Increasing Diversity and Student Success in Engineering and Computer Science through Contextualized Practices

Dr. Doris J. Espiritu, Wilbur Wright College- One of the City Colleges of Chicago

Doris Espiritu is the Executive Director of Engineering and Professor of Chemistry at City Colleges of Chicago-Wilbur Wright College. She pioneered Engineering at Wright. She promotes collaboration between K-12 schools, community colleges, 4-years institutions, non-profit organizations, and industries to develop Community of Practice, Professional Identity, and Self-Efficacy for students to help increase diversity in Engineering and Computer Science. Doris Espiritu is one of the first National Science Foundation's research awardees under the Hispanic- Serving Institutions (HSI) Program.

Dr. Ruzica Todorovic, Wilbur Wright College

Ruzica Todorovic is the Engineering Coordinator for the NSF: HSI "Building Bridges into Engineering and Computer Science". She is also a faculty at Wilbur Wright College.

Increasing Diversity and Student Success in Engineering and Computer Science through Contextualized Practices

1. Introduction

Community colleges play a significant role in STEM education and are crucial to increasing participation among women and underrepresented minorities in engineering and computer science.[1] In 2017, enrollment in community colleges accounted for thirty-five percent (35%) of total undergraduates, and about thirty-eight percent (38%) of engineering graduates attended a community college at some point in their studies. [2-3] Due to the open access policy in community colleges, students opting for this path to an engineering or computer science degree are very diverse in terms of their entry characteristics, demographics, and educational goals.[4] Nevertheless, the recruitment and retention of women and underrepresented minority groups have proven challenging. It has been shown that for Hispanic, female, and low-income students, factors such as gender, ethnicity, or class can be deterring and a major barrier to retention and success in the profession.[5-10]

Several factors have been identified as key challenges: (a) the lack of exposure to engineering or computer science as fields of study or as career opportunities [11], (b) the lack of professional identity (inability to see oneself as a professional) [7], (c) an impaired sense of belonging [12, 13], and (d) the lack of self-efficacy (how well one can execute a course of action to deal with a prospective situation) [14]. Adding to the challenge is the rigor of engineering curriculum which substantially contributes to high dropout rates from engineering [15], averaging at 50%, and ranging from 60 to 67% for minorities [12, 16, 17]. These numbers are strongly driven by high failure rates in math and science barrier courses (calculus, physics and chemistry).[18] In addition, students matriculated at a community college usually take a long time to transfer to a 4-year institution, and once transferred, take a longer time to finish their baccalaureate degree [19].

Based on current literature, retention and graduation of underrepresented minorities can be positively affected by (a) improving math proficiency through summer bridges, (b) providing extensive faculty mentoring, (c) research experiences, (d) student support designed to break down barriers to inclusiveness, and (e) fostering a local community of practice (CoP).[20-25] Institutional frameworks that would narrow/eliminate the gap in STEM skills for talented yet underprepared students could increase their ability to succeed in a rigorous university curriculum, leading to an increase in student success and diversity in Engineering and Computer Science fields.[26] This paper will share the overview of the NSF HSI Building Bridges into Engineering and Computer Science project, the research design, expanded practices, and the preliminary results and insights from the development and implementation of this program. During the next phase of the project, the developed frameworks will be applied to provide all students at Wright College, and throughout City Colleges of Chicago (CCC), an equitable engineering and computer science education.

Wilbur Wright College, an open-access community college in northwest Chicago, is an independently accredited institution in the CCC system. Wright is a federally recognized Hispanic-Serving Institution (HSI) with the largest enrollment of Hispanic students among community colleges in Illinois (approximately 60%). However, despite Wright College open enrollment policy, only 0.8% of underrepresented students pursue an Associate in Engineering Science (AES) degree. AES enrollment has been flat for 20 years. In 2015 Wright piloted a selective guaranteed admission program to The Grainer College of Engineering at the University

of Illinois at Urbana-Champaign (UIUC). The Engineering Pathways (EP) program is a 2+2 cohort model with prescriptive and rigorous curriculum aligned to UIUC. Wright built programmatic frameworks to support the EP students. These frameworks include intentional advising, extensive tutoring, faculty and professional mentoring, access to professional organizations, and options to transfer to other 4-year institutions.

1.1 Building Bridges into Engineering and Computer Science Project

Building from the EP frameworks, Wright College obtained a National Science Foundation (NSF) HSI research grant (Award #1832553) to expand the EP programs to non-pathway students. The main goals of the NSF HSI funded project "Building Bridges into Engineering and Computer Science" are to increase the number of underrepresented students pursuing and completing an AES degree at Wright College, to increase transfer to 4-year institutions within two to three years, and to decrease time to degree completion after students transfer. Through the grant, Wright College has developed intentional interventions contextualized for the needs of near-STEM ready students. These interventions aim to increase the overall success for participating students by narrowing the educational gaps for underprepared students from different racial and ethnic backgrounds, thereby addressing academic inequities without stigmatizing any group of students. One of the interventions is the design and implementation of the Engineering Summer Bridge and subsequent placement into the selective Engineering tracks at Wright College. Wright College also developed assessment tools and increased the number of 4-year partnerships.

The Engineering Summer Bridge is an academic intervention during the summer prior to students staring their engineering/computer science curriculum. It is a preemptive strategy to help prepare students for college-level math (specifically calculus) and chemistry, by which shortening, or in some cases, eliminating remediation. It is designed to deliver a specific curriculum in a condensed period of 6 weeks. It utilizes mathematical modules contextualized to address topics identified as the main deterrents of students' success in engineering math requirements and tailored towards student's individual deficiency. In addition, the Bridge is designed to perform the following functions: (1) provide the knowledge and skills to seek out mentorship, tutoring, and other institutional support structures, (2) increase students' sense of self-efficacy, and (3) create a community of learners who would support one another and foster a community of practice (CoP) among engineering and computer science students at Wright College. Most importantly, the Engineering Summer Bridge provides a smooth transition from high school to college, as students are given an opportunity to get to know their peers, tutors, advisors, and the Wright College culture before their formal first day of college.

Figure 1 summarizes the Engineering tracks for admission into Engineering Cohorts (EC) at Wright College. Students are recruited from high schools, CCC, and transfers from other colleges or universities. Students whose math skills are at the Calculus level are placed into Engineering Cohort (EC) directly or after satisfactory completion of the Engineering Summer Bridge. The Applied Engineering cohort (AP) is an alternative engineering pathway for students who, after completing the semester of Pre-Engineering classes, maintain their interest in engineering, but opt for a less demanding degree program.

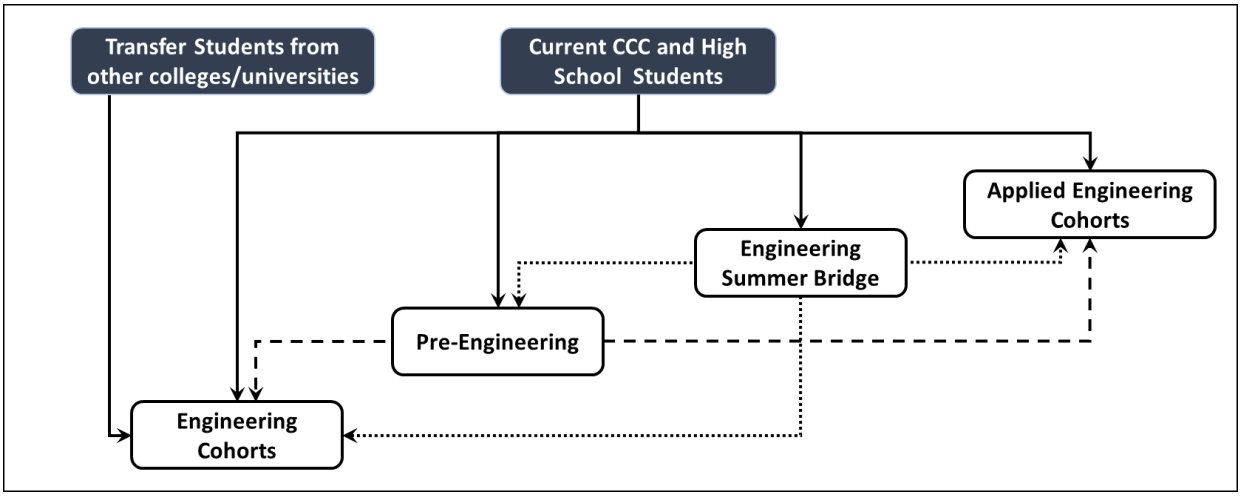

Figure 1. Engineering tracks at Wright College

By providing clear transfer pathways and options, Wright College is in a position to improve persistence, retention, and raise graduation and transfer rates. Building on the preexisting UIUC's EP framework, Wright College is increasing the number of partnerships with transfer institutions that offer degree programs in engineering or computer science. The Engineering tracks are strong articulated programs, developed to facilitate successful transfer by completely aligning the Wright College curriculum to that of 4-year institutions. It aims to provide students with the best preparation, decreased financial obligations, and to allow students to transfer as rising juniors while obtaining an associate degree.

1.2 Addressing Self-Efficacy and Professional Identity through Community of Practice

Self-efficacy (how well one can execute a course of action to deal with a prospective situation) turns out to be among the factors most closely correlated with student success, as they are directly related to emotional, behavioral, and cognitive factors. These factors directly relate to what students feel, think, and do. Another barrier faced by transfer students is acquiring a sense of community [32] and identity (sense of belonging) [7, 8] at the new school and the academic department. In universities, a sense of connection established between students within departments is a well-developed concept. However, its presence in community colleges is, at best minimal.[27] Programmatic frameworks such as one-stop intentional advising; mandatory tutoring; near-peer, faculty, and professional mentoring; and access to professional organizations play an important role in developing the sense of CoP.[28-31] Wright College, through the Building Bridges into Engineering and Computer Science project, has developed these programmatic frameworks. The project designed the "Wright Near-Peer Mentoring Model." Near-peer mentoring targets students' social identities, as such, providing crucial support, especially for underrepresented students who face uncertainty about belonging in a group [28]. Providing an appropriate mentor-mentee relationship can prove to be essential to students' retention [31], as they are building blocks for developing a CoP [33]. Wright Near-Peer Mentoring Model matches current Wright College students with mentors (Wright alumni) of the same engineering major currently matriculated at the 4-year transfer institutions. Developing the mentor-mentee relationship before transferring is expected to minimize, if not eliminate, the difficulties students face acquiring a sense of community at the transfer institution.

In addition, Wright College provides work opportunities and memberships in professional societies to provide students different avenues to develop their leadership skills and a sense of belonging in the profession. Such activities are reported to enhance levels of engagement among students.[29, 30]

2. Methods

In 2015, Wright College used an existing City Colleges of Chicago/UIUC articulation agreement to offer the first UIUC Engineering Pathways (EP) cohort. At that time, only STEM-ready students with academic profiles listed in Table 1, and with no college credits qualified for the admission. Students were recruited directly from high schools through a selective process. Wright College has developed programmatic practices to support the EP students from the time of admission until students transfer. Building from these practices, and with funding from the NSF, new programs were developed, initialized, and established. Figure 2 summarizes the new programmatic framework. In the next stage of the project, these practices will be assessed, analyzed, repeat, and continuously improved.

2.1 Contextualized and Intentional Practices

Intentional advising; intensive tutoring; near-peer, faculty, and professional mentoring; and access to professional organizations play an important role in developing self-efficacy and professional identity. Wright College has designed practices that address the needs of its diverse student body. Through the project, it has developed an institutionalized collaboration with academic departments, student support services, and CCC administration to enhance the framework. The academic departments participate in planning and offering courses for cohorts, and provide supportive faculty while maintaining the quality of their curriculum. The Wright student support services (admissions including testing and recruiting; advising, transfer resources, the tutoring center, the financial aid office, disability center, and other student support services) coordinate with the project to make the student experience a smooth process. Wright College administration provides a physical space for students to network as well as receive academic, personal and professional support.

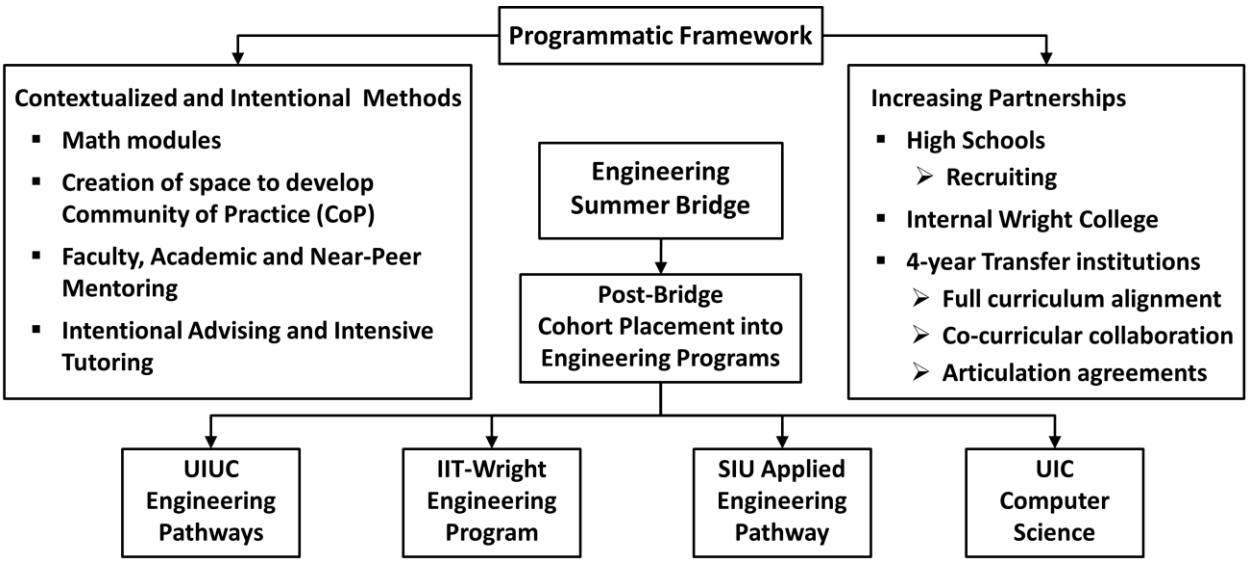

Figure 2. Programmatic frameworks at Wright College Engineering

2.2 Increasing Partnerships

The project bridges two transitions, from high school to Wright College and from Wright College to 4-year transfer institutions. Wright College is currently:

1) providing information sessions, high school visits, high school counselors breakfasts, and STEM teachers' professional developments
2) actively expanding programmatic articulation agreements and more intentional transfer programs to facilitate a seamless transition to 4-year transfer institutions
3) aligning course offerings to that of transfer institutions, including the content of the curriculum
4) developing additional technical courses needed for students to transfer as juniors.

2.3 Engineering Cohorts Recruitment and Placement

Students are recruited from high schools, CCC, and transfers from other colleges or universities, and are required to submit an application packet. The purpose of the application packet is to understand the academic and personal needs of the participants. Admission and initial placement are determined holistically based on high school/college transcripts, SAT/ACT scores, ALEKS (Assessment and Learning in Knowledge Spaces from McGraw Hill) Math placement scores, and essays (Table 1). As students become part of the cohort system, they are required to attend an orientation session and they follow a streamlined curriculum. Students in a particular cohort take the same math and science classes, with the same instructors, which permits direct comparison in all assessment activities. Each semester, a mandatory cumulative progress review is conducted on each student within the Engineering tracks at Wright College. Based on their performance during the semester, students can either advance to the next semester of their curriculum plan or are provided with alternatives.

Placement	High school Math/Science GPA	SAT/ACT scores	ALEKS scores
STEM ready	> 3.5	> 580 / 21	> 76
Group 1	< 3.5	< 580 / 21	> 76
Group 2	2.0 - 3.0	< 530 / 15	< 76
Group 3	Completed Pre-Engineering Math (Foundational Math, College Algebra or Precalculus)		

Table 1. Placement criteria into different Engineering and Computer Science tracks. STEM ready students do not qualify for Bridge participation. Group 1 students are admitted only upon the admission committee's recommendation. Group 2 students are the target group for the Engineering Summer Bridge. Group 3 students are admitted based on the availability of seats.

2.4 Engineering Summer Bridge

The Engineering Summer Bridge is a paid summer program for near-STEM ready students (Group 2), intentionally designed to prepare students for a rigorous engineering and computer science curriculum. The Engineering Summer Bridge staff administers the program contextualized to participants needs. As such, the Math modules are individually designed to address specific topics which will most benefit each participant. The Engineering Summer Bridge is a six-week, four days per week, 4-hour per day program that combines lecture using the Math modules, contextualized online ALEKS assignment and social interaction. The Bridge participants have access to engineering tutors, mentors and professionals.

2.5 Assessment

The project evaluation is done in collaboration with MUSE Consulting, LLC. In the first year of the project, surveys and case study interview protocols, assessing self-efficacy and professional identity, were written and approved by the CCC's Institutional Research Board (IRB). MUSE Consulting, LLC will conduct site visits, at least twice a year, to assess the implementation of proposed practices. All project participants will be required to take the online survey.

The first Engineering Summer Bridge was assessed through analysis of Math proficiency before and after the Bridge participation. Results will be correlated with the qualitative and quantitative results of the surveys and case study interviews. Data on transfer, associate and bachelor degree completion rates, and time to degree completion will also be correlated with the survey and case study results for a longitudinal study.

Through the Project, Wright is instituting practices that will provide financial support to students through employment opportunities as engineering tutors, near-peer mentors or engineering ambassadors.

1. Academic tutors recruited from the Engineering cohorts. All students in the Engineering or Pre-Engineering tracks are required to attend intensive tutoring throughout their participation in the program.
2. Wright College is developing the "Wright Near-Peer Mentor Model". The model is programmatic in its approach. It solicits near-peer mentors from among Wright College alumni already enrolled at the transfer institutions. Having already experienced the actual transfer process, near-peer mentors assist mentees through academics, the transfer process, adjusting to the new environment, and provide support when the student initially

attends the transfer institution. Peer mentors are trained by Wright College professionals and matched with mentees of compatible personalities and with same engineering major. Near-peer mentors and mentees are required to participate in case study interviews. While still at Wright College, students in Engineering tracks will be assigned a near-peer mentor and will also be trained as future near-peer mentors. Near-peer mentors will be required to submit a mentoring plan and outcomes to their faculty mentor.

3. Faculty mentors are recruited. All near-peer mentors will be guided and advised by faculty mentors.

3. Preliminary Results

3.1 The UIUC/Wright Engineering Pathways

The UIUC/Wright Engineering Pathways (EP) is a highly selective, guaranteed admission program with prescriptive and rigorous curriculum aligned to UIUC. Only STEM ready students can be admitted into the program; as such, the admission rate is fairly low (Table 2). Once accepted, EP students have to satisfy a set of academic requirements to remain guaranteed to The Grainger College of Engineering. The first EP Cohort was offered in Fall 2015. Eighty-nine percent (89%) of the first EP cohort transferred to UIUC or the University of Illinois at Chicago (UIC) after two years, and all have completed or are on track for bachelor's degree completion. Based on the 2015-2016 data, an average of 75% of EP students transferred to UIUC or other 4-year transfer institutions after 2-3 years. The UIUC/Wright EP program is achieving its goals but only up to 40% of applicants are being served. The UIUC/Wright EP does not provide access to near-STEM ready students.

Cohorts	**Fall 2015**	**Fall 2016**	**Fall 2017**	**Fall 2018**	**Fall 2019**
Applications (EP)	23	35	15	30	35
Admitted to EP	9	14	5	21	*28
Guaranteed after 2 years	5	6	1	4	-
Transfer to UIUC	4	5	0	-	-
Transfer to other institutions	4	5	3	-	-
Transfer to other disciplines	-	-	1	-	-
Total transfer after 2 years	8	10	4	-	-
Graduated or on track for bachelor's degree completion	8	9	4	-	-
**New intentional programs	-	-	-	-	62
Pre-engineering students	-	-	-	-	3

Table 2. Summary of Wright College Engineering Pathways data

During the first two years of the EP program, students not satisfying the STEM-ready criteria were denied admission. The majority of these students were underrepresented and first-generation college students. With the goal of increasing access, the EP committee piloted a conditional admission in Fall 2018. Students offered conditional admission were required to successfully complete Pre-Calculus in the summer before Fall EP admission, without the programmatic EP frameworks and support during the summer. As expected, the EP admission and enrollment were increased in Fall 2018 (Table 2). However, the EP Fall 2018 to Fall 2019

retention was only 38% (results not shown), and only 19% are retained in the program in Spring 2020. This outcome implies that without providing support and without acclimating students to the college culture, math remediation as an admission requirement is not a solution to retaining students in engineering. Although there was an increase in enrollment, students' performance in Calculus courses did not improve, which is especially true for students whose math placements were below Pre-Calculus.

3.2 Bridging the Gap for Near-STEM Ready Students through Contextualized Practices

First Engineering Summer Bridge eliminated up to three semesters of math remediation

In the first year of the Bridge, thirty-two (32) students officially participated, out of which thirty-one (31) completed the Bridge and were successfully placed in the Engineering track. Based on the academic profiles at admission, all Bridge participants were divided into three groups (Groups 1, 2 and 3) (Table 1). Group 1 participants were already placed in Calculus I, at the time of application. These students should have been disqualified from the Bridge participation. However, their Pre-Bridge ALEKS math placement was inconsistent with their high school math and science GPA and SAT scores. The admissions committee believed that Group 1 participants could benefit from the contextualized Bridge program. For Group 3, receiving passing grades in remedial math courses at Wright College was interpreted as calculus ready. For this paper, it is noted that the Post-Bridge ALEKS math placement scores of Group 1 unexpectedly decreased, which pose a new and interesting research question on the value of motivation that will be further studied and discussed separately. Group 1 and 3 are excluded from the analysis of the Engineering Summer Bridge results.

	No. of Students		**GPA**		**Math SAT**		**ALEKS Math Placement**		**Fall 2019 Placement**		**Semester(s) of recommended Pre-Engineering Math**
	Started	**Completed**	**Avg**	**Range**	**Avg**	**Range**	**Pre-Bridge**	**Post-Bridge**	**Calculus I**	**Pre-Engineering**	
Group 1	8	8	3.21	2.9-4.0	524	450-590	80.25 (77-83)	60.12 (33-94)	6 (UIUC)	2 (UIUC)	+(1-3)
Group 2	21	20	3.03	2.4-3.6	528	350-680	43.24 (8-63)	69.05 (30-95)	11 (7 UIUC + 4 IIT)	7 (4 UIUC + 3 IIT)	- (1-3)
Group 3	3	3	2.48	2.1-2.9	N/A	N/A	40 (40-43)	45 (40-50)	2 (IIT)	1 (UIC)	No Change

Table 3. Pre and Post-Bridge academic profile and placement for Engineering Summer Bridge participants.

Group 2 participants eliminated up to three semesters of Pre-Engineering math. Eleven (11) out of twenty (20) eliminated all the Pre-Engineering math requirements, and were placed in Calculus I and admitted to the EP program. All eleven (11) students earned a B or higher in Calculus I after their fall semester. The remaining nine (9) students eliminated at least one to two semesters of Pre-engineering math and were placed in the Pre-Engineering Track (Table 3). Figure 3 demonstrates a significant shift in score distribution towards Calculus I and the eliminated need for Foundational Math. On average, all students showed 30-70% improvements in the ALEKS Prep for Calculus baseline assessment, after spending an additional 50-100 more

hours outside the classroom practicing and working on their online assignments (data not shown). One student, who initially scored 22 on Pre-Bridge ALEKS math placement, scored 85 on the Post-Bridge after logging 100 hours of work outside the classroom. Two other students finished the Prep for Calculus (100%) online modules and both scored 95 in the Post-Bridge ALEKS placement, a significant improvement from their original scores of 60s.

Contrary to the Fall 2018 cohort, the Group 2 students in Fall 2019 EP cohort, received contextualized support that was not provided to the Fall 2018 conditionally admitted students. So far, the Fall-to-Spring retention of the Bridge students is 100%. It will be important to compare the Fall-to-Fall retention rate between the conditionally admitted students required to take Pre-Calculus in the summer without the support of the EP, from the Fall-to-Fall retention of the Bridge students once data are available.

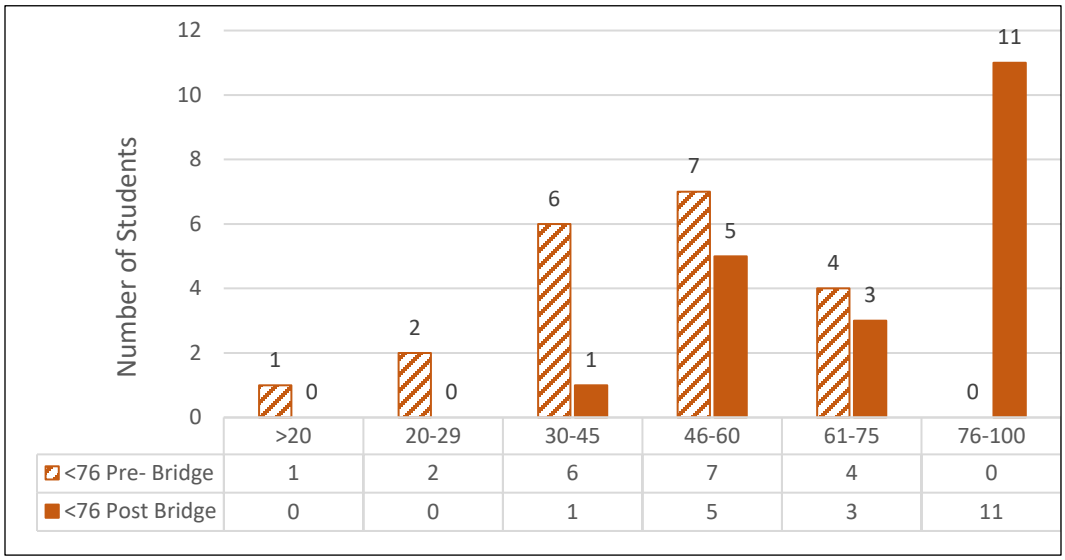

Figure 3. ALEKS math placement distribution before and after the Engineering Summer Bridge.

Increased intentional partnerships with 4-year transfer institutions

The project is instrumental in growing partnerships with 4-year transfer institutions. The newly formed partnerships include not only articulation agreements, but also intentional programs that provide aligned courses and rigorous content of the curriculum (including technical classes to prevent an imbalance of schedule as students transfer). The partnerships also offer co-advising, access to engineering courses, and participation of co-curricular activities at the 4-year transfer institutions before transfer. This is intended to provide a seamless transition from Wright to 4-year institutions.

In the first year of the Project, Wright was able to solidify new partnerships with The Armour College of Engineering at Illinois Tech (IIT) and Southern Illinois University (SIU), and a conversation is ongoing with the University of Illinois at Chicago (UIC). The Applied Engineering Pathway, collaboration with SIU, is a dual admission program in which students can complete an Associate in Science (AS) at Wright College and transfer into BS in Electrical Engineering Technology at SIU, or an Associate in Arts (AA) transferring into BS in Industrial Management and Applied Engineering. The collaboration with IIT is a dual admission program that offers students a seamless transition from Wright College to Armour College of Engineering. An articulation agreement was created where students are guaranteed admission to

their major and an option to pursue co-terminal degrees (bachelors and masters) in 3 years after transfer to IIT. While City Colleges of Chicago and UIC had an existing articulation agreement that guarantees admission to students with a 3.0 GPA, a conversation to grow this partnership is ongoing especially with the Computer Science Department.

For the first year of the Illinois Tech-Wright Program, sixty-two (62) students were accepted, out of which nine (9) students were from the first Engineering Summer Bridge. Currently, all sixty-two (62) students are dually admitted to Wright College and Illinois Tech. These students are enrolled in at least one course, Engineering 101, that Illinois Tech designed specifically for this program.

Increased institutional collaborations

The success of the Engineering Pathways to UIUC can be partly contributed to the collaborative effort of the student support services, the academic departments and the support from the administration. This cooperation created institutional practices that holistically support the diverse EP student body. The Building Brides into Engineering and Computer Science Project expands these practices at Wright College and extends the collaboration to the CCC system. The academic departments, the student support services and the administration, collaborate to recruit, retain and transfer students. Through this Project, Wright College established an Engineering Center, a place where students build their community of practice (CoP), network, support each other both academically and professionally, and develop Professional Identity. Students at the Engineering Center find support from like-minded students, all working together to be successful in the major. During the first semester of the project, the Engineering Center hosted 176 unique engineering students (EP, Bridge, IIT and non-pathway). All students who visited the center in the Fall are retained in the Spring.

3.3 Increasing Diversity in Engineering and Computer Science at Wright College

The first Engineering Summer Bridge demonstrates a significant potential for increasing diversity in the engineering profession. The Bridge participants represented 24 different high schools across Chicagoland and hosted a diverse student population. Seventy-four percent (74%) of the thirty-one successful Bridge participants are Hispanic, twenty-six percent (26%) are women, and seventy-seven percent (77%) are first-generation college students. In addition, ninety-seven percent (97%) are receiving Financial Aid assistance. Because of the contextualized Engineering Summer Bridge, nineteen (19) students are officially accepted to the EP, out of which eleven (11) would have been automatically denied admission if not for the Bridge. Nine (9) participants are currently placed in the Illinois Tech/Wright Program. All of these students are on track for transfer in Fall 2021.

3.4 Increasing Professional Identity and Self-Efficacy

"Self-efficacy and Professional Identity" survey and Case Study interviews were designed by MUSE Consulting, LLC in collaboration with the Principal Investigator. The first survey was administered to all participants that completed the Engineering Summer Bridge. Additional surveys will be administered at the end of Spring 2020 semester. Thirteen (13) students participated in the Case Study interviews. These survey and case study results will be correlated with the Engineering Summer Bridge success and retention rates. Although the initial survey results are not reported in this paper, the first Bridge participants are exhibiting signs of belonging. They are actively engaged, leading Wright College Chapters of national

organizations, currently constituting fifty percent (50%) of the Society of Hispanic Professional Engineers SHPE Wright Chapter leadership and all are officers/active members of other organizations at Wright (American Chemical Society (ACS), Society of Women Engineers (SWE), Society of Hispanic Professional Engineers (SHPE), and Society for Asian Scientists and Engineers (SASE)). In addition, few participants are leading study groups, engineering tutoring sessions, and eight (8) participants are Engineering ambassadors actively involved in advocating for the Bridge program. This noteworthy student engagement implies that they belong in the profession. It will be essential to confirm these observations with the quantitative data from MUSE Consulting, LLC.

4. Next Steps

The Building Bridges into Engineering and Computer Science uses the Appreciative Inquiry Approach [34] to engage participants, pursue a Continuous Feedback loop to be responsive, and change, abandon, or adopt new instructions. Based on the first Engineering Summer Bridge participants feedback, the following will be considered:

1. Incorporation of Chemistry into the Engineering Bridge, as such we will slightly modify the timing.
2. Use Brinkerhoff Success Case Method [35] to randomly select interview participants for a more meaningful assessment of professional identity.

In addition to the suggested changes the next steps will

1. Offer the second Engineering Summer Bridge. Wright College is actively recruiting and is increasing the available enrollment seats from 35 to 40.
2. Modify the assessment. Incorporate the non-Pathway and non-Bridge engineering students at Wright to IRB protocol. The survey and case study interview will also be correlated with retention and persistence rate at the end of the second year.
3. Launch the Wright Near-Peer mentoring model
4. Expand the Engineering Center
5. Continue the engineering specific tutoring and provide the engineering cohort leadership opportunities and a community in which they feel they can belong.
6. Create a programmatic pre-engineering track.

This material is based upon work supported by the National Science Foundation under Grant No. DUE-1832553. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Approved by the City Colleges of Chicago IRB (IRB2018007).

[1] T. D. Holmlund, K. Lesseig, and D. Slavit, "Making Sense of "STEM Education" in K-12 Contexts," *International Journal of STEM Education,* vol. 5, no. 1, p. 32, 2018.
[2] L. G. Knapp, J. E. Kelly-Reid, and S. A. Ginder, "Enrollment in Postsecondary Institutions, Fall 2010; Financial Statistics, Fiscal Year 2010; and Graduation Rates, Selected Cohorts, 2002-07," NCES 2012, vol. 280.
[3] G. Mooney and D. Foley, "Community Colleges: Playing an Important Role in the Education of Science, Engineering, and Health Graduates.," *InfoBrief. NSF,* vol. 11, no. 317, pp. 1-6, 2011.
[4] T. D. Snyder, S. A. Dillow, and C. M. Hoffman, "Digest of Education Statistics," NCES, 2008.
[5] N. D. Campbell, *Science, Technology, & Human Values,* vol. 34, no. 1, pp. 130-133, 2009. [Online]. Available: http://www.jstor.org/stable/29734077.
[6] B. M. Capobianco, "Undergraduate women engineering their professional identities" vol. 12, no. 2-3, pp. 95-117, 2006-08-30 2006, doi: 10.1615/JWomenMinorScienEng.v12.i2-3.10.
[7] K. L. Meyers, M. Ohland, A. Pawley, S. Stephen, and K. Smith, *Factors relating to engineering identity*. 2012.
[8] M. C. Loui, "Ethics and the Development of Professional Identities of Engineering Students," *Journal of Engineering Education,* vol. 94, no. 4, pp. 383-390, 2005, doi: 10.1002/j.2168-9830.2005.tb00866.x.
[9] A. Rodriguez and M. P, *Factors related to advanced course-taking patterns, persistence in science technology engineering and mathematics, and the role of out-of-school time programs: A literature review*. 2007.
[10] Z. Hazari, P. M. Sadler, and G. Sonnert, "The Science Identity of College Students: Exploring the Intersection of Gender, Race, and Ethnicity," *Journal of College Science Teaching,* vol. 42, no. 5, pp. 82-91, 2013.
[11] L. L. Leslie, G. T. McClure, and R. L. Oaxaca, "Women and Minorities in Science and Engineering: A Life Sequence Analysis," *The Journal of Higher Education,* vol. 69, no. 3, pp. 239-276, 1998.
[12] Y. B., "Going the Distance in Engineering Education: Best Practices and Strategies for Retaining Engineering, Engineering Technology, and Computing Students.," *American Association for Engineering Education* 2012.
[13] D. R. Johnson *et al.*, "Examining Sense of Belonging Among First-Year Undergraduates from Different Racial/Ethnic Groups," *Journal of College Student Development,* vol. 48, no. 5, pp. 525-542, 2007.
[14] *Expanding Underrepresented Minority Participation: Americas Science and Technology Talent at the Crossroads*. Washington, DC: The National Academies Press (in English), 2011, p. 286.
[15] R. Suresh, "The Relationship between Barrier Courses and Persistence in Engineering," *Journal of College Student Retention: Research, Theory & Practice,* vol. 8, no. 2, pp. 215-239, 2006.
[16] C. Morning PE and J. Fleming, "Project Preserve: A Program to Retain Minorities in Engineering," *Journal of Engineering Education,* vol. 83, no. 3, pp. 237-242, 1994.
[17] L. R., "Retention by Design," NACME, New York, 2005.
[18] F. Araque, C. Roldán, and A. Salguero, "Factors Influencing University Drop Out Rates," *Computers & Education,* vol. 53, no. 3, pp. 563-574, 2009.

[19] C. T. Coston, V. B. Lord, and J. S. Monell, "Improving the Success of Transfer Students: Responding to Risk Factors," *Learning Communities Research and Practice,* vol. 1, no. 1, 2013, Art no. 11. [Online]. Available: https://washingtoncenter.evergreen.edu/lcrpjournal/vol1/iss1/11.

[20] D. H. Schunk and F. Pajares, *The Development of Academic Self-Efficacy: Development of Achievement Motivation*. San Diego: Academic Press, 2002.

[21] T. Stevens, A. Olivarez, W. Y. Lan, and M. K. Tallent-Runnels, "Role of Mathematics Self-Efficacy and Motivation in Mathematics Performance Across Ethnicity," *The Journal of Educational Research,* vol. 97, no. 4, pp. 208-222, 2004.

[22] K. E. Freeman, S. T. Alston, and D. G. Winborne, "Do Learning Communities Enhance the Quality of Students' Learning and Motivation in STEM?," *The Journal of Negro Education,* vol. 77, no. 3, pp. 227-240, 2008.

[23] M. T. Jones, A. E. L. Barlow, and M. Villarejo, "Importance of Undergraduate Research for Minority Persistence and Achievement in Biology," *The Journal of Higher Education,* vol. 81, no. 1, pp. 82-115, 2010.

[24] M. R. Anderson-Rowland, Urban, J. E., Haag, S. G., "Including Engineering Students," in *Frontiers in Education Conference*, 2000, vol. 2: IEEE.

[25] S. E. Walden and C. Foor, ""What's to Keep you from Dropping Out?" Student Immigration into and within Engineering," *Journal of Engineering Education,* vol. 97, no. 2, pp. 191-205, 2008.

[26] T. Kelley and J. Knowles, "A conceptual framework for integrated STEM education," *International Journal of STEM Education,* vol. 3, 2016.

[27] D. A. Jorgenson, L. C. Farrell, J. L. Fudge, and A. Pritchard, "College Connectedness: The Student Perspective," *Journal of the Scholarship of Teaching and Learning,* vol. 18, no. 1, pp. 75-95, 2018.

[28] G. M. Walton and G. L. Cohen, "A Question of Belonging: Race, Social Fit, and Achievement," *Journal of Personality and Social Psychology,* vol. 92, no. 1, pp. 82-96, 2007.

[29] A. Doherty, "Peer Mentoring and Professionalism," in *HEA STEM Conference*, 2013: The Higher Education Academy, pp. 163-167.

[30] R. Hill and P. Reddy, "Undergraduate Peer Mentoring: An Investigation into Processes, Activities and Outcomes," *Psychology Learning & Teaching,* vol. 6, no. 2, pp. 98-103, 2007.

[31] P. Wilcox, S. Winn, and M. Fyvie-Gauld, "'It was Nothing to do with the University, it was Just the People': the Role of Social Support in the First-Year Experience of Higher Education," *Studies in Higher Education,* vol. 30, no. 6, pp. 707-722, 2005.

[32] E. Wenger, *Communities of Practice: Learning, Meaning, and Identity* (Learning in Doing: Social, Cognitive and Computational Perspectives). Cambridge: Cambridge University Press, 1998.

[33] M. Inzlicht and C. Good, "How Environments Can Threaten Academic Performance, Self-Knowledge, and Sense of Belonging," in *Stigma and group inequality: Social psychological perspectives.*, (The Claremont symposium on Applied Social Psychology. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, 2006, pp. 129-150.

[34] R. Jan, N. Agneta, and H. Lena, "Appreciative Inquiry: Research for Action," in *Handbook of Research on Information Technology Management and Clinical Data Administration in Healthcare*. Hershey, PA, USA: IGI Global, 2009, pp. 631-645.

[35] R. O. Brinkerhoff, "The Success Case Method: A Strategic Evaluation Approach to Increasing the Value and Effect of Training," *Advances in Developing Human Resources,* vol. 7, no. 1, pp. 86-101, 2005.