A Multidimensional Approach to Providing Excellent FYE that Increases Belonging, Retention, and Success of Engineering Students

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

Doris Espiritu is the Dean of the Center of Excellence for Engineering and Computer Science and Professor of Chemistry at City Colleges of Chicago-Wilbur Wright College. She also serves as the Senior Advisor to the Provost of the City Colleges of Chicago. 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 2500% within five years. Doris founded seven 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 ten 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.

©American Society for Engineering Education, 2024

A Multidimensional Approach to Providing Excellent First Year Experience (FYE) that Increases Belonging, Retention and Success of Engineering Students

I. ABSTRACT

This ***Complete Evidence-Based Practice Paper*** presents a new model of engineering orientation through a multidimensional seminar approach, the Engineering Success Seminar (ESS). Creating an excellent first-year experience (FYE) involves implementing several evidence-based practices such as cohort-based programs, academic and social integrations, and belonging seminars. Although community colleges (CC) implement several FYEs -- retention, and student success can be improved. Wright College, one of the City Colleges of Chicago, a Hispanic Serving community college, developed a framework that holistically and programmatically support engineering students through admission, transfer, and degree completion (associate and bachelor). This framework resulted in a 75% transfer rate to 4-year engineering programs within two years. The course provides excellent first-year experience, measures belonging and self-efficacy, and tracks the success of engineering students.

The ESS is a three-credit hour seminar incorporating *Introduction to the Engineering Profession*, *College Success*, and *Professional Skills*. The *Introduction to the Engineering Profession* introduces students to engineering skills and ensures the transferability of the course. The *Professional Skills* dimension infuses career-based skills to ensure professional success and increased employability. ESS students learn career and professional skills as early as their first semester at CC. Skills -- including oral and written communication, critical thinking, problem-solving, and teamwork, are incorporated into the curriculum and assessed through resume writing, mock interviews, and project-based learning. Students pitch their projects through pitch competitions, concept paper submissions, and presentations before professional judges. The ESS introduces students to industry roles, project management, and leadership. ESS also incorporates a professional speaker series for networking and mentoring. The *College Success* dimension provides skills on how to navigate college. These skills include but are not limited to time management, financial literacy, wellness, and managing academic load. The College Success dimension also ensures that students know where to find resources. Each dimension incorporates evidence-based practices, woven with diversity and inclusion initiatives. The course culminates with the project competition. We hypothesize that the multidimensional approach to the course will develop belonging to the profession and student success. Belonging to the engineering profession is assessed through a pre-and post-belonging survey. The number of internships attributed to ESS and employers' feedback are also assessed.

Since its inception, six-hundred thirty (630) students have enrolled, six-hundred twenty (620) completed with a 93.2% success rate (students who earned a C or higher). All successful students are retained in the engineering program and graduate or are on track for graduation. Students are also hired for internships while they are still in the class. Industry partners that hire ESS students are impressed with students' professionalism and skills. Through the ESS, Wright College's Engineering Program is slowly breaking through the hiring processes that exclude community college students from internships. Intentional industry partnerships that hired engineering interns from ESS now pilot the "Cohort internship model" or "Cohort Pipeline to Engineering

Workforce." Most interns received return offers while working towards associate and bachelor's degree completion. Most importantly, students who completed the ESS increased their belonging, self-efficacy to the engineering profession, and confidence in their goals.

II. INTRODUCTION

Regardless of academic preparation, many students enroll in college without the strong skills and strategies to navigate higher education effectively [1]. To streamline transitions and bridge the skills gap, first-year experience (FYE) courses, often referred to as college success seminars or freshman seminars, are designed for first-year students in 2-year and 4-year institutions. First-year seminars or experiences are considered one of the high-impact practices (HIPS) [2], and are designed to increase first-year retention. The general goals of first-year experience courses are to support college students' academic performance, social development, persistence, and degree completion. The College Success courses often introduce first-year students to campus resources, time management, study skills, career planning, cultural diversity, and student development issues [1]. The majority of 4-year institutions require first-year courses for credit [4]. However, due to the diversity of FYE design and configuration, research shows mixed results regarding positive outcomes [3]. Zerr and Bjerke [5] compared a three-credit academic-themed first-year seminar with a 2-credit hour orientation and transitioned-themed seminar and found no significant differences regarding retention, academic performance, and social integration. In contrast, Barton and Donahue [6] found that a 4-credit hour transition-themed FYE has significantly higher retention than a 1-credit hour or one-week transition-themed FYE.

The integration of introduction to engineering into a university seminar course has been presented in the past [7]. However, the result was very preliminary, and the number of participants was limited to drive a conclusion. The integration of academic themes with first-year seminars at two-year institutions is uncommon. Although academic-themed FYE courses are implemented at 4-year institutions, FYE programs at two-year institutions vary. Community Colleges (CCs) adopt numerous first-year practices at different degrees - including first-year seminars and shorter first-year experiences such as orientation in the two-year context [8]. CCs often enroll diverse, low-income, first-generation, and underprepared students [9]. Unfortunately, while 80 percent of CC students intend to transfer to complete a bachelor's degree [10], only a fraction succeed. **For the Fall 2015 cohort, the overall transfer rate from CC to baccalaureate institutions is only 31.6%, and 15.5% of all students who start at a Community College complete a bachelor's degree within six years [11].** Creating, implementing, and assessing intentional first-year experience (FYE) at community colleges is critical to improving transfer outcomes.

Wright College, one of the City Colleges of Chicago, a Hispanic Serving community college, developed frameworks that holistically and programmatically support engineering students through admission, transfer, and degree completion (associate and bachelor), resulting in 75% transfer to 4-year engineering programs within two years [12]. This *Complete Evidence-Based Practice Paper* presents a multi-themed, multidimensional First-year seminar approach to increase student belonging, retention, and success in engineering, the Engineering Success Seminar (ESS). The ESS incorporates Tinto's integration Theory [13] into the introduction to the engineering profession, professional skills, and student success. The ESS

provides first-year experiences and measures belonging, career confidence, and self-efficacy (how well one can execute a course of action to deal with a prospective situation) [14–15]. Self-efficacy is known to influence career-related behavior and career choices and has been shown to be helpful for undergraduates in gaining insights into career development in STEM fields. [14,16]. The current paper also presents ESS success in the classroom and its implication with Fall-to-Fall retention.

II.1 Engineering Success Seminar Structure

The ESS is infused with career-based professional skills needed by the workplace, which are usually not emphasized in college. Activities that develop belonging in college and the profession were also added. The ESS presented here is a three-credit hour, 16-week seminar for first-year engineering students. The course is an elective for completing the Associate in Engineering Science degree. The course also replaces the Introduction to Engineering Profession at the transfer institution partner to complete the bachelor's degree requirement. Wright College Engineering requires first-year Engineering Pathway students to take the course. The course guides students to choose a field or pathway at the end of the semester, which is vital to decrease the time to degree completion. Table 1. summarizes the essential ESS components. Assessments and additional components will be discussed in Methods and Results.

Dimensions	FYE theme: Impact	Sample Activities
Introduction to the Engineering Profession	Academic-themed: Credit accumulation, engineering skills, belonging and self-efficacy	Idea Competition Engineering Professional Engineering Profession Speakers, Engineering-road map
Professional Skills	Career: career integration belonging, career confidence, self-efficacy, internship and workforce preparation	Softskills: Pitch, resume, mock interview, Professional branding, communication, teamwork, networking, Industry speakers
College Success	Social integration and student skills: belonging, confidence, self-efficacy	Study skills, financial literacy Time management Resources, etc.

Table 1. A three-credit hour Engineering Success Seminar three dimensions.

As summarized in Table 1, the Engineering Success Seminar incorporates three dimensions into the course: *Introduction to the Engineering Profession,* the *Professional Skills* and the *College Success dimensions*.

II.1.A. The *Introduction to the Engineering Profession* introduces students to engineering fields early. Early exposure to STEM leads to more STEM careers [17], yet most first-generation, low-income, and underrepresented students need access to information to shape STEM experiences [18]. Fifty percent of all Wright College students are undecided without a declared major, and about thirty percent who declared engineering are undecided among engineering fields. In this dimension, students have the opportunity to network with professionals from various engineering fields. The speakers are asked to speak about their field, experiences, and skills needed to succeed in their specific field. This dimension plays a role in aiding students to choose the engineering field they want to pursue. Although there has yet to be a consensus on the impact of

choosing a major early [19-20], choosing an engineering field early at community college helps advisors build study plans early, prevents students from taking courses that will not transfer, and helps students pick their co-curricular and extra-curricular activities. The knowledge provided by speakers will contribute to students making informed decisions when they decide on the field they pursue.

II.1.B. The *Professional Skills* dimension infuses career-based skills to ensure professional success and increased employability. The National Soft Skills Association study found that only 15% of job success is based on technical skills, and the rest are based on soft skills [21]. The ESS students learned career and professional skills as early as their first semester at community college. Skills, including oral and written communication, critical thinking, problem-solving, and teamwork are incorporated into the curriculum and assessed through resume writing, mock interviews, and project-based learning. Students pitch their projects through pitch competitions, concept paper submissions, and presentations before their peers and professionals. In addition, the ESS introduces students to industry roles, project management, and leadership. The professional speakers are also asked to discuss the most important professional/soft skills they need to succeed.

II.1.C. The *College Success* dimension provides skills for navigating college and ensures students know where to find resources. This dimension incorporates time management skills, study skills, finding college resources, financial literacy, wellness, college etiquette, college expectations, and managing academic load.

Each dimension incorporates evidence-based practices woven with diversity and inclusion initiatives. The course culminates with the project competition. Students are also required to write reflections and a roadmap to their careers. We hypothesize that the multidimensional approach to the course will develop belonging to the profession and STEM Efficacy. STEM Efficacy is the students' beliefs about their abilities to perform STEM learning activities [22-23].

II.2. Engineering Speaker Series, Reflection Paper, and Career Roadmap

Every semester, a minimum of 10 professional speakers are invited to speak about the three dimensions through

1. their specific field,
2. the skills to be successful in the field,
3. their story and insights on how to succeed in college, as an engineer, and as a professional for 30-40 minutes.

Questions and answers follow the presentation. The ESS speaker is scheduled at the end of the 3-hour class to provide networking opportunities after the presentation. At the end of the semester, students are asked to pick one or two speakers they can relate to and reflect on their presentation and their story. The reflection paper assesses students' written communication skills and, most importantly, their critical thinking. To synthesize the speaker's story and reflect, filter, and integrate to create their own story, requires critical thinking. Students are also asked to write a career roadmap based on their research, speakers' presentations, and the skills they learned throughout the semester to further enhance their writing skills and showcase an understanding of the various engineering fields. Currently, majority of Engineering Speakers are recruited from former ESS students who successfully transferred, completed their bachelor's degree, and are

now in the field. Speakers are chosen according to their field of work, stories, and careers. For example, two mechanical engineers can speak in the same field if one is pursuing a doctorate and one is working in the industry.

II.3. Industry Partnerships

An *internship* is an experiential learning opportunity that integrates knowledge in the classroom with practical applications [24]. For engineering students, an internship is a transformative period and a gateway to personal and professional growth [25]. Internships are a high-impact practice that builds confidence, improves networking, and develops skills that prepare students for their careers [26-28]. However, some students often lack internships because of socioeconomic status, race, and connections [29-30]. Community college students are disadvantaged as many industries rely on portfolios from selective Research I institutions and rarely hire from community colleges. Industry practitioners are asked to serve as ESS speakers or Idea Project Competition judges. Wright College leverages the ESS Project and students' skills to start the conversation to create intentional partnerships. The ESS serves as an incubator for engineers who have the skills required by industry.

II.4. Projects and Assignments

All projects and activities are designed to enhance any of the three dimensions.

II.4.A. *Resume Writing and Mock Interview*

It usually only takes 6-8 seconds for recruiters to decide whether an applicant will be given an interview or not [31], so the resume must represent the applicant well. However, resumes are not easy to write and are not often taught in engineering classrooms. The ESS provides students with training to write good resumes that will get them the interview. After students complete a resume, students are asked to volunteer for a mock interview in front of the class. The entire class is introduced to the STAR (Situation, Task, Action, Result) method of the behavioral interview [32] and is also given tips on technical interviews.

II.4.B. *Idea Project*

The "Idea Project" is a semester-long project designed to holistically summarize students' semester learning and to expose students to skills necessary for the workplace. The Idea Project is a systems-based project that involves a team of 5-6 ESS students working together as a team from the second week of the project and culminating in a competition at the end of the semester. The Idea Project is designed to develop creative thinking, problem-solving, teamwork, research, and communication skills. The team consists of a team manager, researchers, designer, and speaker who all work together to create a poster/video, prototype, or model. The team presents their idea to a panel of industry, faculty, and staff judges at the end of the semester. The team is given three times to meet during the ESS class but is also required to work outside the class to enhance teamwork and community of practice; CoP (CoP is a group of people who share a concern or passion for something they do) [33]. Students must pitch their ideas by midterm and submit a concept paper for feedback.

II.4.C. *Reflection Paper and Career Road Map* (See II.2)

II.4.D. Others
Other soft skills, such as personal and professional branding, are also integrated into the courses either through lectures, speakers, or the creation of an actual product, such as a LinkedIn profile.

II.5. Assessments and Continuous Improvement
The course success is assessed in several ways (see methods and results III.C/IV.C). The ESS continuously improves based on the students' feedback and the current industries' needs. Continuous improvement is necessary to provide excellent first-year experience to make students feel they belong in college and the profession. The course student learning outcomes have yet to change, but the approaches are continuously modified according to students' suggestions and requests.

III. METHODS

III.1. **Seminar Development**
The Engineer Success Seminar (ESS) combined two Wright College courses: One-credit hour College Success and two-credit hour Engineering Orientation. The resulting ESS is infused with professional skills needed at the workplace and incorporates practices that make students feel they belong in college and the profession. The author combined the two courses and shared the syllabus with 4-year transfer partners to ensure the transferability of the course. After the input from the transfer institution, the ESS was submitted to the Wright College curriculum approval process and was approved by the Illinois Community College Board.

III.2. **Implementation**
A three-hour class is offered once a week, with one lead instructor, ESS faculty and professional mentors, and several teaching assistants. The course is designed for face-to-face implementation, but it had to switch to remote synchronous in the Fall of 2020 and face-to-face/synchronous in the Fall of 2021. In the fall of 2018, 2022, and 2023, implementations were face-to-face. The speakers' topics are aligned with the ESS dimensions and the engineering fields. All projects and activities, including the Idea Project Competitions, are designed to increase belonging, self-efficacy, and confidence in the engineering field.

III.3. **Assessment**

III.3.A. Course rubrics
There is no quiz or exam for the class. Students are graded based on participation, projects, and assignments. At the end of the course, students have their resumes polished for application, and students are ready for the interview. A professionally crafted LinkedIn profile is also proof of course success. Student's reflection on their learning and a career road map contributes to the student's grades. The Idea Project equates to 40% of the student's final grade. All activities for the semester are given points that total 100%. There is no curve in the class, but students can discuss their grades. Students are provided letter grades, A-F, according to Wright College Policy. Projects and activities are summarized in Table 2.

III.3.B. Belonging, Confidence and Self-efficacy Survey.
The ESS is one of the components of the NSF Building Bridge Project, "the Bridges" provided to Wright College Engineering Program. The Bridges Project assesses belonging and self-efficacy's impact using the "Belongingness" within Lave and Wenger's Communities of Practice and Bandura's self-efficacy [14] concepts. The ESS belonging, confidence and self-efficacy survey was derived from the Belonging and Self-efficacy survey designed by MUSE Consulting, LLC and Ruxton Research, LLC. (IV.4.)

A 12-question Likert Scale (strongly disagree, slightly disagree, neutral, slightly agree, strongly agree) pre-survey was administered to all ESS students on the first day of the course. The same survey with additional questions was administered at the end of the class. The 12-question survey can be grouped into three general categories: Self-efficacy, Confidence, and Belonging.

Pre-Survey

Self Efficacy	Confidence on the major choice	Belonging
(1) I know my career goals very well.	(7) I feel that I have a good grasp of the range of jobs I will be qualified for when I am finished with my degree.	(9) I feel like I belong to the larger community of "college students", not just at Wright College, but across the country.
(2) I am100% sure of my major and I will not be influenced by anyone.		
(3) I feel that I will be able to achieve most of my goals that I have set for myself.		
(4) I feel that when facing difficult tasks, I am certain that I will accomplish them.	(8) I feel that in terms of understanding all Engineering fields, I have the understanding of what each do.	(10) I feel like I belong to the community of Wright College
(5) I feel that I can succeed at most of my endeavor to which I set my mind into.		(11) I feel like I belong to the community of Wright College engineering students
(6) I feel that even when things are tough, I can perform well.		(12) I feel like I belong to the community of future engineers.

Table 2. Self-Efficacy, Career choice Confidence and Belonging questions.

Post-Survey: Pre-survey plus

1. What were the most impactful elements of the Engineering Success Seminar? What did you learn the most from?
2. What Professional skills did you learn, and will apply?

III.3.C. Qualitative outcomes from students, judges, and employers
Student's qualitative perceptions of the course are assessed through their reflection paper, and the quality of student's projects is assessed through judges' feedback. The employers' feedback on students' resumes and student employment due to their attendance in ESS is also tracked.

III.4. **Analysis**

III.4.A. Course performance

The course was piloted in 2016 with only 23 students.

Significant changes in the course structure were implemented in 2018, and the data presented for the analysis only includes the 2018-2023 implementation. Students' persistence rate (total students counted by the drop STAT date - student or administrative withdrawal/total enrollment at the STAT date x 100) and student grades are presented.

III.4.B. Belonging, Confidence and Self-Efficacy

All analyses are performed using Excel 2016 on Office 365.

The Likert scale data was coded as follows: 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree, and a t-test was used to analyze the variance. Students' GPAs are analyzed for the entire population; in this case, the impact of remote implementation was not accounted for.

IV. RESULTS and DISCUSSION

For the past six years (2018-2023), the ESS has only been offered in the fall because most first-year students who intend to major in engineering start in the fall. As the Wright College Engineering Program grows, the number of first-year students also increases, and there is a need to offer the ESS in Spring. The data presented in this paper is exclusive of Fall data.

IV.1. **Enrollment**

As shown in Table 3, the Engineering Success Seminar was implemented through different modalities. Because the difference in persistence rate between modalities is marginal, the modalities of course implementation were not accounted for in the analysis of 6 years data. The authors recognized a slight decrease in the persistence rate for Fall 2020 and 2021 implementation, but the number remains too low to be considered significant. It is important to note that to achieve consistent outcomes, additional interventions, including longer office hours and a virtual engineering center, have to be available for the students to facilitate belonging and compensate for the remote implementation. For the Engineering Success Seminar that fosters a lot of team interaction and belonging, the Face-to-Face implementation is preferred.

Fall	Mode of Instruction	Enrollment (STAT* date)	ADW/WTH	Persistence rate (%)
2018	F2F	52	1	98.0%
2019	F2F	54	2	96.3%
2020	Synch	87	2	97.7%
2021	Synch/F2F	105	3	97.1%
2022	F2F	157	1	99.4%
2023	F2F	174	1	99.4%
Total		630	10	98.4%

Table 3. Summary of ESS enrollment, modality, and persistence rate.

The Engineering Success Seminar is the only course at Wright College that allows enrollment above 29 and yet retains students at a very high rate. The ESS is also the only class that teaches three dimensions that prepare students for workforce leadership as early as they join college.

IV.2. **Demographics**

Table 4. shows the five-year Wright College demographic data. Wright College serves a diverse population of students. The Engineering Success Seminar student's racial/ethnic demographic is even more diverse, with 11.8% Black and 15.3% Asian, compared to an average of 7.0% Black at Wright College, **Figure 1**. The ESS female students are only at 20.3 % in contrast with the Wright College population of more than half female. Although fewer female students are in ESS than Wright College, 20.3% is higher than the national average of 15% [34]. The higher female population of Wright College also serves as an opportunity for Engineering.

Race/Ethnicity	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Hispanic	59.17	59.30	58.16	58.80	59.16
White	22.63	22.25	22.88	21.70	20.77
Asian	7.62	8.06	8.56	8.85	8.84
Black	7.05	6.52	6.88	7.21	7.75
Other	3.22	3.36	3.52	3.43	3.44
Gender/Identity					
Female	54.21	54.24	57.21	54.36	53.24
Male	45.58	45.59	42.68	45.26	46.66
Others	0.21	0.17	0.10	0.15	0.10

Table 4. Wright College overall student demographics.

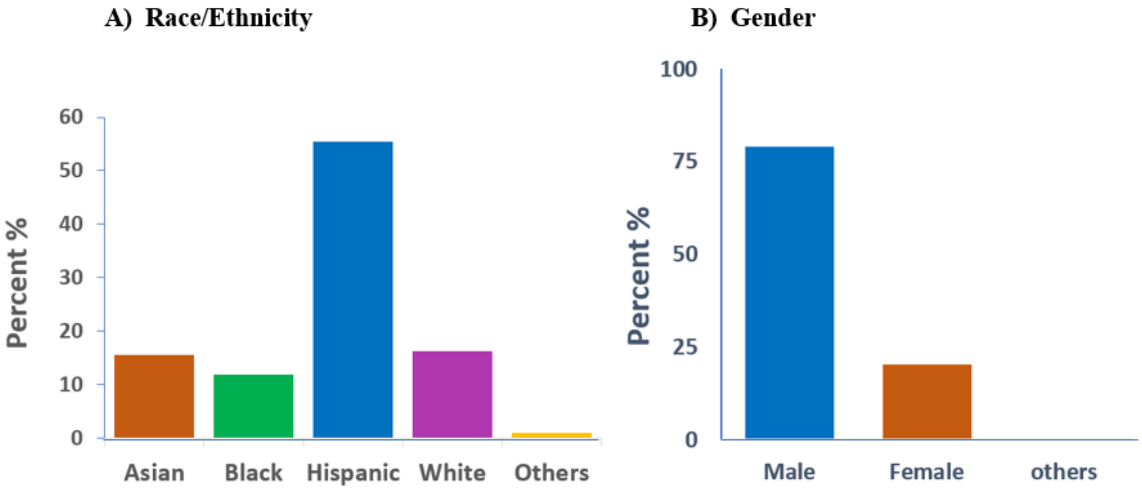

Figure 1. ESS (2018-2022) students demographics. Race/Ethnicity (Asian:15.6%, Black: 11.8%, Hispanic: 55.3%, White: 16.2%, others (American Indian and others: 1%), Gender Identity (Male: 79.1%, Female: 20.4% and others: 0.54%).

Although the Engineering Program mimics the Wright College population, the engineering student success rate is significantly higher. This can be attributed partly to the ESS and the holistic and programmatic approach to supporting students. Figure 2 summarizes the retention, completion,

and transfer rate of AY 2020-2021. This cohort was selected because of the length of time to track students longitudinally. This was also a cohort during COVID-19. This outcome shows that the ESS and the holistic and programmatic approach negate the impact of the pandemic

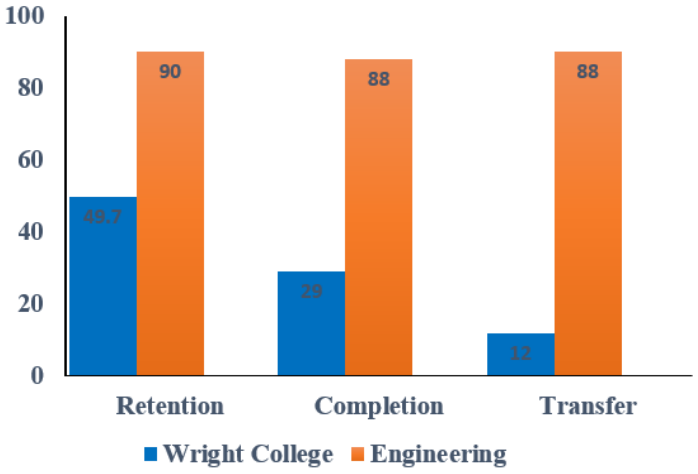

Figure 2. Wright College and Engineering Program retention, completion and transfer rate after 2-3 years of initial enrollment.

IV.3. **ESS Students' Success**

The Engineering Success Seminar is a three-credit hour that transfers as a three-credit to 4-year transfer partners. The grade in ESS is important for credit accumulation at Wright College to satisfy the AES degree and the bachelor's degree requirement at the transfer institution. All Engineering Pathway students are required to take the ESS in their first year. This is to allow first-year students to make informed decisions on their major. The college success component is also very important to learn early. The ESS final grade is from all ESS activities, including assignments (resume, professional profile, etc.), Idea projects (final competition, pitch, concept paper, teamwork grade), participation (class discussions, attendance, networking with speakers), and career road map (course reflection and career road map) accumulated throughout 16 weeks. Table 5 summarizes the overall grade distribution. As shown in Table 2, of the 630 students who initially enrolled in ESS, 98.4% (620 students) persisted and completed the course.

Grades	A	B	C	D/F	WTH
# students (630)	449	71	58	42	10
% student (630)	71.3	11.3	9.2	6.6	1.6

Table 5. Overall ESS Grade distribution (2018-2022)

All students who scored As, Bs, and Cs in the Fall semester Engineering Success Seminar are retained in the following Spring, and they are retained in the Wright College Engineering Program. The Wright College Engineering Program averages a 93% Fall to Fall retention and a transfer rate of 75-88% within 2-3 years from initial enrollment. The Wright Engineering Program outcomes align with ESS outcomes. However, longitudinal data has to be analyzed to ensure correct correlation and to verify the assumptions.

IV.4. **Self-Efficacy, Confidence, Belonging Outcomes**

Students who responded to pre-survey and did not respond to the post-survey were removed from the analysis. Table 6 shows that all ESS students who completed the pre- and post-survey, regardless of racial or gender identity, increased their sense of belonging after 16 weeks of ESS implementation. Student responses to question (1) shows that the Engineering Success seminar also significantly increases students' knowledge of their engineering career goals. Although there is a slight increase in students' self-efficacy in questions (3-6), the increase is not statistically significant.

	Total Respondents (560)			Total Male (443)			Total Female (114)		
Question	Pre	Post	*p* value	Pre	Post	*p* value	Pre	Post	*p* value
(1)	3.56	3.9	<0.0001	3.56	4.0	<0.0001	3.56	3.91	<0.0001
(2)	3.7	3.9	0.008	3.7	3.9	0.02	3.7	4.07	0.008
(3)	4.1	4.2	0.17	4.1	4.2	0.17	4.1	4.3	0.04
(4)	4.0	4.2	0.02	4.08	4.22	0.09	4	4.2	0.081
(5)	4.25	4.3	0.6	4.25	4.33	0.6	4.25	4.37	0.09
(6)	4	4.15	0.28	4.08	4.14	0.4	4	4.2	0.37
(7)	3.3	4.01	<0.0001	3.46	3.98	<0.0001	3.3	4.1	<0.0001
(8)	3.15	4.13	<0.0001	3.125	4.1	<0.0001	3.125	4.44	<0.0001
(9)	3.65	3.96	<0.0001	3.65	3.92	<0.0001	3.65	4.14	<0.0001
(10)	4	4.27	<0.0001	4	4.18	0.03	4	4.55	<0.0001
(11)	4.1	4.38	<0.0001	4.1	4.35	0.001	4.1	4.5	<0.0001
(12)	4.04	4.24	0.001	4.04	4.25	0.013	4.04	4.27	<0.0001

Table 6. Overall Self-Efficacy, career confidence and belonging outcomes disaggregated according to gender identity. Only three (3) participants respond as others.

The most consistent impact of the ESS is increasing students' confidence in their career choices and their knowledge of engineering jobs. The overall population, regardless of gender, increased confidence significantly in questions (7) and (8). Students feel that they have a good grasp of their job when they finish their degree (7), and students develop an understanding of what each field does after the course (8). Interestingly, female students increased their knowledge of the engineering discipline more than males, question (8) (3.125 to 4.44 for females) vs (3.125 to 4.1 for males). This data could provide insights into why there are fewer females in the engineering discipline, and this could open the possibility for more targeted research and intervention to increase the number of women in engineering. The increased knowledge in engineering careers could also be attributed to students changing their engineering field of choice. Approximately 30% of ESS students changed their engineering field pre-ESS. Most changes are influenced by their new knowledge of the discipline through lectures and speakers. Questions (9), (10), and

(11) show that although the ESS increased the belonging of male students, female students feel they belong more in the Wright College community, the Wright College engineering community, and engineering community in the country.

When the pre-and post-survey results were disaggregated by race/ethnicity; Hispanic and Black ESS students showed an even greater increase in belonging to the Wright College community (question 10), Wright College engineering community (question11), and they can see themselves as future engineers (question 12) than White ESS students. Regardless of race, ethnicity, or gender background, Table 6 and Table 7 show that the Engineering Success Seminar increased students' knowledge of the engineering field and confidence in their engineering qualifications, and the course contributes to ESS students' engineering goals. These results mimic the students' road map and the reflection paper outcomes.

Question	Asian			Black			Hispanic			White		
	Pre	Post	*p* value	Pre	Post	*p* value	Pre	Post	*p* value	Pre	Post	*p* value
(1)	3.58	4.11	0.0009	3.5	4.09	0.002	3.58	3.875	0.0009	3.4	3.8	0.01
(2)	3.7	3.95	0.01	3.7	4.18	0.5	3.7	3.92	0.08	3.7	3.8	0.66
(3)	4.1	4.33	0.06	4.2	4.18	0.9	4.07	4.14	0.35	4.3	4.2	0.49
(4)	4	4.21	0.11	4	4.38	0.006	4.09	4.15	0.466	4.23	4.28	0.76
(5)	4.25	4.33	0.38	4.3	4.5	0.18	4.23	4.26	0.65	4.35	4.28	0.37
(6)	4	4.15	0.75	4	4.2	0.86	4.09	4.08	0.94	4.22	4.2	0.88
(7)	3.3	4.01	0.004	3.6	4.18	0.003	3.48	3.96	<0.00001	3.54	4.11	0.002
(8)	3.125	4.13	0.0006	3.03	4	0.0002	3.13	4.117	<0.00001	3.33	4.24	0.00007
(9)	3.65	3.96	0.18	3.66	3.78	0.57	3.69	4.09	0.0001	3.75	3.8	0.6
(10)	4	4.27	0.03	3.98	4.25	0.015	4.02	4.29	0.003	4.04	4.17	0.5
(11)	4.1	4.3	0.06	4.15	4.5	0.04	4.12	4.43	0.001	4.08	4.28	0.3
(12)	4.04	4.24	0.1	4.11	4.4	0.04	4.03	4.23	0.03	4.14	4.28	0.47

Table 7. Self-Efficacy, career confidence and belonging outcomes disaggregated by race or ethnicity. Only four indigenous students took the pre-and post-survey and statistically negligible.

IV.4. **Qualitative Results and Other ESS Impacts**

Through the additional post-survey questions, students identified several ESS components that are impactful to their learning. The consolidated results show that the Idea Project, speakers, group discussion/teamwork activities, and soft skill lectures are very impactful. Students also believed that they learned and will use communication, both oral and written, networking, teamwork, problem-solving, critical thinking, and interview skills. The Reflection and the Career Road Map papers affirm the pre- and post-survey results. These activities provided a wealth of data regarding first-year experience and helped identify factors valuable for first-year engineering students.

The Idea Project tops the list of impactful activities because ESS students find friends and community to solve problems. The Idea Project makes students feel they belong, consistent with the increase in belonging in the pre- and post-survey. The Idea Project is really important for first-year students, especially at commuter schools such as community colleges, where finding a

community is difficult. In addition, ESS students unanimously agreed that the speaker series provided them with valuable tips to succeed as engineers and helped them identify their major. Students also take advantage of the speakers to network, which further contributes to students belonging to the engineering profession. For example, at the end of the Fall 2019 semester, ESS speaker A mentored Student A. Speaker A assisted ESS Student A with resume and interview processes and provided career tips. Student A was a first-generation high school dropout before joining the ESS. She joined the ESS right after she completed her GED without knowing what field to pursue. Student A found a mentor through the ESS. Student A transferred, completed a bachelor's degree in engineering within 4.5 years and now works as an engineer. The multidimensional ESS approach transformed ESS Student A's life.

Approximately thirty percent (30%) of students declare a major or change engineering major during or after the seminar. Declaring a major early is important because students who are undeclared or change their majors will have taken more courses, often leading to an additional one or two years of college [35] and increasing higher Education costs [36]. All students feel they know their career goals and are confident about what engineers do after the Engineering Success Seminar, Table 6 and Table 7, questions (1), (7), and (8). Most of the time, the new engineering field ESS students reflect upon and wrote about in the Career Road Map paper became the engineering field they pursue for a bachelor's degree. For example, a Fall 2019 student, Student B, thought he wanted to be an electrical engineer because he was an electrician. After taking the ESS, student B decided to be a mechanical engineer. He could have taken additional courses that would not satisfy his mechanical engineering degree. Student B transferred to a 4-year after two years at Wright College, completed his bachelor's in Mechanical Engineering after two years, and is currently working at his dream company as a Systems Engineer. Students also used the Career Road Map paper for scholarship and transfer applications. The multidimensional approach helped Student B succeed in 4 years.

IV.5. **Industry Participation and Internships**

Industry and research professionals serve as speakers and judges for the Idea Project for the ESS. Professional speakers provide tips on skills needed by the industry. Speakers also provide a network to ESS students. Professional engagement in the ESS provides endorsement and opportunities for internships. Since students are prepared for interviews, they often send their applications while they are still attending the ESS. In the Summer of 2023, 70 ESS students participated in either research or industry internships. Most students were offered internship opportunities while still attending the ESS. Employer feedback is also assessed after the internship to improve the professional component of ESS further. The exemplary performance of ESS students, especially in professional skills, results in more internships. Students being hired as interns from a community college in the first year is one of the biggest impacts of ESS, especially since many industries rarely hire from community colleges. Wright College leverages the ESS Project and students' skills to start the conversation to create intentional partnerships. The ESS serves as an incubator for engineers who have the skills required by industry. The success of ESS students hired as interns precipitated the creation of a cohort model internship with Wright College and some industry partners. One prestigious Company A partnered with Wright Engineering and piloted a cohort internship model (CIM) hiring ESS students in 2023. Three students were initially hired. The interns' supervisors were very impressed with the students' professionalism and skills, resulting in all interns of the pilot cohort receiving return

offers. Company A hires three more interns for summer 2024 for a total of six interns. Another employer, Company B, is adopting the cohort model internship for summer 2024. Through the ESS, Wright College's Engineering Program is slowly breaking through the hiring processes that exclude community college students from internships. Industry partners are intentionally collaborating with Wright College to further develop the cohort pipeline to jobs by hiring first-year students for ESS and providing them return offers until they transfer and complete their bachelor's degree and potential full-time job after bachelor's degree completion.

V. SUMMARY AND IMPACTS

The Engineering Success Seminar (ESS) provides a multidimensional approach to providing excellent first-year experience for engineering students at Wright College. The main goal is to increase belonging to engineering and increase retention and success in the engineering field. After six years of implementation and 630 participants, the ESS is showing positive impacts in belonging, student confidence in their fields of study, retention, and student success.
The impact on belonging is even more evident with female students. If the ESS multidimensional approach is replicated, this could increase the number of women in engineering. The ESS approach retained students and prepared them to be professional. This evidence-based practice could assist and guide institutions, especially community colleges, to increase retention, belonging, and student success, especially for female and underrepresented groups in engineering.

VI. FUTURE WORK

The current paper presents fall-to-fall retention, completion, and transfer rates of Engineering students.

Although Wright College Engineering students must take the ESS, longitudinal tracking needs to be done for ESS students for better correlation. The researchers will track ESS completers.
The results of the current cohort internship model will be assessed and improved to increase partnerships and even increase opportunities. The impact of ESS will also be correlated with students' employment by assessing employers' perceptions of students' professional skills, especially those who were hired as interns after taking the course. A comparative study between Engineering students who completed the ESS and Wright College students who did not attend ESS will be compared with respect to retention, internships, and employability. ESS will also be offered in the Spring. The Fall ESS will be compared with the Spring ESS to see the difference between students who start their first year in the fall versus spring entry.

Speakers' and employers' support is integral to the Engineering Success Seminar's successful implementation. Speakers' feedback will be assessed.

VII. ACKNOWLEDGMENT

This material is based upon work supported by the National Science Foundation under Grant No. DUE-1832553. Any opinions, findings, 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. The PI especially acknowledges the late Melissa Mercer-Tachick, President and Lead Consultant of MUSE Educational Consulting. Melissa designed, meticulously administered, and analyzed the survey and case study interview. Her contribution, collaboration, and feedback contributed positively to the development and implementation of the project. The author also acknowledges Megan Ruxton of Ruxton Research, LLC and Solaris Research for the survey. The author especially acknowledged, Bridget O'Connell, Associate Dean of the Center of Excellence for Engineering and Computer Science. Bridget, helped a great deal especially on the internship aspect of the Engineering Success Seminar since 2021. Bridget also pulled the assessment data for this paper. The author acknowledges the judges, the speakers, and all who contributed to the success of the ESS course especially Ruzica Todorovic for also helping students with their idea and reviewing students' posters. The author would also acknowledge the speakers and the judges of the Engineering Competition. Approved by the City Colleges of Chicago District IRB protocol IRB2018007.

REFERENCES

[1] WWC Intervention Report. (2016, July. [Online] Available:https://ies.ed.gov/ncee/wwc/Docs/InterventionReports/wwc_firstyear_071916.pdf. [Accessed on: Jan 15, 2024]

[2] G.D. Kuh, High-impact educational practices: What they are, who has access to them, and why they matter. Association of American Colleges and Universities. 2008.

[3] L.M. Boettler, R.A. Goldfine, D.W. Leech, and G.R. Siegrist, Academic Skills, Community Engaged, Leadership, and Global Themed First-Year Seminars: Comparisons in Student Success. *Journal of College Student Retention: Research, Theory & Practice*, *24*(1), 213-233. 2022. https://doi.org/10.1177/1521025120912696.

[4] D.G. Young and J.M. Hopp, 2012-2013 National survey of first-year seminars: Exploring high-impact practices in the first college year (Research report No. 4). Columbia: University of South Carolina, National Resource Center for The Freshman Year Experience. 2014.

[5] R.J. Zerr and E.Bjerke, Using multiple sources of data to gauge outcome differences between academic-themed and transition-themed first-year seminars. *Journal of College Student Retention: Research, Theory and Practice*, 18(1), 68-82. 2016. https://doi.org/10.1177/1521025115579673.

[6] A. Barton and C. Donahue, Multiple assessments of a first-year seminar pilot. The Journal of General Education, 58(4), 259–278. 2009.

[7] K.G. Talley, A. Martinez Ortiz, C. Novoa and V. Sriraman, Integrating an Introduction to Engineering Experience into a University Seminar Course. American Society for Engineering Education. 2016.

[8] Center for Community College Student Engagement, "A Matter of Degrees: Practice to Pathways – High Impact Practices for Community College Student Success", Austin, TX: The University of Texas at Austin, Program in Higher Education. 2014.

[9] J. Goodman, M. Hurwitz and J. Smith, College Access, Initial College Choice and Degree Completion. Journal of Labor Economics *35, no. 3: 829-867.* 2017.

[10] "Community College Transfer", 2021. [Online]. Available:https://ccrc.tc.columbia.edu/publications/community-college-transfer.html. [Accessed on Jan 21, 2024].

[11] D. Shapiro, A. Dundar, F. Huie, P.K. Wakhungu, X., Yuan, A. Nathan and Y. Hwang, Tracking Transfer, Update for the Fall 2015 Cohort, N.S.C.H.R. Center, Editor. 2022: Herndon, VA. 2022.

[12] D.J. Espiritu, R. Todorovic and N. DePaola Revolutionizing transfer: A Novel and Holistic Programmatic Model that Eliminated the Visible and Invisible Barriers to Student Success. In 2021 ASEE Virtual Annual Conference. https://peer.asee.org/37688. 2021.

[13] M.E. Samoila and T.- Vrabie, First-ear seminars through the lens of Vincent Tinto's theories of student departure. A Systemic review. Front. Educ. Sec. Higher Education Vol 8. 2023. https://dpi.org/10.3389/feduc.2023.1205667.

[14] A. Bandura, "Self-efficacy Mechanism in Human Agency", American Psychologist, vol. 37, no. 2, p. 122–147. 1982.

[15] P. McClure and A. Rodriguez, 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, New York, NY: The Coalition for Science After School.2007.

[16] J. Ma, Pender, M.; Welch, M., (2016). Education Pays 2016: The Benefits of Higher Education for Individuals and Society. *The College Board.*

[17] CSO – STEM Exploration Experience for Kids (SEEK). 2022. Vanderbilt University. [Online] Available https://vupace.vanderbilt.edu/public/category/programStream.do?method=load&selectedProgramAreaId=1317740&selectedProgramStreamId=1317753 [Accessed on Feb 1, 2024].

[18] N.A. Fouad and M.C. Santana, SCCT and underrepresented populations in STEM fields: Moving the needle. Journal of Career Assessment, 25(1), 24–39. 2017.

[19] D.B. Spight, Early Declaration of a College Major and Its Relationship to Persistence. NACADA Journal Volume 40(1). 2020.

[20]. K. Mangan, Texas takes steps to streamline the path to a college degree. The Chronicle of Higher Education. 2011. [Accessed from http://chronicle.com/article/Texas-TakesSteps-to/128404/].

[21] "The Value of Soft Skills in the Labor Market",(2017. [Online]. Available https://www.nationalsoftskills.org/the-value-of-soft-skills-in-the-labor-market/ Accessed on: Jan 28, 2024.

[22] T. Luo, W.W.M. So, Z.H. Wan, and W.C. Li, STEM Stereotypes Predict Students' STEM Career Interest Via Self-Efficacy and Outcome Expectations, International Journal of STEM Education, vol. 8, no. 1, 2021. doi: 10.1186/s40594-021-00295-7.

[23] J. Han, T. Kelly and J.G. Knowles. Factors Influencing Student STEM Learning: Self-Efficacy and Outcome Expectancy, 21st Century Skills, and Career Awareness. Journal for STEM Educ Res 4, 117–137. 2021. https://doi.org/10.1007/s41979-021-00053-3

[24] A. Liu, S. Toma, M. Levis-Fitzgerald, and A.A. Russell, A. A. (2020). The Role of a Summer Field Experience in Fostering STEM students' Socioemotional Perceptions and Social Justice Awareness as Preparation for a Science Teaching Career. Berkeley Review of Education, 9(2). 2020. https://doi.org/10.5070/B89244648

[25] R. David, 2023. The Importance of Internships for Engineering Students. [Online]. Available: https://chipedge.com/the-importance-of-internship-for-engineering-students/ Accessed on: Jan 28, 2024.

[26] L. Berry and J. C Sweeney (2019). The impact of internships on students' academic, personal, and professional outcomes. Journal of Marketing Education, 41(3), 149-163. 2019.

[27] K.P. Green and P.C. Green (2017). Exploring internship outcomes: Implications for community college students. Community College Review, 45(2), 108-129. 2017.

[28] E.T. Pascarella, C. T. Pierson, G.C. Wolniak and P.T. Terenzini, P. T. . First-generation college students: Additional evidence on college experiences and outcomes. The Journal of Higher Education, 75(3), 249-284. 2004.

[29]. Pager, D., & Shepherd, H. (2008). The Sociology of Discrimination: Racial Discrimination in Employment, Housing, Credit, and Consumer Markets. Annual Review of Sociology, 34, 181-209. 2008.

[30] E.J, Allen and S. B. Robbins, Enhancing academic performance and college persistence among community college students. Journal of College Student Development, 49(5), 387-405. 2008.

[31]. R. O'Donnell, "Eye Tracking Study Shows Recruiters Look at Resumes for 7 Seconds". [Online]. Available: https://www.hrdive.com/news/eye-tracking-study-shows-recruiters-look-at-resumes-for-7-seconds/541582/ Accessed on Jan 28, 2024.

[32]. K Boogard. The STAR Methods Is the Secret to Acing Your Next Job Interview.]. [Online]. Available: https://www.themuse.com/advice/star-interview-method. Accessed on Feb 1, 2024.

[33] E. Wegner. Communities of Practice: Learning, Meaning, and Identity. Cambridge University Press, Cambridge. 1998.

[34] K. Evans. Women in Engineering Statistics: 32 Notable Facts. [Online]. Available: https://www.fictiv.com/articles/women-in-engineering-statistics-32-notable-facts#:~:text=By%202019%2C%20women%20represented%2048,1970%20to%2027%25%20in%202019. Accessed on Feb 1, 2024.

[35] R. Ellison How Choosing the Right Major can Lead to More Success and Less College Debt. [Online]. Available https://www.forbes.com/sites/forbescoachescouncil/2019/12/26/how-choosing-the-right-major-can-lead-to-more-success-and-less-college-debt/?sh=10330946a83e [Accessed on Feb 2, 2024].

[36] New Survey: Student Confusion Selecting Majors Increases Higher Education Cost and Time to Earn Degree (2019, July). [Online]. Available:https://www.businesswire.com/news/home/20191014005009/en/New-Survey-Student-Confusion-Selecting-Majors-Increases-Higher-Education-Cost-and-Time-to-Earn-Degree Accessed on Feb 5, 2024.