

Equity, Engineering, and Excellence: Pathways to Student Success

Dr. Doris J. Espiritu, Wilbur Wright College

Doris J. Espiritu, PhD is the Executive Director of the College Center of Excellence in Engineering and Computer Science and a professor of Chemistry at Wright College. Doris Espiritu is one of the first National Science Foundation's research awardees under the Hispanic- Serving Institutions (HSI) Program. She pioneered Engineering at Wright and had grown the Engineering program enrollment by 700 % within two years of the NSF-HSI project. Doris founded six student chapters of national organizations including the Society of Women Engineers (SWE), the Society of Hispanic Professional Engineers (SHPE), the Society of Asian Scientists and Engineers (SASE), the National Society of Black Engineers (NSBE) and nine times Outstanding Chapter Awardee, the American Chemical Society-Wright College Chapter. Doris promotes collaboration between K-12 schools, other community colleges, 4-year institutions, non-profit organizations, and industries. Doris' current research is to design and implement practices that develop Community of Practice (CoP), Professional Identity, and Self-Efficacy to increase diversity in Engineering and Computer Science and to streamline transfer from community colleges to 4-year institutions.

Bridget Eileen O'Connell, Wilbur Wright College

Bridget O'Connell is an Academic and Career Coordinator for the Engineering Program at City Colleges of Chicago-Wilbur Wright College. She has a Master of Science in Higher Education Administration and Policy, a Bachelor of Science in Electrical Engineering, and worked in engineering industry for thirteen years. She is committed to serving underrepresented students in their pursuit of engineering education.

David Potash, Wilbur Wright College

David Potash has served as president of Wright College, one of the City Colleges of Chicago, since 2013. The first CAO at Curry College in Milton, MA, Potash was Associate Provost at Hunter College and Baruch College, CUNY. Trained as an historian, he holds a BA from Rice University, an MA from NYU, and PhD from Cambridge University. Potash is active with several professional organizations (including AAC&U, Campus Compact, Excelencia in Education, and HACU) and blogs regularly (www.thedigitalquad.com).

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ABSTRACT

Wright College, an urban open-access community college, independently accredited within the City Colleges of Chicago (CCC) system, is a federally recognized Hispanic-Serving Institution (HSI) with one of the largest community college enrollments of Hispanic students in Illinois. Wright College's student success rates measured by completion have been strong and improving relative to other national urban community colleges, but are below state and national averages.

In 2015 the college piloted a selective guaranteed admission program, Engineering Pathways (EP), to one of the nation's top engineering schools (The Grainger College of Engineering at the University of Illinois Urbana Champaign, UIUC). Initial results for the small first-year cohort were very positive: 89% transfer rate and all students who transferred to UIUC graduated. The program's initial success rested on a) cohort model with a small number of students and strong controls; b) co-branding that attracted local students interested in pursuing engineering at UIUC who might not otherwise have enrolled at Wright; c) academic rigor (small class size with Wright College's curricula matching UIUC); d) robust student support services and structures; and e) a holistic college commitment to equity and inclusive excellence.

Wright College obtained a National Foundation Science (NSF)-HSI research grant in 2018 to support the Engineering Pathways. The grant examines EP students' self-efficacy and sense of belonging. Wright College foregrounds student "belonging" in its equity efforts. Equity work calls for the systemic analysis and tracking of student performance, engagement and participation throughout the student life-cycle, with data-informed analysis of behavior and outcomes through a lens of race, gender and wealth. EP students shared similar racial and ethnic backgrounds as Wright College's non-engineering students. They attended the same elementary and public schools, have similar family structures, socioeconomic status (SES) and supports.

NSF resources assisted Wright College's creation of a contextualized engineering summer bridge and a more structured pre-engineering program. As enrollment in the EP program increased, the college dedicated additional resources, including faculty, enhanced student support, and guaranteed junior-level transfer to other nearby baccalaureate engineering schools. Central to the effort was significantly greater structure and monitoring of student performance, including academic and support frameworks for non-EP students. Wright College and baccalaureate transfer institutions reviewed and updated articulation agreements. In the Engineering Summer Bridge Program's first two years, forty-five (45) students who would otherwise have been denied admission to EP are thriving and are positioned to transfer to four-year engineering programs.

In this paper, Wright College will review the college's equity efforts, the structure and implementation of the Engineering Pathways, and the creation of new engineering transfer programs. It will explore visible and invisible barriers to students' success, contrasting students in Wright College's EP program with other Wright College students. The authors argue that the systemic pursuit of equity, particularly with a focus on self-efficacy, belonging, and the creation of an environment committed to inclusive excellence, will result in very strong student outcomes.

INTRODUCTION

The importance of community colleges to STEM education, and in particular to the education of engineers, is a critical and increasingly studied strand within the higher education research landscape. More than twenty percent (20%) of all engineering baccalaureate students complete at least 10 credits at a community college [1]. Thirty-eight percent (38%) of engineering graduates attend community college at some point [2, 3]. Currently, more than 41% of all students in higher education in the US are enrolled at a community college. Fifty-six (56%) of all Native Americans, 52% of all Hispanics, and 42% of all Black students in higher education are community college students [4]. For the US to benefit from a growing number of diverse and successful engineers, community colleges will have to play a major role.

Although community colleges are recognized as a promising pool of diverse future scientists and engineers, research on how community colleges are preparing racial and ethnic minorities for successful transfer and degree completion in engineering and computer science program is limited [5]. Nationally, overall transfer success rates from community college to baccalaureate institution are not encouraging: only 14 percent of community college students who transfer to a four-year institution successfully complete a baccalaureate degree within six years [6].

The scarcity of actionable research constrains the extent to which researchers, policymakers, and practitioners can understand and improve underrepresented students, especially Hispanic and Black students, in STEM education in community colleges [7]. In 2011, an Association for the Study of Higher Education (ASHE) Report made the stern warning that “researchers studying racial and ethnic minorities in STEM education have excluded community colleges” and saw a need to focus on minority serving institutions [7]. The following year, ASHE provided another extensive framework for methods to improve equity in education [8]. Nearly a decade later, community college focused research remains a priority [9].

Wright College, an urban Hispanic Serving open-access community college within the City Colleges of Chicago (CCC) system, understands and appreciates the opportunity and need to develop equitable frameworks that are focused on access and excellence. In the past eight years, Wright College and CCC have adopted many of the best practices to improve student access and success. Wright College prioritized equity work and inclusive excellence, by integrating diversity and equity within mission and operations [10]. These efforts set the foundation for an innovative engineering transfer program. Through NSF-HSI funded research, Wright College found success in developing aspiring engineers and computer scientists. Diverse students start at Wright College Engineering Pathways, transfer, and successfully complete at four-year institutions within a reasonable time. Through the EP framework, Wright is positioned to make significant contributions to increasing diversity in engineering. Critical to the effort have been the removal of well-known barriers to community college transfer, an institution-wide commitment to equity and inclusive excellence, and the addition of focused attention on student self-efficacy.

This paper will review the system and college changes that set the foundation for the Wright College Engineering program. It will detail the deliberate growth of the Wright College Engineering Pathways, which provides underprepared students access to additional preparation, support, and excellent engineering and computer science education - equivalent to that of a top engineering transfer institution such as UIUC and other transfer institutions. The holistic and programmatic framework levels up academic preparation, develops students’ sense of belonging

to the profession and empowers students who historically would not have succeed in engineering, in particular, Hispanic students. The Wright College Engineering Pathways approach eliminates many barriers, including the false belief that community colleges are inferior institutions, by emphasizing inclusive excellence, equity and self-efficacy.

OVERVIEW

SYSTEM AND COLLEGE

Elitism, and more, specifically issues of class, status, race and privilege are woven throughout higher education. Students of color, often community college students, are the victim of elitism [11]. In a 2017-2018 survey administered by the National Association for College Admission Counseling (NACAC), over a half of the students and parents responded that they believe community colleges are inferior and should only be considered as a fall back option [12, 11]. Community colleges receive substantially less resources per student and are more likely to serve students of color who have lower SES than white, four-year students and their families [13]. For many community college systems, student completion rates as measured by the federal government (first-time full-time first year students who complete a certificate or degree within three years) were in the single digits or low teens.

At Wright College and its larger system, these failings – particularly of student success – were well known for decades. Through a comprehensive series of reforms and changes implemented over five years, rates began to improve. Among the many changes were the implementation of guided pathways, targeted completion programs (College Completes), customer business models, predictive scheduling, revisions to developmental education, and more [14]. None of these changes were unique; all were drawn from research on best practices. High level, the community college system followed many of the reforms advocated in Bailey et. al.'s critical study, *Redesigning America's Community Colleges* [15].

From 2013 to 2016, Wright College's IPEDS completion rates rose from 13% to 15%. Community college completions are tracked by IPEDS, the Integrated Postsecondary Education Data System. IPEDS methodology measures first-time full-time students who begin in the fall semester and complete a degree or certificate within 150% of expected time to degree completion. For associate degree students, that is three years. Problems for students transferring from Wright College remained, as did unequal student outcomes when viewed through a lens of race. Wright College's student success rates were strong relative to other urban community colleges serving mostly Hispanic students, but below state and national averages in terms of IPEDS completion and transfer student success. Progress was underway, with more work needed to be done. Wright College leadership and faculty looked to best practices in promoting student success, seeking innovation and guidance. Key was guidance by Excelencia in Education, a research organization associated with Hispanic Association of Colleges and Universities (HACU), highlighting the importance of equity [16].

Wright College prioritized pursuing an equity agenda. In 2015 Wright College was selected as one of twelve colleges throughout the nation to participate in the American Association of Colleges and Universities (AAC&U's) Committing to Equity and Inclusive Excellence Project. Professional development across all college stakeholder groups and the distribution of student performance data at the course section level, disaggregated by race, were foundational to Wright College's equity

work. Wright College's ongoing efforts, coupled with a data-informed commitment to continuous improvement led to ongoing changes and reforms. By 2020, Wright College's IPEDS completion rate was 26 percent. In 2020, Wright College published a formal equity plan, aligned with a new strategic plan [17]. Under this work, the college collectively created an integrated equity action plan that set the stage for enhanced intentional focus on equity, further employing equity analysis throughout the activities of the institution.

ENGINEERING PATHWAYS

At the same time that Wright College made its initial commitment to the Equity Project through AAC&U, Wright College piloted a selective guaranteed admission program, Engineering Pathways (EP) to one of the nation's top engineering schools, The Grainger College of Engineering at the University of Illinois Urbana Champaign. The EP is an initiative created to increase Hispanic, Black and Women in engineering. The Wright College Engineering Pathways recognized the many challenges and barriers students face, even before they choose community college for their engineering education. The EP was designed, expanded, and adapted to address the multiple challenges found throughout the community college student life cycle, from recruitment to orientation, from advising through transfer support, and in the classroom and beyond. Mathematics self-efficacy has been found to be a predictor of mathematics performance and a strong predictor of academic achievement [18, 19]. Informed by research and direct experience with student success reforms, Wright College designed and implemented an equity-focused, holistic and programmatic approach for transfer that increases math self-efficacy and belonging to the engineering profession as key pillars of the EP.

The initial results for the small first year EP cohort were very positive: 89% transfer rate after two years and all students who transferred completed their bachelor's degree within two to three years after transfer. Equally critical for long-term growth, the communication between Wright College and UIUC was very strong, grounded in a shared commitment to candor, complete honesty, and data. Further supporting the program's initial success were time-tested frameworks to mitigate or remove barriers for community college students: a) a cohort model of a small number of students; b) its ability to co-brand and attract local students interested in transferring to the strong engineering school at UIUC or other transfer institutions; c) academic quality (the curricula at Wright College matched that at UIUC - no loss in credit hours, and changes in teaching/pedagogy); d) robust student support structures; and e) a holistic college commitment to equity and inclusive excellence (the students were both "normal" Wright College students and "special" in the EP to UIUC).

Although most counselors have agreed that community colleges offer cost savings and have an easy application process, parents, students and counselors do not view the open enrollment system (100% of applicants are accepted) as positive. The lack of selectivity is often equated to lack of academic rigor leading to the false belief that selectivity equates with excellence. Scholars such as Gina Ann Garcia have made compelling arguments that academic quality can flourish at the community college level [20]. Nonetheless, students, parents, and high school partners are often skeptical of Wright College's programs. All these resulted in a very small initial number of applications and students enrolling in the EP.

In addition, most high school academic counselors reported less positive attitudes about the academic rigor of community college coursework [12]. Since underrepresented minorities (Black

and Hispanic), women, financially challenged, and first-generation college students more often begin their higher education at community colleges than their white, male, and higher income counterparts [21, 22], they are already confronted with an inferiority barrier by the time they enroll at a community college. The false belief that community colleges are inferior, represent some second-class status, and limited academic preparation can contribute to the low success rate at community colleges, especially for minority students. Believing that one is inferior can also lead to a lack of professional identity, an inability to see themselves as professionals. This lack of professional identity [23] is another reason that students initially interested in engineering or computer science may leave the field. Black, Hispanic, female and low-income students often believe that they cannot be successful professionals due to their gender [24, 25], ethnicity, or class [23, 26, 27]. Wright College hypothesizes that the lack of professional identity and the lack of preparation are two of the reasons why Black and Hispanics are not completing engineering and computer science degrees at equitable rates [28, 29, 30].

To empower underprepared and underrepresented students to break down barriers, faculty and administration at Wright College's Engineering Pathways formed a team to address mindset and equity challenges systematically, with support and agency to make changes. The team, consisting of faculty, staff and administration, collaborated and developed frameworks, contextualized interventions, followed best practices, employed research and the use of data, and then secured an NSF-HSI research grant. The Engineering Pathways frameworks focus on academic and social barriers while promoting increased belonging to the college and the profession [31] and providing access to an excellent education. Messaging to students from inception was that Wright College was confident in student success, individually and collectively – with student commitment and effort. The Engineering Pathways frameworks are designed to enable initially underprepared students to succeed in a demanding engineering curriculum even beyond the associate degree. These reforms aligned and resonated with larger college-wide equity and student success efforts.

Another significant barrier to community college students transferring to baccalaureate institutions is the transfer process itself. Not all community colleges courses may transfer and count towards the degree and elite institutions may have additional requirements. An inefficient transfer is a critical problem in the community college/baccalaureate world and is well-known to Wright educators. Most academic counselors have reported concern about the ease of transfer to four-year colleges [12]. As outlined in the 2017 Congressional Report of the United States of Government Accountability Office [32], one third of community college students transfer within six years and students usually take a longer time to complete after transfer. The length of time to degree completion is affected by the loss of credits when students transfer. On average, students can lose up to 43% of their credit hours when they transfer [4]. Wright College knows that this is a real barrier and has worked to provide more information about expectations and consequences to students, advisors and faculty. Recognizing the transfer barrier posed particular problems for engineering students, Wright College developed and piloted a holistic and programmatic approach for transfer (HPAT) model to help transfer students in the EP [33]. The HPAT model incorporates known best practices [34, 15, 35] with early active participation of the four-year transfer partner, structured within a well-thought-out transfer articulation agreement that builds on a joint commitment to quality and student success. The HPAT model is customized to eliminate barriers and make students feel they belong in both institutions at all stages of their higher education.

EQUITY, INCLUSIVITY, EXCELLENCE AND ENGINEERING

Wright College researchers identified several key STEM studies [7, 36] across the higher education spectrum to inform efforts to remove barriers and create more equitable programs, practices, and policies. The practices, now implemented, are intentional and data-informed at Wright College, and individualized in their application to students. It is not a generalized “equity for all” initiative, but instead rests on broader and sustained equity efforts.

Wright College actively supported and promoted system-wide initiatives for several years, building capacity without realizing significant improvements in student outcomes. Change in higher education often takes time. In 2017, Wright College and the City Colleges of Chicago system launched a new scholarship program. The program offers all graduating high school seniors with at least a 3.0 from the Chicago Public School system with a free community college education, including books. This last-dollar scholarship is open to all, including undocumented students. Wright College actively recruited students eligible for the scholarship, provided enhanced student services and student life in cohorts, and achieved significantly higher retention and completion rates. Wright College attention to these scholarship students led to interesting dynamics within student data, demographics and behavior. While the scholarship students had the same racial and SES profile as high school graduates in prior years, the new group tends to study full-time at a higher rate. The students are significantly more active and engaged in college life. Their retention rates have mirrored those at nearby selective baccalaureate institutions. Complementing and going beyond the scholarship, the college increased focus on student engagement built upon practices specific for Hispanic Serving Institutions and launched its first college-wide equity plan.

Building upon these best practices identified for improved equity in STEM education [37, 5, 38], Wright college ensures greater accountability in outcomes for Black, Latinx, and Pell-eligible students. The college is utilizing quantitative and qualitative inquiry using a practitioner-researcher model, introducing interventions to improve these groups’ access, retention, and degree attainment. The college is regularly adapting policies, support structures, and pedagogical methods that have not benefitted student groups equally. These have ranged from specialized mentor programs to college-wide activities.

For example, Wright College is working toward increasing diversity in its faculty, full and part-time, by focusing on broadening practices through the recruiting and hiring process, while also considering culture climate feedback to improve retention of a diverse staff. The college conducts capacity building for existing faculty, ensuring more inclusive teaching practices and alternative teaching modalities. The college is expanding the advising process to the final year of high school and continuing until students transfer to four-year institutions, emphasizing coaching and mentoring, including partnering with faculty. To reduce financial barriers, the college has created a financial literacy team, is partnering with local high schools and a four-year public institution through a Title V grant, and is expanding financial education to high school students and their families. A college team is evaluating and promoting the use of more Open Education Resources. Wright College formed a Racial Justice Committee (RJC), separate from its Equity team and plan. The committee helps identify institutional barriers and advances an equity-conscious culture. The RJC improved the use of data to determine where gaps exist to target learning supports in early college courses. The college and system implemented a college wide debt-forgiveness plan, to encourage students to continue their education.

These Wright College-wide initiatives contributed to increased completion from 15% in 2016 to 26% in 2020.

THE ENHANCED ENGINEERING PATHWAYS FRAMEWORK

In 2015, Wright College started a selective Engineering Pathways to The Grainger College of Engineering at UIUC as a carefully controlled pilot. The inaugural cohort results were very positive: 89% transfer rate after two years and all students who transferred completed their bachelor's degree within two to three years after transfer. Importantly, students who enrolled in the EP program were in many ways similar to other students at Wright College. They shared the same racial and ethnic backgrounds; they attended the same elementary and public schools; they had similar family structures, supports and expectations; and their academic profiles were similar across the board. What set the EP students apart was a willingness to commit to a rigorous engineering program with the promise of transfer.

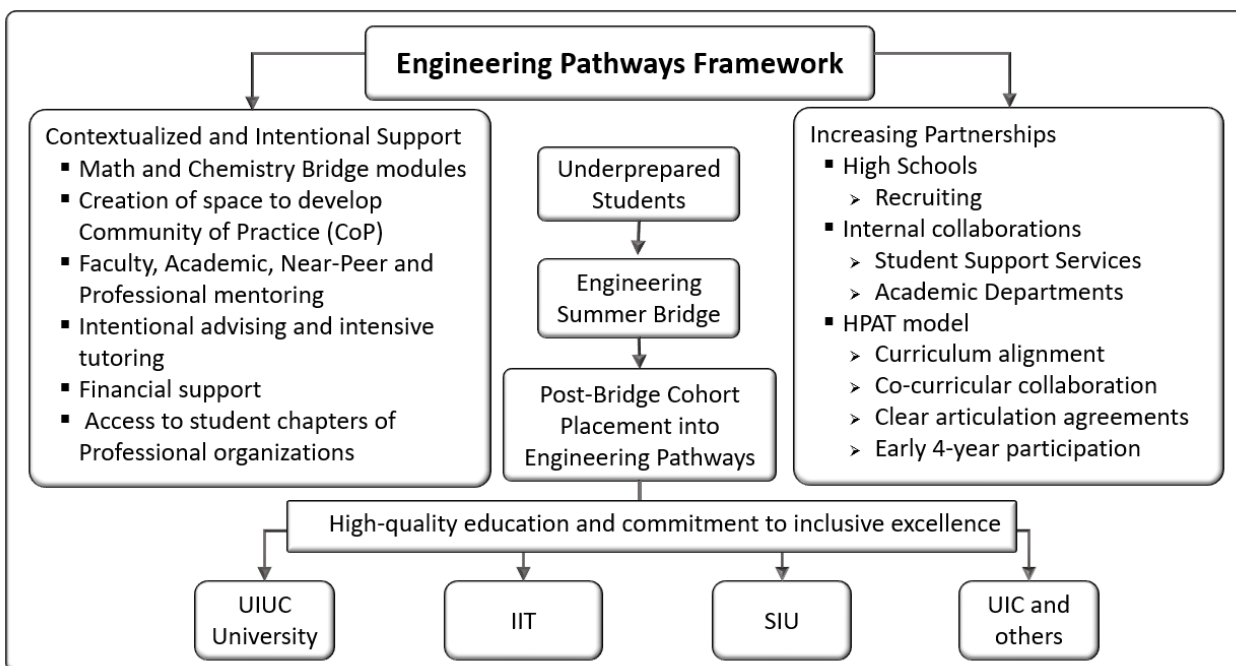


Figure 1. Enhanced Engineering Pathways Framework. The UIUC Engineering Pathways framework was expanded to universities: University of Illinois at Urbana Champaign-UIUC, Illinois Tech (IIT), Southern Illinois University (SIU), University of Illinois at Chicago (UIC)

Instead of selectively admitting students through their high school performance alone, the EP assesses students' motivations. The Wright College EP program believes that students who were initially denied admission at UIUC or other first-choice institutions will be successful if provided the preparation and robust support. The main modification is that the EP holistically supports students from admission, through their tenure at Wright College and even beyond transfer. The Wright College EP developed a framework that prepares students academically and provides them with intentional support that develops belonging before admitting them into a demanding program that aligns with UIUC. In 2018, through the NSF-HSI research grant, the EP framework was

enhanced by creating the contextualized Engineering Summer Bridge and a more structured pre-engineering program that intentionally supports underprepared and underrepresented students. In 2019, the EP framework was expanded to other colleges (Figure 1) to provide students more options. A more detailed description of the EP frameworks is described by Espiritu et.al. [31,33].

The enhanced Engineering Pathways framework strives to alleviate academic, financial, socialization and adjustment barriers. It increases belonging to the college and the profession, and develops self-efficacy [33]. The first two years of the contextualized Engineering Summer Bridge afforded forty-five (45) underprepared students a second chance to be directly admitted to the EP. The Bridge Program addresses students' academic preparation and increases their self-efficacy. Emphasizing equitable practices during the Engineering Bridge also plays an important role in increasing student performance: all 45 students are now positioned to transfer to UIUC or other engineering institutions within two to two-and-a-half years. Seven (7) participants of the inaugural Bridge cohort are now transferring to The Grainger College of Engineering, two years after the Bridge Program. This is a significant impact because none of these students would have had access to a top and very selective engineering college such as at UIUC without the enhanced EP framework.

BELONGING, SELF-EFFICACY and CONTINUOUS IMPROVEMENT

Increased sense of student belonging and student self-efficacy are critical components in the success of the Engineering Pathways. Continuous improvement has been the hallmark of Wright College Engineering Pathways since its inception. The enhanced Engineering Pathways framework intentionally provides talented and underprepared students a second chance with clear goals and pathways. The contextualization of curricula and student support tailored to the unique participants' needs are also instrumental for students' success. The EP developed courses such as the Engineering Success Seminar to enhance the engineering students' first-year experience and to help students build professional identity by identifying their major early. The EP also developed more technical courses in collaboration with transfer institutions to streamline two-year to four-year transition. Students in the EP understand that they were admitted to the program because the college is confident that they can handle the demanding engineering curricula regardless of their prior preparation. From admission to the Bridge and into different pathways, socialization activities, mentoring, networking and leadership opportunities were integral to the program. These practices develop belonging and community of practice [31].

In addition to assessment, the Belonging and Self-Efficacy survey were designed and implemented for Wright College engineering students to feel that they have a voice. Students in the Bridge were asked to take the survey before the start of the summer Bridge and at the end of the Fall semester to have their voices heard. The outcomes of the survey were used to enhance the Bridge and the Engineering Pathways at Wright College. An Appreciative Inquiry method [39] was also used for case study interviews. The information from these interviews guides the program for continuous improvements. The Appreciative Inquiry also empowers participants to be heard and to be involved in the continuous improvement process. Student participation in EP is essential to increase students' sense of belonging to the college. Wright College administration supported this and expanded student participation in a host of college committees and events.

The contextualized Engineering Bridge Program continuously evolves and creates more equitable approaches to prepare talented, underprepared, and underrepresented students. The survey and the

case study interview empower students to contribute to further improving the Wright College Engineering Pathways. Hearing students' voices and implementing students' suggestions itself develops belonging.

SUMMARY

The college-wide equity work and programs resulted in increased completion from 15% in 2016 to 26% in 2020 and a more formalized Equity Strategic Plan. The new Equity Strategic Plan, when fully implemented, aims to eliminate equity gaps across the college. The Wright College Engineering Pathways framework facilitated 95% fall to fall retention, elimination of foundational and developmental Math and 75% transfer and degree completion within two to three years. Table 1 compares Wright College and EP success rates for AY 2019-2020. The EP did not admit non-Calculus ready students in its first four cohorts, therefore the earlier success rates of EP cannot be accurately compared with Wright College. In FY 2019-2020, the EP through the NSF-HSI grant afforded opportunities for underprepared students to be admitted to the EP through the Engineering Summer Bridge, enhanced EP. The students in enhanced EP have the same demographic profile as Wright College students (data not shown).

AY 2019-2020		Wright College (%)	EP (%)
Completion		26	75
Fall to Fall retention		52.7	95
2019 cohort transfer rate in 2 years		2.8	64
FS & Dev Ed Math students	Tested and admitted	18.2	19.6
	Enrolled in FS/Dev Math in Fall	18.2	*3.2
	Enrolled in Calculus 1 in Fall	-	16.4
	Associate degree completion/transfer rates after 2 years	-	**52

Table 1. Wright College and EP success rates. FS (Foundational Studies) and Dev Ed (Developmental Education) Math students are required up to two (2) years or one year of math remediation, respectively. *Only Dev Ed, **percentage based on the total of FS/Dev Ed students admitted at application.

Regardless of the similarity of students' background and academic profile at admission (18.2% vs 19.6%), students in the Engineering Pathways stand out. The percentage of students enrolled in FS and Dev Ed Math by the Fall 2019 is much lower than the general Wright College students (18.2% vs. 3.2%) because the contextualized Engineering Summer Bridge eliminated up to two years of FS and Dev Ed Math, resulting in Calculus I enrollment. Most importantly, 52% of students who were initially tested at FS and Dev Ed at application are now completing their associate's degrees and transferring two years after admission to Wright College and Engineering Pathways.

The college attributes the greater success rates among engineering students, as compared to that of the entire Wright College, to the students having a clear sense of direction, increased belonging to the college and in the profession, increased self-efficacy, all of which are in conjunction with the college's structured support and attention. EP pathway students join the program because they believe that Wright College Engineering Pathways will prepare them for a demanding curriculum when they transfer to UIUC or other institutions. The students believe "they can" succeed regardless of their initial Math preparation. The contextualized academic preparation, including the NSF- HSI Bridge Program and the intentional student support, further increases the students' ability to succeed [31]. The Engineering Pathways outcomes offer clear evidence that underprepared and underrepresented students, especially Hispanic, can succeed in a demanding environment with the right mindset and support. It demonstrates the efficacy of structured

community college curricula and support. In fact, to date, many students choose Wright College as their first option for engineering and they choose to be engineers because of the holistic and programmatic frameworks of the Engineering Pathways.

Given the success rate of the Wright College Engineering Pathways serving mostly non-white, lower income, female, and first-generation and underprepared students entering a very demanding engineering program, the Wright College Engineering Pathways framework is positioned to improve equity that will eliminate barriers to students' success; especially underprepared and underrepresented students. The NSF-HSI research grant is instrumental in guiding and enhancing the EP's data-driven and continuous improvement approaches. Implementation of the Engineering Pathways framework to other disciplines could positively improve equity and excellence for all Wright College students, and it could potentially be duplicated by other community colleges. Women, Black, Hispanic, low-income, first-generation students who are underprepared will be provided a new sense of belonging and self-efficacy, consequently making them succeed. Essential to that is academic programming with clear pathways and programmatic outcomes that resonate with students.

The authors argue that the systemic pursuit of equity, particularly with a focus on self-efficacy, belonging and creating an environment committed to inclusive excellence, will result in very strong student outcomes regardless of students' diverse background.

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