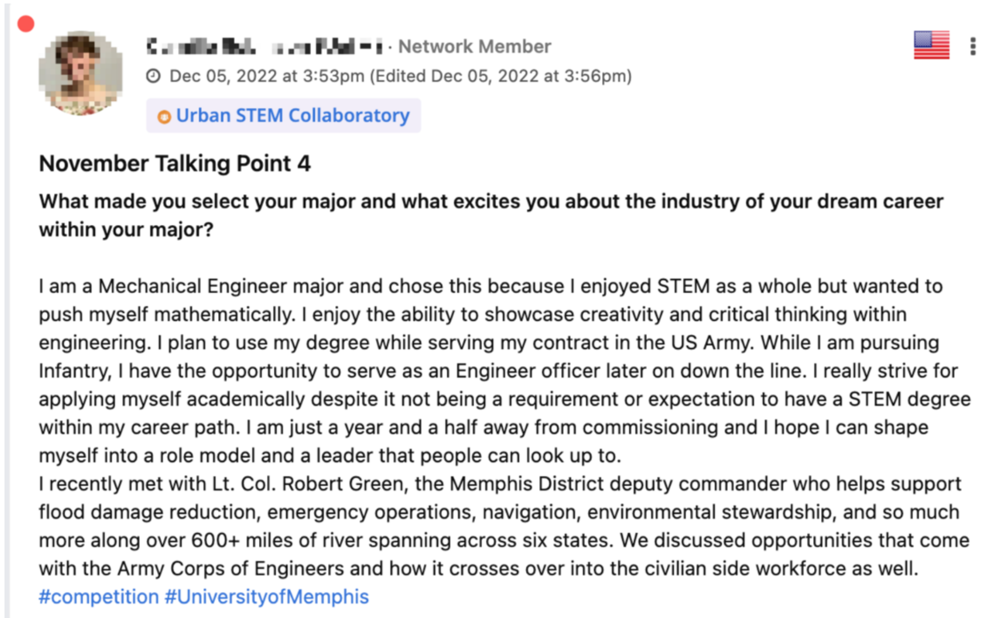
In a CN poll sent out to scholars in Spring 2023, 26 respondents participated. Of those, 73% revealed that they enjoyed communicating with other scholars in the CN Network; 70% agreed that CN helped create a sense of community for the program, and 65% accepted that building an ePortfolio through the program helped them develop their STEM identity. This is further exemplified in a quote from one participating scholar:

> The competition between the universities for posting and interacting and things. Those are really good catalysts for participation in the CN. So I've posted on the CN and gotten feedback from people at other universities and talked to different people in the comments. It's been generally a good experience all the way around.

Examples of student posts are provided in Figures 2 and 3.

Beyond the CN platform, the research team used a variety of approaches to better understand how students were developing STEM identity and sense of belonging. Interviews and focus groups were used each year to elicit student feedback. In these sessions, Urban STEM Scholars reported that participating in the Urban STEM Collaboratory helped them to feel more connected and engaged during the COVID pandemic [13]. The importance of the community of scholars and faculty and the communications between them was underscored by one student, who said:

The conversations that I've had in person and um on the CN have just kind of helped me feel like my goals are reachable and so that's encouraged me to rethink what I'm doing.


[redacted] · Network Member

Dec 05, 2022 at 3:53pm (Edited Dec 05, 2022 at 3:56pm)

Urban STEM Collaboratory

**November Talking Point 4**

**What made you select your major and what excites you about the industry of your dream career within your major?**

I am a Mechanical Engineer major and chose this because I enjoyed STEM as a whole but wanted to push myself mathematically. I enjoy the ability to showcase creativity and critical thinking within engineering. I plan to use my degree while serving my contract in the US Army. While I am pursuing Infantry, I have the opportunity to serve as an Engineer officer later on down the line. I really strive for applying myself academically despite it not being a requirement or expectation to have a STEM degree within my career path. I am just a year and a half away from commissioning and I hope I can shape myself into a role model and a leader that people can look up to.

I recently met with Lt. Col. Robert Green, the Memphis District deputy commander who helps support flood damage reduction, emergency operations, navigation, environmental stewardship, and so much more along over 600+ miles of river spanning across six states. We discussed opportunities that come with the Army Corps of Engineers and how it crosses over into the civilian side workforce as well.

#competition #UniversityofMemphis

Figure 2. Example scholar post from CN platform.

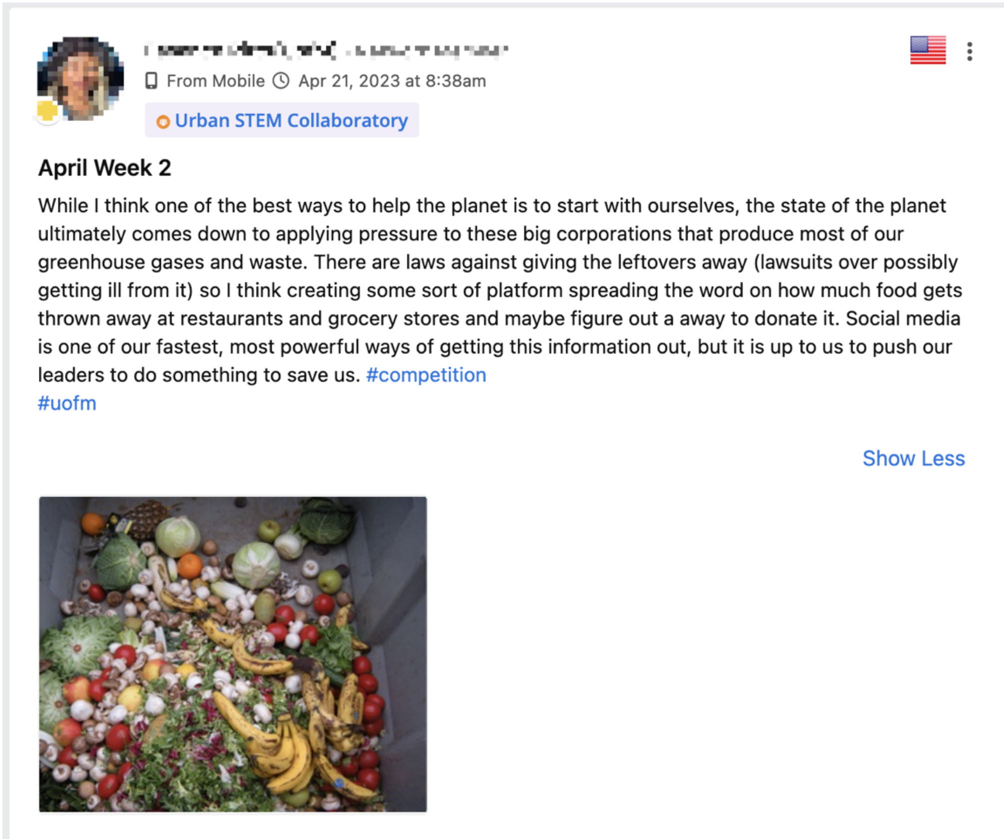



Figure 3. Example scholar post from CN platform.

STEM Identity

In our research on STEM identity, we found that quantitative measures of STEM identity were not particularly revealing. Most of our scholars scored very highly on the measures and there was relatively little variation. However, qualitative interviews showed greater nuance and detail in how Urban STEM scholars developed and experienced their STEM identities. In our qualitative research, we apply and extend existing theories of identity in general [14] and STEM identity in particular [15] to explicate a "Communication Theory of STEM Identities" [4-5]. This theoretical model is multi-layered and foregrounds interactional and relational aspects of STEM identities. Both formal peer mentoring and informal peer relationships between Scholars (and other STEM students) were key components to their developing STEM identities. At the same time, this theoretical model also includes layers for individual traits (e.g., STEM self-efficacy) and social identities and theorizes "gaps" in STEM identities that may pose challenges to STEM student success.

Individual Outcomes

For each campus, brief descriptions of findings related to the unique interventions each deployed are described in the following sections.

*University of Colorado Denver (UCD)*

The Engineering Learning Community (ELC) at UCD has three key features, each designed to encourage community among engineering students attending an urban, primarily commuter, campus. The first feature of the ELC is a weeklong summer bridge program that occurs the week preceding the student's first semester at the Engineering College. During this week, incoming students become acquainted with their learning community peers as well as staff and Faculty members teaching first year coursework in Mathematics, English Composition, and Engineering Design. In addition to community building, students receive short lectures on first year topics and participate in daily engineering design challenges. Although a Summer Bridge Week is common among the Urban STEM Collaboratory, it is an integral part of the Engineering Learning Community at UCD. The second feature of the ELC is a first year Interdisciplinary Design course that was developed to engage students in a variety of design topics; providing them with hands-on experiences during their first year in the UCD engineering program. The ELC leadership group believes that engineering design is one of the building blocks of STEM identity for engineering students and engineers that helps to lay down a strong educational foundation and is a focal point to increasing student retention. To that end, ELC students enroll in the same sections of first year math and English composition coursework helping to build on that sense of community and establishing a strong support network, up front. The final feature of the ELC is a near-peer mentorship program that we termed "Layered Mentorship Program", where second year learning community participants meet regularly with first year ELC students and serve as an additional layer of support and community engagement. Moreover, selected third-year students serve as lead mentors to help second year students become more effective at mentoring as well as enabling the communication of relevant information back to the leadership group, for further interventions as needed.

Over the course of this collaboration, our team has focused on studying the strengths and weaknesses of the learning community program. Here, we note some of the best practices to date. Student surveys and interviews have revealed that Summer Bridge Week helped the scholars make initial connections before the first day of class, sometimes a difficult task at a commuter school. Likewise, since our learning community scholars took combined coursework, they were able to easily connect and support each other. Scholars have reported that numerous connections that began during the ELC bridge week continued across multiple years. Additionally, faculty have reported frequently seeing groups of scholars on campus together. For these reasons, our team has noted that community building during the bridge program is consequential. As such, second- and third-year student mentors have been included in planning and facilitating portions of the summer bridge effort, to promote more student-student interaction. Similarly, scholar surveys on the Layered Mentorship program and informal interviews reveal that many students preferred to be paired with an upper classmate from the same major as to receive more targeted advice related to their coursework and enrollment options. Other students preferred more variety and meetings that are more frequent. Because of this feedback mechanism, our team was able to adjust the program to meet the needs of our student population. Finally, the project notes that a frequent student feedback mechanism has been instrumental in informing and strengthening the educational process.

*Indiana University Purdue University Indianapolis (IUPUI)*

Inspired by nearly two decades of successful implementation in introductory Chemistry classes at IUPUI, and more recently in several sophomore-level Engineering classes that traditionally show high rates of D, F, and Withdraw (DFW) grades, IUPUI implemented a Peer-Led Team Learning (PLTL) section specifically for the Urban STEM scholars in Calculus 1. In the PLTL model, students who have recently been successful in a class are recruited to serve as peer leaders for small-group problem-solving activities in a special recitation section. Unlike a traditional recitation, the focus is on active, team-based problem-solving, with the peer leader providing guiding questions and hints on approaches to consider, rather than simply demonstrating the solution. PLTL has been shown to reduce DFW rates in large introductory Chemistry classes [16-17] – and, perhaps more importantly, to decrease performance gaps between demographic groups [18-19].

Implementation of PLTL in a special recitation section of Calculus 1 – the first time PLTL had been attempted in a math class at IUPUI – was a stunning success [20]. The two Urban STEM cohorts (Fall 2019, n=25 and Fall 2020, n=20) had an overall DFW rate of only 6.7%, compared to the overall rate of 25.4% in the course across those two semesters (n=776). This achievement is all the more remarkable considering all students in the Urban STEM cohort demonstrated financial need and showed greater overall gender and ethnic diversity than the course as a whole. Moreover, no students in either Urban STEM cohort failed the class. (By comparison, 12.8% of the class overall received F grades.) Among the Urban STEM cohorts, the only DWF grades occurred in the Fall 2020 semester, when one student received a D+, one received a D, and one withdrew from all classes to pursue a military career. All three of these students were White and male. In other words, all students in the cohort from traditionally underrepresented gender, racial, or ethnic groups passed Calculus 1 with a grade of C- or higher. In the class, DFW rate was 47% for Black/African American students 27% for Hispanic/Latinx students, and 22% for students of two or more races. Gains from PLTL persisted even when comparing the Urban STEM cohort to other students who opted into a traditional (non-PLTL) recitation section (22% DFW rate, n=131) as well as to another learning community of students enrolled in both a traditional recitation section and a first-year seminar as a cohort (14.6% DFW rate, n=48). Each Urban STEM cohort also participated together in a first-year seminar; our results from this project suggest that allowing students to build community with each other while solving STEM-focused problems together through PLTL is more impactful to their success than more traditional recitations or freshman seminars.

*University of Memphis (UofM)*

The STEM Ambassador program (a paid outreach position where students work directly with K-12 students in support of STEM teaching and learning) was developed by the University of Memphis (UofM) in 2012 in response to community needs. This program not only provides undergraduate students with a paid work experience, but also provides the opportunity to enhance leadership and communication skills through a structured training program and the work itself. The STEM Ambassadors work in individual and team assignments with local schools and community organizations to teach STEM concepts and inspire K-12 students to consider STEM majors and careers.

The total number of urban STEM scholars who have been part of the STEM Ambassador team since inception is 21. The UofM research team has tracked retention in the Urban STEM Scholars cohort, retention in original major, and retention in a STEM major for all scholars. The data was analyzed for scholars who are part of the STEM Ambassador program versus those who are not. Results indicate positive trends for students participating in the STEM Ambassador program in all the areas assessed as shown in Table 11 below. Scholars who are also part of the STEM Ambassador program are retained at higher frequency in the program, in their original major, and in a STEM major than the Scholar-Only cohort. These results, while promising, require further study to better understand the role the Ambassador program plays in building community and student success and differences that may exist between the population that self-selected into the Ambassador program versus those that did not.

Table 11. Urban STEM Scholars: Comparison of Scholar-STEM Ambassador and Scholar-Only Cohorts

| | Scholar - STEM Ambassador (N=21) | Scholar Only (N=35) |
|---|---|---|
| Retention in Urban STEM Scholars Program | 95% | 72% |
| Retention in original major (major declared upon program entry) | 90% | 56% |
| Retention in STEM major | 100% | 72% |

**Lessons Learned**

It is clear from student feedback that the financial stress alleviated by the scholarship support awarded through this project was very influential in enabling students to focus more on their academic studies. This certainly supported improved academic performance and progress to degree outcomes. The scholarship award process itself posed challenges for all three campuses in obtaining timely information from campus financial aid offices given that as ‘last dollar’ awards, this information was needed each summer when financial aid offices are faced with peak workloads. After the first year, the PI at UofM was trained to access the information within the financial aid system and could then look up eligibility for scholars and initiate awards, with the financial aid office verifying award amounts on the back end before they were processed. This significantly improved the award process for the UofM campus, however; neither UCD nor IUPUI were able to implement a similar process at their institutions.

We also know that the community building aspects of the project were impactful; in fact, we were surprised at all three campuses to see that fostering community among cohorts of STEM students seemed to have more impact on student success and persistence than more academic-focused interventions meant to improve foundational math skills. We are less certain about the degree to which each component contributed to the overall student outcomes as more research is needed. Students reacted very positively to activities intended to enhance STEM identity, such as panels with diverse alumni discussing their career paths, as evident by record attendance in these sessions and comments made during discussions with program faculty. Qualitative interviews also demonstrated the importance of peer mentoring and peer relationships (community) in developing STEM identity. Another limiting factor in tying interventions directly to student outcomes is the influence of self-selection bias, as students had to actively apply to and participate in the Urban STEM program.

We learned a lot while implementing the project because of the COVID-19 pandemic. Our first cohort of student scholars began in the Fall of 2019. Interventions for this group launched with in-person summer bridge programs and a slate of academic year workshops and networking gatherings. The connections the students built, both with their Urban STEM peers and faculty, were very important as shared in student interviews and as seen in academic performance and progress data. With the second cohort of students arriving to a predominantly virtual experience, it was apparent that the bonds formed among the scholars were not as strong as with the initial cohort. We began to struggle with participation in project interventions and program retention suffered as well. Interestingly, as the project began its third year in the summer of 2021, the research team noted that students from the second cohort, while having completed a year of coursework, were essentially feeling and acting like freshmen. Many of the students were unfamiliar with their campuses, had never met one another in person, and were experiencing anxiety like that of an incoming freshman. Interventions targeting stress management and other aspects for mental and overall health became important components of the academic year meetings. A surprising outcome is the impact of the Collaboratory on faculty as we navigated the pandemic. The strong partnerships formed through the project led to many of the regular bi-weekly project meetings becoming sharing sessions, brainstorming, and strategy development for not only supporting our students but also supporting one another in our instructional practices. This shared experience strengthened bonds within the research team and created a foundation of open communication that helped to improve project interventions and outcomes as the project evolved.

A challenge pertaining to the CN is declining participation observed in recent years compared to the initial two to three years of the program. Scholars who joined the program in later years (except those from UCD) and those who graduate later exhibit lower motivation levels in Network discussions and ePortfolio building compared to scholars who joined earlier or who have already graduated. The absence of synchronous platform training and the fact that CN participation is merely considered a soft expectation have likely played a role in the reduced engagement.

**Conclusion and Future Direction**

While there are limitations, preliminary analysis of project data in combination with surveys, focus groups, CN network observation, anecdotal evidence, and institutional knowledge of the research team have led to richer understanding of the interventions that are important and how they influence engineering students' achievement and connection to their engineering disciplines. The design of project interventions evolved through formative evaluation at each campus, allowing the research team to understand how differences across the three campuses impacted implementation and success. We have seen increased academic achievement and persistence to graduation for our scholars as compared to their program-eligible peers, however, it is difficult to determine the role that self-motivation may play in this outcome. While all eligible students were notified of the program opportunity, they did not all apply. We also need to better understand the impact of the financial support and the interventions individually. The unexpected benefits of the collaboration for the PI team has been an especially important outcome, likely to lead to long-term partnerships. Future research will include deeper exploration of project data as the final scholar cohort completes the Spring 2024 semester to determine overall outcomes and approaches to further understanding the impact of the financial support and individual interventions. We will also begin to examine longer-term impact with scholars who have graduated and are now in the workforce. This insight is important for recognizing implications for scale and translation to other institutions.

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