Bridging Gaps and Building Pathways to Increase Transfer through Data-Driven,Innovati and Evidence-Based Strategies at Community College

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I. INTRODUCTION

Community Colleges (CCs) enroll more than 41% of all students in higher education in the US out of which 80% intend to transfer and complete a 4-year college degree.[1, 2] However, the National Student Clearing House Research Center reports that only 31.6% of students starting at CC's transfer and 15.5% complete a bachelor's degree within six years after transfer.[1, 2] In a 2017-2018 survey administered by the National Association for College Admission Counseling (NACAC), over 50% of students and parents responded that CCs are inferior and should only be considered as a fallback option.[3, 4] Meanwhile, compared to 4-year institutions, CCs receive substantially less resources per student while serving more students of color with lower socioeconomic status.[5] CCs enroll 56% of all Native Americans, 52% of all Hispanics, and 42% of all Black students in higher education.[6] This exacerbates the gap between students who intend to transfer and complete 4-year college degrees compared to those students who actually graduate.

To make sure quality engineering education programming is as strong as possible, producing the most competitive and talented STEM professionals, these programs need to be more accessible and welcoming, creating spaces where students can cultivate meaningful identities and a deep sense of belonging. Encouraging student participation in STEM at the university level requires supportive experiences that help students foster a professional identity, and develop and affirm a sense of self-efficacy.[7] A number of studies have suggested that lower completion rates may be due to the academic, sociocultural, and transfer challenges.[7-9] Recent literature highlights various strategies and initiatives aimed at enhancing the academic experiences and outcomes of transfer students in engineering. These publications provide insights into effective strategies and models for supporting transfer students, emphasizing mentorship, research opportunities, institutional support, and identity navigation.[10]

In the past ten years, Wilbur Wright College, one of seven urban colleges in a City Colleges of Chicago (CCC) system, has prioritized excellence and service within its mission and operations.[11] These efforts have set the foundation for an innovative engineering transfer program. Through the National Science Foundation funded research, Wright College developed, implemented, and assessed innovative strategies: Contextualized Bridge [12], Holistic and Programmatic Approach for Transfer (HPAT) [13], and Multidimensional First-Year Experience (MFYE) [14] in developing the most talented and competitive aspiring engineers and computer scientists.

The evidence-based strategies streamline transitions from high school to CC, and from CC to four-year institutions, while also developing processes that extend beyond these transitions. Essential to these innovations have been the removal of well-known barriers to CC transfer, the development of a sense of belonging, and focused attention on the self-efficacy of near-STEM ready students. Most importantly, these strategies narrow the achievement gaps for the most competitive students who just do not have the resources to pursue an education in engineering, having the potential to disrupt the current CC landscape, and can have a non-trivial impact through 4-year transfer institutions and toward the most competitive engineering workforce. To ignore these needs for change would serve as a major threat to the national economy and to our STEM dominance internationally.

II. METHODS

Through a data-informed continuous improvement process, Wright College has developed and implemented innovative, high-impact evidence-based strategies for aspiring engineers and computer scientists of all ages, interest areas, and backgrounds. Students are recruited from high schools, Wright College (credit and adult education), and transfers from other colleges or universities (reverse transfer). The Contextualized Bridge was developed for near-STEM ready students - students who need additional preparation for college level engineering courses. After the Bridge completion, participants are enrolled in different transfer pathways. Students whose math skills are at the Calculus level are placed into Engineering or Computer Science pathways. Pre-Engineering is an alternative pathway for students who, after completing the Bridge, are not Calculus ready (Figure 1).

This paper is an overview of the methodologies of the evidence-based practices developed at Wilbur Wright College over the course of six years, that have shown to successfully eliminate equity gap, and increase retention, transfer, associate and bachelor's degree completion, and completion gaps for engineering and computer science students. If replicated and implemented with high fidelity, these strategies could elevate the entire CC system, not just for engineering disciplines, and could improve communication and collaboration among institutions.

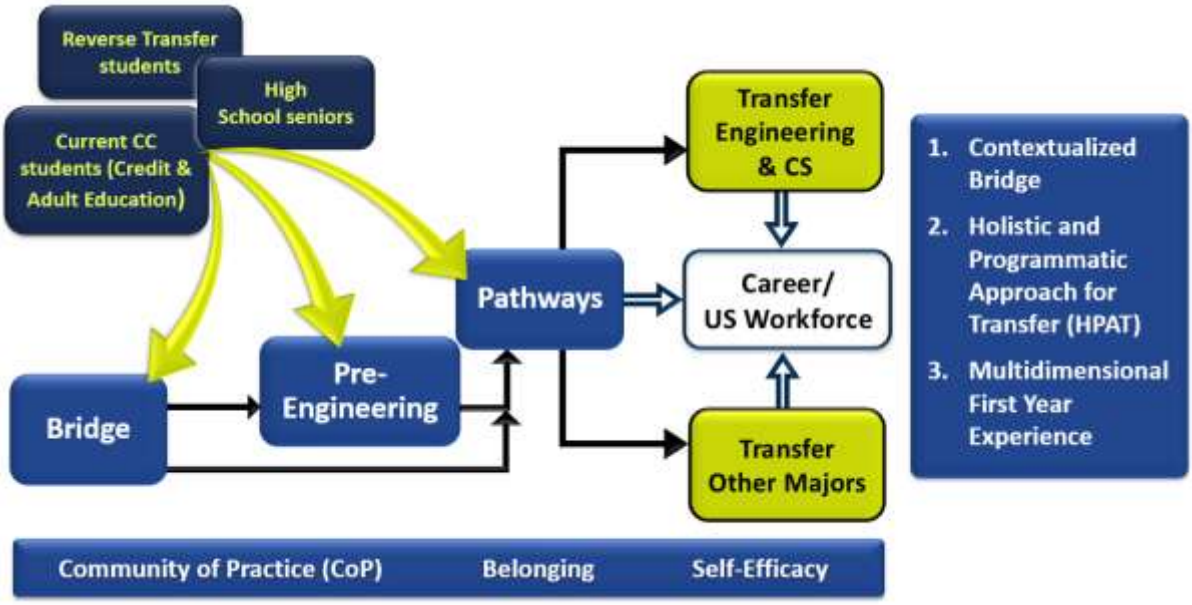

Figure 1. The overall framework for bridging gaps and building pathways to increase diversity in engineering

1. The Contextualized Bridge: Transforming Remediation into Accelerated Progression and Success

The Contextualized Bridge approach first described by Espiritu et.al. [12] is a high-impact strategy to address low self-efficacy by eliminating Math remediation, developing professional identity by creating a cohort system, promoting socialization activities, strengthening connections to the college, and building awareness of engineering fields and career opportunities.[12] The Contextualized Bridge is designed to help prepare students for college-level math and chemistry

prior to students starting their engineering/computer science curriculum, during a 6-week, 4 days per week, 4 hours per day academic intervention during the summer. It is contextualized to address topics identified as the main deterrents of students' success and tailored towards student's individual skills. In addition to math and chemistry preparation, the Bridge is infused with mentoring, tutoring and socialization activities to develop a sense of belonging to the college and to engineering.

The quantitative and qualitative outcomes of all cohorts (students starting with or without Bridge) are assessed through belonging and self-efficacy surveys based on the Bandura's toolbox [15] and Appreciative Inquiry case study interviews [16] supplemented with retention, persistence, transfer, and degree completion rates as previously reported [17]. The self-efficacy and belongingness surveys were administered at the beginning and end of the Bridge program, and are administered repeatedly to track students longitudinally. For the case study face-to-face interviews, students were randomly selected for inclusion based on cohort and leadership roles. Interviews were audio recorded and transcribed by Otter.ai. Two researchers reviewed each transcript and coded the text using data driven coding, followed with the data analysis using the thematic analysis process. The purpose of the case study interviews was to critically examine the experiences of students and to better understand how the program impacts academic progress. The emerging themes were used for continuous program improvement.

Longitudinal outcomes for each cohort were further determined using the key performance indicators for quantitative assessment (retention rates at all levels, associate and bachelor's graduation, and transfer rate). In addition, admission data (high school GPA, Math and English placement, and student demographics), transfer GPA, time to degree completion, and graduation rate were used. These metrics provide a more comprehensive set of leading indicators of longitudinal outcomes and were measured for each student cohort and compared year-to-year.

2. Holistic and Programmatic Approach for Transfer (HPAT): Empowering Seamless Transitions and Community of Practice (CoP)

In 2019, Wright College developed and implemented a model for a holistic and programmatic approach for transfer (HPAT) that eliminates visible and invisible barriers to student success. The model includes early and active participation of the 4-year transfer partner with transfer articulation agreements which build on a joint commitment to quality and student success. Amongst other goals, it emphasizes a fully collaborative and holistic approach to admission; curriculum alignment; co-curricular activities; co-advising and co-mentoring.

The HPAT model focuses on empowering students throughout their educational journey from admission to CC, transfer, and associate as well as bachelor's degree completion.[13] It recognizes that additional resources and support are needed to ensure success for CC students upon transferring to 4-year institutions. As such, beyond academic support, it addresses students' financial, emotional, social, and career readiness barriers. It provides the foundation that supports the successful continuation of existing CCs community of practice (CoP) to transfer institutions. CoP, defined as a group of people who share a concern or passion for something they do [18], has been shown to increase a sense of belonging and self-efficacy, both of which are important factors for retention, transfer and completion. The frameworks and initial outcomes of the pilot were published in 2021.[13] The complete model and outcomes of the six-year study, funded by NSF, are forthcoming.

3. Multi-Dimensional First-Year Experience (MFYE): Bridging the gap between college and engineering workforce

Further enhancing students' experience in the HPAT model, Wright College designed and implemented the multidimensional first year experience (MFYE) approach to increase students' sense of belonging to the college and the profession, and develop/increase confidence and self-efficacy. [14] MFYE presents a new model of engineering orientation implemented through a multidimensional seminar approach, Engineering Success Seminar (ESS). The MFYE model centers around the implementation of several evidence-based practices that prepare students to succeed beyond associate degree completion and transfer, by preparing them to be professionals.

The ESS is a 3-credit hour seminar incorporating Introduction to the Engineering Profession, College Success, and Professional Skills that bridges the gap between the technical engineering classrooms and the industry needs. The Introduction to Engineering dimension provides students with early exposure to engineering fields so they can make informed decisions on choosing a career in which they are most likely to feel they belong. The College Success dimension imparts students with skills to navigate college. These skills include time management, financial literacy, wellness, and academic load. The College Success dimension also ensures that students know where to find resources and help.

The course activities such as project-based learning, resume building, mock interviews, and the creation of LinkedIn profile are designed to develop oral and written communication, critical thinking, problem solving, and teamwork to prepare students to be professionals.[14] Students work in groups to propose, research, and develop a technical project. Through this process they navigate the pitch competition during which they create a clear and concise two-to-three-minute presentation that highlights their project, concept paper submissions, and final presentations before professional judges. The MFYE also introduces students to careers, industry roles, project management, leadership, and research. It provides an opportunity to build networks through a professional speaker series and mentorship. In addition, through intentional partnership with engineering employers, students have opportunities to earn internships as early as after the completion of their first year. This is particularly important as most employers do not provide opportunities for CC students.

Each dimension incorporates evidence-based best-practices. The intentionality demonstrated by MFYE programming prepares students technically, but it also ensures they are equipped with the soft skills necessary to success in their careers. The course provides an excellent first-year experience, measures belonging and self-efficacy to the engineering profession, increases students' confidence in their professional goals, as well as tracks the success of engineering students.

III. RESULTS

1. Contextualized Bridge

In 2022, the qualitative and quantitative outcomes of the first Bridge cohort were assessed through surveys and case study interviews supplemented with retention, persistence, transfer, and degree completion rates.[17] The outcomes showed that the established framework overwhelmingly increased belonging and self-efficacy. All participants who completed the Bridge eliminated up to two years of math remediation, and 54% were directly placed in Calculus 1. The impact on

retention was significant, 93% of students were retained and 75% transferred after two years from initial enrollment.[17]

The Project has had a direct impact on underprepared and under-resourced students pursuing engineering and computer science. Over six years, the Engineering Summer Bridge Program has enhanced STEM preparation and has fostered a greater sense of belonging in the profession, leading to greater success in more fulfilling careers. Current cohorts consist of engineering and computer science students both in guaranteed admission transfer pathways, as well as pursuing other transfer options. Outcomes seen by the first cohort have continued, wherein significantly reduced time to degree completion for underprepared or near-STEM students is observed. By eliminating the need for up to two years of math remediation, these students gained greater self-efficacy, succeeded in transferring to 4-year institutions, and are now contributing to the U.S. workforce.

The data collected from the Bridge program influenced the creation of the "Level-up Program" for non-engineering students at Wright College. This program, offered for the second time in Summer 2024, provides non-engineering students with an opportunity to develop college skills, though it lacks the mentoring component of the Bridge. In addition, the foundational Chemistry component of the Bridge has played a crucial role in increasing students' chemistry preparation. As a result, more students are now enrolling in College Chemistry courses without taking a preparatory course which could increase the time to degree completion. By Year 6, Bridge students no longer required preparatory chemistry courses, reducing the number of non-transferable credit hours and decreasing the time to degree completion.

After six iterations, the Contextualized Bridge served 425 students of all backgrounds and interest areas. Some participants have completed their bachelor's degree and are already working in the industry as engineers or continuing their graduate education. Detailed process descriptions and complete outcomes along with the developed and implemented evidence-based practices, are forthcoming in a future publication.

2. Holistic and Programmatic Approach for Transfer (HPAT): Seamless Transitions and Community of Practice (CoP)

The HPAT model has increased the Wright College Engineering enrollment from 25 students in Fall 2018 to about 650 students in Fall 2024 (Figure 2). In addition, the outcomes show a 93-96% Fall to Fall retention, 75% transfer rate within two years, and a transfer of more than 400 Wright College students to date. Since the implementation of HPAT, Engineering at Wright College has increased the number of the transfer partners and continues ongoing discussions with other 4-year institutions. Most recently, two additional partnerships with 4-year transfer institutions were solidified, that streamline transfer in Computer Science and Cybersecurity programs. Ongoing discussions with other 4-year institutions are being explored as transfer opportunities.

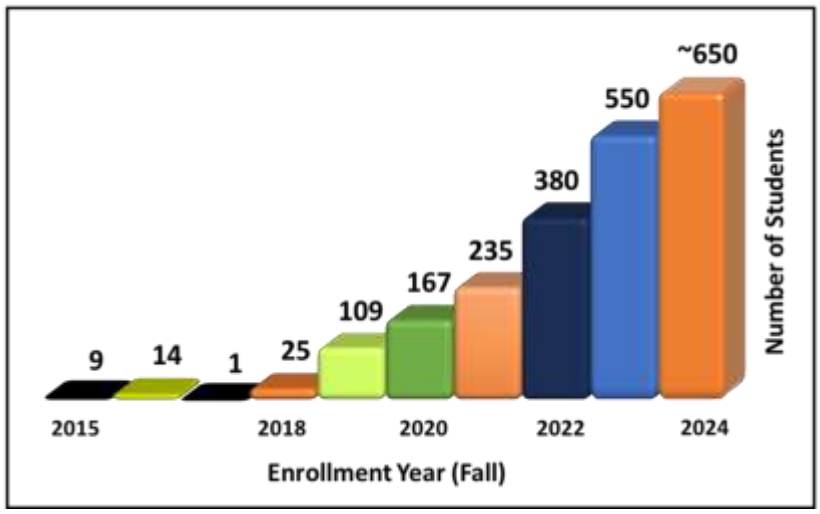

Figure 2. Wright College Engineering Program enrollment trend showing the impact of Contextualized Bridge, HPAT and MFYE.

At present, what has become evident is that with continuous improvement, data sharing and assessment, developed frameworks can serve to successfully support students from admission to undergraduate/graduate degree completion.[19] Thoughtful and intentional collaboration with transfer partners has proved particularly important, resulting in a more comprehensive and strategic alliance that extends far beyond a signed articulation agreement. An example of a more comprehensive partnership is the launch of the Engineering Access Alliance (EAA) between the City Colleges of Chicago and a top engineering program in the country. Building on the pre-existing guaranteed admission pathway, EAA includes not only an aligned curriculum but also student support and concurrent enrollment opportunities. This initiative addresses concerns raised by alumni about feeling unprepared in some aspects upon transferring. Through the EAA, CCC students can concurrently enroll at the partner 4-year transfer institution at a discounted price, significantly improving the academic transition.

The HPAT model was first developed in partnership with a private engineering school in Chicago (13). Through data-driven and continuous improvement processes at both institutions, amendments to the articulation agreement, adjustments such as an increase in transfer scholarship amounts – from $25,000 to $30,000 and inclusion of additional majors into the guaranteed dual enrollment transfer pathways have been achieved. In 2025, Wright College's articulation agreement was expanded to the entire CCC with more streamlined processes that incorporates dual advising, mentorship and data sharing. Additionally, majors such as Artificial Intelligence, Data Science, and Business and Engineering were fully implemented in Fall 2023.

The 4-year transfer partners also now assist the orientation, co-advising, and curriculum alignment further strengthening early collaboration which is integral to the HPAT model.

A common challenge, not limited to engineering and computer science students, is the extended time to graduation when transferring from CC to 4-year institutions. In addition to the Bridge which reduces the need for remediation, Wright College Engineering spearheaded the development and articulation of curriculum with quality and rigor aligned with 4-year transfer partners to streamline transfer to junior level standing.

Since its implementation, the HPAT model has emphasized intentional academic advising. In addition to one-on-one advising sessions at the start of the semester, midterm reviews and end-of-semester planning have been introduced. Even when students change their transfer or major goals, great care and academic planning is taken to ensure students have opportunities to transfer with optimal course alignment. In Spring 2024, City Colleges implemented mandatory advising for all students, requiring them to develop a transfer or completion plan, similar to the model already implemented by Wright College Engineering. Additionally, the seamless transfer developed for Wright's engineering and computer science pathways, which align curricula across institutions, is expanding beyond the engineering discipline. For example, the cohort system and intentional advising is currently being piloted in the Business Department. Similarly, the Biology Department is establishing clubs and organizations to help nursing, pre-pharmacy, and pre-med students build a supportive community. While some aspects of the HPAT model are challenging to adopt, faculty and staff have shown great interest in its potential.

3. Multi-Dimensional First-Year Experience (MFYE): Bridging the gap

The MFYE model has had a positive impact on students' lives and career decisions. After seven-years of implementation, 888 students (out of 903 initially enrolled) completed the Engineering Success Seminar. Interestingly, the success rate of ESS closely correlates with the Wright Engineering Program's Fall-to-Fall retention rate of 93%. EES was first offered in Fall 2016 semester. Since then, out of 903 enrolled students, 828 students completed the class with grade C or higher.

The MFYE innovations, the Cohort model, and leadership opportunities through chapters of national organizations develop essential soft skills needed to succeed in college and in the workforce. Through these experiences, students improved their communication (oral and written), problem-solving, teamwork, team building, and other critical skills. As previously shown [14], the MFYE was able to increase belonging, self-efficacy, and confidence.

The positive impact of MFYE implementation is also seen outside of the engineering discipline. Although not all components of this model have been implemented for non-engineering students, Wright College has hired a Director of the First Year Experience to gradually introduce key components of MFYE to the college at large.

IV. DISCUSSION AND SUMMARY

The Contextualized Bridge was first implemented in Summer 2019, contributing to a drastic increase in enrollment from 25 students in Fall 2018 to 109 students in Fall 2019. As shown in Figure 2, subsequent implementation of MFYE model followed by HPAT continued the enrollment increase trend, wherein in Fall 2015, Wright College enrolled 650 engineering and computer science students from all ages and backgrounds. More importantly, 93% average Fall-to-Fall retention rate from Fall 2019 to Fall 2024 is observed, directly correlating to the observed exponential growth of students transferring to 4-year engineering programs (Figure 3).

Since its inception in 2015, Wright College's Engineering Program transferred approximately 400 students, and among those who transferred, most have completed or are on track for bachelor's

degree completion. Most importantly, there is no observed preparation gap among graduates, where a direct correlation is observed between the outcomes and data obtained from the ESS belonging, confidence and self-efficacy surveys. [14] *Regardless of gender and race*, students feel more confident in their career choices and their knowledge of engineering jobs which could be a consequence of approximately 30% of students changing their engineering major during or post EES. Interestingly, while increased sense of belonging is reported by all genders, it was higher for female students. Similarly, when disaggregated by race/ethnicity, higher sense of belonging was reported for Hispanic and Black students. [14]

Case study interviews indicate similar observations. Students believe that their opportunities for academic advancement were expanded, that they were supported as individuals throughout the program, and they contribute their academic success to peer support within the cohort model. In general, their sense of belongingness developed and grew within the local community first, and eventually translating to the more global community. Similarly, their sense of self-efficacy was initially strengthened primarily by the programmatic practices and then sustained as more content areas are learned and self-efficacy in those areas strengthened.

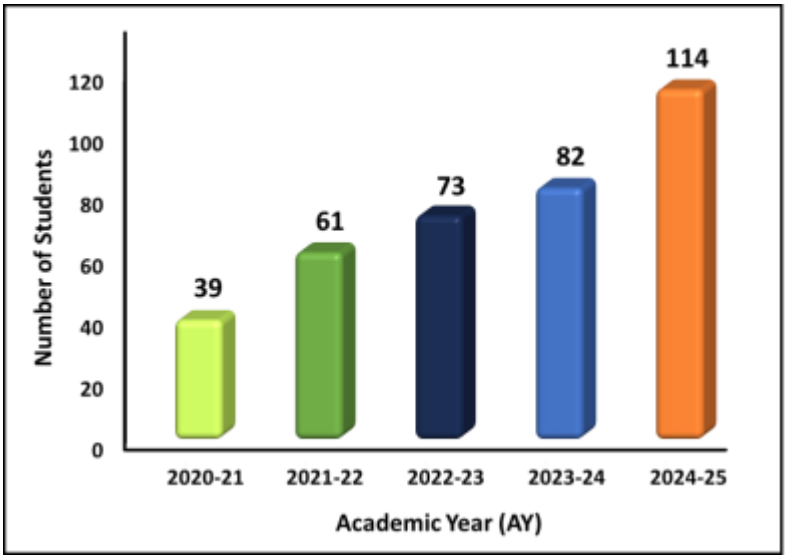

Figure 3. Wright College Engineering Program transfer trend showing the impact of Contextualized Bridge, HPAT and MFYE.

Although not unique, Amanda's story is an example of how one can eliminate the academic gap of near-STEM students and provide essential contributions to the US workforce. Amanda is a first-generation college student who dropped out of high school seven years before she completed her General Education Diploma (GED). She had never thought of attending college, let alone being an engineer. She serendipitously watched a Society of Women Engineers (SWE)sponsored robotics competition, which motivated her to inquire and join the Bridge Program. As expected, after taking the Math placement, Amanda was placed in Foundational Math that required up to 1.5 years of Math remediation. The Bridge math curriculum was contextualized to Amanda's skills. The personalized support and her new-found community helped eliminate the entire remediation after completing 6-weeks of the Bridge. Amanda was placed directly into Calculus 1 [20]. Through

the holistic and programmatic approach and the multidimensional first-year experience, Amanda transferred after two years of completing the Bridge. She was a leader of the Society of Women Engineers (SWE) at Wright College and was actively engaged with the Society of Hispanic Professional Engineers (SHPE) after she transferred to one of the HPAT transfer institutions. Currently, Amanda is employed as a Systems Engineer in a Fortune 500 company. She is the first of her family to finish college. If a GED completer can finish a Computer Engineering degree within 4.5 years, regardless of initial preparation, the evidence-based strategies developed and implemented at Wright College provide hope for everyone. Amanda contributes her tremendous success to the Contextualized Bridge, HPAT and MFYE.

Due to the contextualized nature of the process, the effects are undeniable. Regardless of their high school preparation, hundreds of first-generation, low-income, and underprepared Wright College engineering students have gained confidence while increasing their sense of belonging and self-efficacy. The implementation and the observed impact of these evidence-based strategies indicates the importance of understanding how different academic and sociocultural backgrounds affect students' identity trajectories, and the importance of providing an environment that fosters a stable academic transition from CCs to 4-year institutions.[10]

These key evidence-based practices are now ready for broader implementation, and if replicated effectively, could significantly transform the higher education landscape, particularly CC transfer, completion rates and career opportunities. In general, for a community college attempting to replicate these strategies, the first step is to examine your baseline data, identify your students' needs, transfer institutions, industry needs, and then contextualize these strategies to fit your institution. These models provided a blueprint that can be customized for a specific institution. With 80% of CC students aiming to transfer, and with CC students succeeding at a accelerated rate, these evidence-based practices could assist and guide institutions, particularly CCs, to increase retention, belonging, and student success in engineering. The most crucial factor would be innovative leaders who are willing to do the work and create the change.

V. FUTURE WORK

The Contextualized Bridge, as well as the HPAT and MFYE models at Wilbur Wright College are the result of continuously improved strategies based on the assessment of data and iterative implementation. The effect of the implementation of these evidence-based practices on the students' success will be further tested by adding two additional target groups for comparison (Bridge participants that opted out of program, and STEM students who did not participate in the program). As previously described, the longitudinal outcomes will be measured for each group and compared year-to-year.

Building inter-institutional programs is always an extremely difficult task. However, adding programming with built-in student support between institutions with limited budgets and resources (i.e., CCs) with a more resourced institutions (i.e., R1) is expected to further improve the current practices. Leveraging the cross institutional data will enhance the HPAT and MFYE models. Wright College will continue to customize the MFYE experience to emerging industry needs, continue tracking the longitudinal data including bachelor's degree completion and employment, and engage its alumni to augment student voices.

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