

## **Three Years of the Urban STEM Collaboratory**

### **Maryam Darbeheshti (Faculty)**

Dr. Maryam Darbeheshti is an Assistant Professor of Mechanical Engineering at the University of Colorado Denver. Her research interests are in multiphase fluid flow, and Engineering Education.

### **Miriam Howland Cummings (Graduate Research Assistant)**

Miriam is a PhD candidate in Education Research and Evaluation Methods at the University of Colorado Denver (CU Denver) and a graduate research assistant on an NSF S-STEM grant in CU Denver's College of Engineering, Design, and Computing.

### **Stephanie S Ivey (Associate Dean for Research)**

### **David J. Russomanno (Dean)**

### **Michael S. Jacobson**

### **Tom Altman**

Dr. Tom Altman – Professor Tom Altman received his B.S. degrees in Computer Science and in Mathematics, and M.S. and Ph.D. (1984) in Computer Science, all from the University of Pittsburgh. Dr. Altman specializes in optimization algorithms, formal language theory, and complex system simulation. He joined CU Denver in 1990 and became a full professor in 1997. Dr. Altman has published a book and over 90 journal, conference, and technical papers. He has been a recipient of numerous research awards, including ASCE Best Research Paper and USEPA Star Award. Professor Altman has been a PI or co-PI on over 20 external grants, including multiple ones from the NSF, DARPA, AFOSR, MDA, AFRL, Army and Navy.

### **Katherine Goodman**

Katherine Goodman is an assistant professor (teaching track) at the University of Colorado Denver. She serves as curriculum lead for Inworks, an interdisciplinary innovation lab within the College of Engineering, Design and Computing. Her research focuses on transformative experiences in engineering education. She is the past division chair of the Technological and Engineering Literacy / Philosophy of Engineering Division (TELPHE).

### **Karen D Alfrey (Associate Dean of Undergraduate Academic Affairs and Programs)**

**Craig O. Stewart**

**Jeffrey Watt**

Professor and Chair, Department of Mathematical Sciences, IUPUI.

© American Society for Engineering Education, 2022  
Powered by [www.slayte.com](http://www.slayte.com)

# Three Years of the Urban STEM Collaboratory

## Introduction

Launched three years ago, the Urban STEM Collaboratory is an NSF-funded S-STEM program at three public urban research universities: Indiana University-Purdue University Indianapolis (IUPUI), University of Memphis (UofM), and University of Colorado Denver (CU Denver). With the first student scholarships awarded in Fall 2019, each campus has observed positive student outcomes despite the disruption of the COVID-19 pandemic. The goals of the program include: to award scholarships to academically talented and financially disadvantaged undergraduate mathematical science and engineering majors; to implement student activities and supports designed to increase student success, attitudes, workforce readiness, and STEM self-efficacy; and to ensure substantial student participation in project activities through a special badge system incentivizing participation using an online academic social networking platform called Course Networking (the CN). Through the CN, students at all three campuses communicate with each other, building a community among the students at each campus.

The Urban STEM Collaboratory project goals are to:

1. Increase at each institution the recruitment, retention, student success, and graduation rates of academically talented and financially needy undergraduate mathematical sciences and engineering majors;
2. Implement ambitious but feasible strategies contributing to student academic success, development of STEM identity, and workforce readiness;
3. Implement mechanisms to ensure substantial student participation in project activities through a special badge system, incentivizing participation;
4. Implement activities for mathematics and engineering classes leading to a high probability of student success, and conduct formative and summative evaluations with special focus on determining effectiveness and impact of the project activities, strategies, and adjustments;
5. Conduct a research study that will focus on developing 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, with particular attention to impact on first-generation and underrepresented students.
6. Conduct formative and summative evaluations of the project that explore the extent to which each objective is being met. A particular impetus will be placed on determining effectiveness and impact of the project activities, strategies, and adjustments made throughout the project.

## Course Networking (the CN)

One feature of the CN is that students are required to engage in activities that earn them badges, and each student is expected to earn five badges each academic year to continue receiving the S-STEM scholarship. Requiring students to earn CN badges facilitates cross-campus engagement among students at all three institutions. It also benefits students because it enables them to

highlight their achievements by creating digital showcases, which can then be shared with potential employers.

During the 2020-2021 academic year, a total of 220 badges were awarded to students. The names of the badges and the number of times each badge has been issued can be found in Table 1.

**Table 1. CN Badges Awarded during 2020-2021 Academic Year.**

<b>Badges</b>	<b>Number Issued</b>
STEM Collaboratory Participant	110
STEM Collaboratory Bridge Scholar	54
Urban STEM Research Contributor	21
Peer Led Team Mentor	8
Community Service Scholar	6
STEM Outreach	4
Sector Industry Intern	3
Diversity Scholar	3
Research Scholar	3
STEM Collaboratory Influencer	3
STEM Professional Member	2
e-Portfolio Master	1
Learning Continuity	1
STEM Professional Leader	1

### **Specialized Programs at Collaboratory Institutions**

While the Urban STEM Collaboratory has commonalities among the implementations at each of the three campuses, each institution also has unique features. It is a stated goal of the Collaboratory to investigate how each campus might replicate these features, in part or in whole, from the others.

#### *The Urban STEM Collaboratory at IUPUI*

At IUPUI, the unique feature of their program is Peer-led Team Learning (PLTL), an internationally used method for guiding students who have recently, successfully completed a course to assist students. PLTL has been applied to various STEM disciplines; IUPUI has implemented it in its math courses as part of its cohort model, and then expanded PLTL into several sophomore-level engineering courses [1]-[3].

The goal of PLTL is to increase student persistence and retention in engineering majors by adding this peer support mechanism to courses that are typically the first in-major courses students encounter, and that typically have high D/F/W rates (final grades of D, F, or Withdraw). One benefit that continued over the three years of the Urban STEM Collaboratory so far is the high proportion of underrepresented students (both women and those whose ethnicity is underrepresented in engineering programs) who have participated as peer mentors. This benefits both the mentors themselves, who are provided leadership training as part of their mentorship

responsibilities, and the underrepresented students taking the course, who may more easily envision themselves as successful engineering students when seeing the example of a successful peer. Both faculty and student participants from IUPUI participated in a workshop with UofM and CU Denver during the year to share PLTL experiences.

### *The Urban STEM Collaboratory at UofM*

At UofM, Collaboratory students have the opportunity to serve as STEM Ambassadors, students who engage in outreach throughout Memphis. The STEM Ambassador program is a paid position where students work directly with K-12 students in support of STEM teaching and learning. There is some evidence that representing the STEM fields to others increases students' STEM identity, and this robust program gives the students opportunities to do just that [4]. Additional research through this project has revealed additional evidence of the program's importance for identity and community building. One Ambassador pointed out the connections through the STEM Ambassador program reduced the impact of the pandemic for them, as they did not feel as disconnected as their non-Ambassador peers. Another scholar described the meaningful impact of the STEM Ambassador assignments, stating,

“Just every time I do it, I feel like I'm giving back because I had mentors in all those camps and stuff like that. I feel like I'm looking at myself half the time and saying stuff I wish I heard, wish I knew.”

Each year, several new Collaboratory members applied to and were selected to join the STEM Ambassador program. This program not only provided students with a paid work experience, but also provided the opportunity to enhance leadership and communication skills through a structured training program and the work itself. Importantly, all Collaboratory members who joined the STEM Ambassador program have been retained in their STEM major and in the Collaboratory. This is not the case for all Collaboratory scholars.

In addition to positive feedback from students, STEM Ambassadors demonstrated and maintained GPAs in the top 10% of their Collaboratory cohort, and several were also selected to serve as part of the UofM's student leadership team.

### *The Urban STEM Collaboratory at CU Denver*

At CU Denver, Collaboratory members are also members of an Engineering Learning Community (ELC), where they take a bundle of first-year courses together. In the first semester, ELC courses include mathematics, English composition, and a first-year design innovations course. In the second semester, ELC courses include mathematics, English composition, physics, and a computing course. These courses are required for engineering majors at CU Denver, and taking these courses together helps to build community among students. Additionally, instructors of the ELC courses work together to ensure that content is coordinated. The ELC at CU Denver has a history longer than the Urban STEM Collaboratory, and ELC participation correlated positively with improved outcomes for students [5], [6].

Additionally, CU Denver Collaboratory students participate in a robust layered peer mentorship program. This program offered mentoring to first year scholars from past Learning Community students who were assigned as mentors. Mentors were students from prior S-STEM cohorts, with each mentor being assigned 3-4 protégés. Surveys were conducted at the end of each semester that indicated the impact of the mentorship program on student success [7]. Protégés indicated that they found mentorship to be valuable (see Figures 1 and 2, taken from end-of-semester surveys), and importantly, mentors also consistently voiced how valuable they found the experience of being a mentor. As one mentor said,

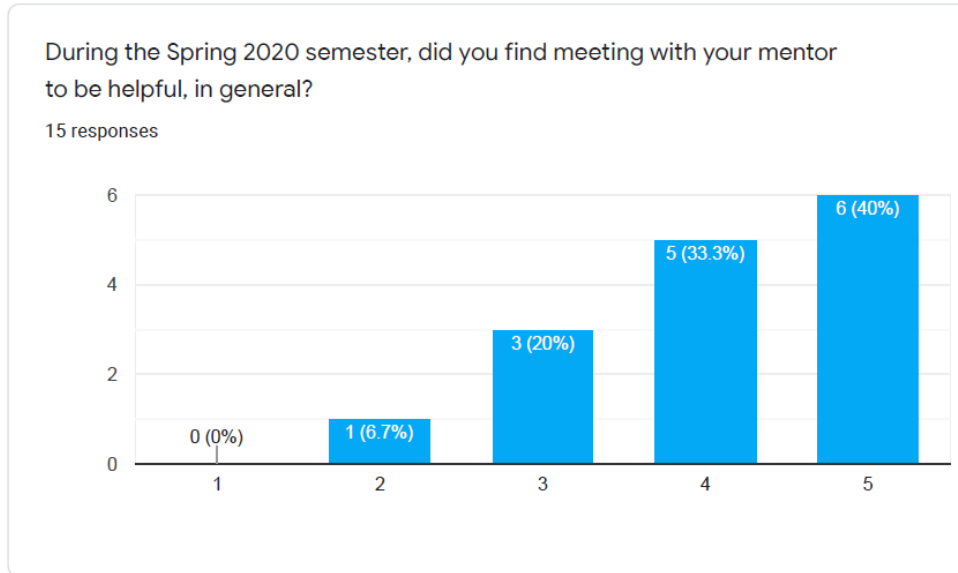
“Mentoring made me more humble, it made me a better listener, and it made me less judgmental. It also made me, as a leader, look at myself and my own academic performance and studying habits and reflect on them.”

It is clear that serving as a mentor developed leadership skills in students, which will be valuable transferrable skills for future engineers to cultivate. The mentors also demonstrated that they took their role of mentor seriously and genuinely cared about the protégés they met with, which is clear from these two mentors’ perspectives.

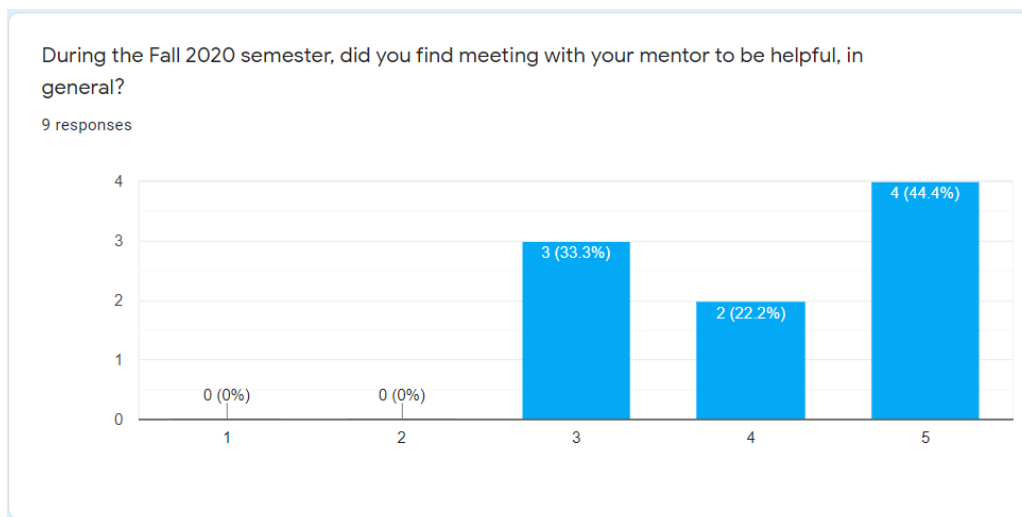
“Having the meetings once a week...allowed me to get to know my mentees and build a trusting relationship with them so they felt comfortable opening up to me and let me know what’s really happening in their life and school.”

“Meeting with the students every week developed a strong relationship. Over time talking with the students seemed easier and students were more open to asking for help and questions. I was able to help alleviate stress, and ground the students when times were rough. Throughout college it seems like there is no outlet for students; usually students must go throughout their academics alone with no help. Mentoring allowed these students to relieve stress and have hope toward their academics. In addition, when students are performing well, mentoring was able to help student progress even further in terms of academics. Overall, mentoring allowed students to develop a friendship that allows for a student to flourish academically when parameters were met.”

**Figure 1. CU Denver Protégé Survey, Spring 2020.**



**Figure 2. CU Denver Protégé Survey, Fall 2020.**



### Tri-Campus Activities

Before the onset of the COVID-19 pandemic, the research teams from all three campuses spent three days together, in person, at UofM in 2019 and at CU Denver in 2020. During the CU Denver visit, there were presentations from CU Denver students, which allowed the IUPUI and UofM research teams to meet CU Denver students and become more familiar with the specifics of the CU Denver program. There were plans for IUPUI to host an in-person research team visit in 2021, but those plans have been postponed due to the pandemic.

Although in person visits had to cease due to COVID-19, there have been several synchronous virtual sessions, spanning all three years, wherein program participants (both students and faculty) from across all three campuses engaged with each other regularly using virtual online

platforms, creating a unique cross-campus community. Over the course of the Collaboratory, each institution has hosted a virtual student panel to share about student experiences. For example, IUPUI students involved with the PLTL program hosted a presentation and mock PLTL session with faculty members from all three institutions. This allowed UofM and CU Denver to learn about IUPUI’s PLTL program, as well as giving the IUPUI students a valuable opportunity to hone their presentation skills. Similarly, UofM students hosted a virtual student panel sharing their experiences with the STEM Ambassador program, and CU Denver students hosted a virtual student panel talking about the ELC and mentorship program. Through these forums, students and faculty across the three campuses were able to engage with each other and build community.

### Student Outcomes

So far, the Urban STEM Collaboratory has served 115 academically talented and financially disadvantaged students across the three campuses (see Table 2). This includes 44 students who come from underrepresented minority groups and 40 female students, who have also been traditionally underrepresented in STEM fields. Additionally, scholars at all three campuses have demonstrated higher GPAs than their program-eligible peers. These higher GPAs are apparent when examining overall GPA, Math GPA, Major GPA, and Calculus 1 GPA; scholars also have more completed credits at the end of their first semester than their program-eligible peers (see Table 3). These initial data show positive benefits of the program so far, but to date no students have graduated with engineering degrees from the Urban STEM Collaboratory. The first Urban STEM students, who began as first-year students in Fall 2019, will graduate in Spring 2023. These students are still being tracked, not only for research purposes, but also to help support them as they enter their engineering careers.

**Table 2. Urban STEM Collaboratory Scholars Served.**

<b>Institution</b>	<b>Underrepresented Minorities</b>	<b>Females</b>	<b>Total Scholars</b>
<b>IUPUI</b>	13	12	41
<b>UofM</b>	19	18	35
<b>CU Denver</b>	12	10	39
<b>Total</b>	<b>44</b>	<b>40</b>	<b>115</b>

**Table 3. 2020-2021 Students’ Academic Rates.**

<b>Institution</b>		<b>Overall GPA</b>	<b>Math GPA*</b>	<b>Major GPA</b>	<b>CALC 1 GPA</b>	<b>Credits**</b>
<b>IUPUI</b>	<b>Eligible</b>	2.79	2.44	2.85	2.39	12.85
	<b>Scholars</b>	3.17	2.74	3.21	2.95	14.34
<b>UofM</b>	<b>Eligible</b>	2.95	2.48	2.74	2.34	11.5
	<b>Scholars</b>	3.35	2.92	3.16	3.55	13.9
<b>CU Denver</b>	<b>Eligible</b>	2.99	2.48	3.04	2.08	12.66
	<b>Scholars</b>	3.14	3.05	3.31	2.69	13.35



\*Calculus 1 or higher

\*\*Credits earned after first semester (full-time students only)

Overall, the Urban STEM Collaboratory has proven beneficial to students in its first three years, particularly in light of the COVID-19 pandemic. As one student said, “being part of those communities really does make you feel closer to the school itself...COVID ...[has] made me feel less connected, but because I have these other opportunities, it's been better.” IUPUI, UofM, and CU Denver look forward to continued collaboration as the program moves forward.

## Conclusion

The Urban STEM Collaboratory plans to continue its work for at least two more years through the conclusion of the S-STEM grant funding. Even after the grant ends, the lessons learned through the Urban STEM Collaboratory will be valuable as each institution seeks to foster continued student success. As Urban STEM Collaboratory students begin to graduate, the program plans to remain connected with graduated students, possibly creating a network of S-STEM alumni and current students including mentorship opportunities between young professionals and undergraduate students, potential internship experiences, and workforce preparation workshops.

## Acknowledgment

This work is supported by NSF S-STEM #1833983.

## References

- [1] D. K. D. Alfrey and I. U. P. University, “CLEAR Scholars in Engineering: Academic, Career, and Leadership Development to Help Students with Financial Challenges Achieve their Full Academic Potential,” in *ASEE Annual Conference and Exposition, Conference Proceedings*, Salt Lake City, UT, 2018, p. 5.
- [2] D. K. Gosser, M. Cracolice, J. A. Kampmeier, V. Roth, V. S. Strozak, and P. Varma-Nelson, *Peer-led Team Learning: A Guidebook*. Prentice Hall: Upper Saddle River, New Jersey, 2001.
- [3] K. Goodman *et al.*, “Launching the Urban STEM Collaboratory,” in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual On line, Jun. 2020, p. 34894. doi: 10.18260/1-2--34894.
- [4] S. H. Ivey, L. Allen, and P. Bridson, “West TN STEM Hub: Cradle to Career Collaborations for STEM,” *Crit. Conversat. J. Tenn. Board Regents*, vol. 1, no. Spring, 2015.
- [5] M. Darbeheshti and D. R. Edmonds, “A Creative First-year Program to Improve the Student Retention in Engineering A Creative First-Year Program to Improve the Student Retention in Engineering,” in *American Society for Engineering Education*, Salt Lake City, UT, 2018.

- [6] M. Howland Cummings *et al.*, “Comparing Student Outcomes from Four Iterations of an Engineering Learning Community,” presented at the 2021 ASEE Virtual Annual Conference, Virtual Conference, Jul. 2021. doi: 10.18260/1-2--36519.
- [7] G. E. Simon *et al.*, “WIP: A Layered Mentorship Program (LMP) for Engineering Student Success and Retention,” presented at the 2021 ASEE Virtual Annual Conference, Virtual Conference, Jul. 2021. [Online]. Available: <https://strategy.asee.org/38066>