

Engineering Living Learning Community Experience: A Model for Improving First-Year Retention and Academic Performance of Black Students

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A. Introduction

The concept of faculty and students living and learning together has historical roots in early universities [1]. The resurgence of this idea in modern times began during the late 1990s resulting in Living Learning Communities (LLCs), wherein students live on the same floor of a residence hall and share common courses and/or social structures with the ultimate goal of creating a shared community that gives participants a sense of belonging at the university or within specific disciplines [1]. Inkelas and her colleagues [1] conducted a survey of LLCs in the United States and estimated that there are more than 600 LLCs on college campuses across the nation. According to these authors, LLCs are most successful when they have a strong infrastructure foundation (e.g., goals/objectives, collaboration between academic affairs and student affairs, and adequate resources), as well as a supportive academic (e.g., common courses, faculty advising, academically supportive climate) and co-curricular (e.g., study groups, social activities, career workshops) environment. The pinnacle of the best practices is an integration of these various layers and an assessment plan that allows practitioners to make changes.

There are two types of research that has been conducted on LLCs: those that compare across multiple programs and those that focus on one particular program. Research comparing LLCs across programs have shown that they can have a positive impact on first-generation participants' transitions to college [2]; increased sense of belonging in their college [3]; and increased openness to diverse ways of thinking [4]. LLC research focusing on individual STEM LLC programs have demonstrated the important role that having a near peer mentor and peers going through the same struggles within their major has on women's persistence in STEM disciplines [5,6,7].

Historically Black Colleges/Universities (HBCUs) make up about 3% of colleges and universities in the United States [8]. However in 2016, they produced almost 15% of the total bachelor's degrees awarded to African-Americans [9]. Moreover, HBCUs produced 16% of the African-American students with bachelor's degrees in STEM fields and nearly 17% of the Black engineers [9]. Pair the graduation statistics with a Purdue-Gallup Index study that discovered black graduates of HBCUs are more likely to have felt supported while they were in college than a black graduate from another type of institution [10]. This knowledge lead Seymour and colleagues to state, "their overall success in providing black graduates with a better college experience than they would get at non-HBCUs needs to be examined more closely, and potentially modeled, at other institutions [11]."

There are studies that show that LLCs can have a positive impact on participants, but few are focused on black students and even less at an HBCU. Consequently, this research highlights the

lack of understanding of the impact of an LLC on underrepresented minority engineering students. This study will focus on students who participate in an Engineering LLC held at a Historically Black College and University (HBCU) to determine the impact of the program on their persistence. Also, providing an insight for Predominantly White Institutions (PWIs) and other institutions to learn and model.

B. Overview

In 2015, Florida A&M University (FAMU) introduced five (5) campus-wide living-learning communities in the newly built FAMU Village residential hall. One of those was the Science, Technology, Engineering and Mathematics (STEM) LLC. Initially, the STEM LLC was comprised of three different cohorts, which included engineering, biology, and chemistry/computer science. The engineering cohort consisted of 20 students living on the same floor of FAMU Village. However, after two years, an independent Engineering LLC was established, because of diverging policies, procedures and objectives for the two colleges. The primary purpose of the Engineering LLC is to facilitate engagement with fellow students and faculty in order to foster a sense of community. Furthermore, the student support program is for first-time-in-college (FTIC) freshmen to assist with their transition from high school to college, while fostering a safe space that is a physical space providing social and emotional safety. Ultimately, creating a safe environment that includes support structures that aim to retain students in engineering, heighten their interest in engineering, and provide the tools necessary to excel in college to create a diverse STEM workforce.

The main goals of the FAMU Engineering Living Learning Community are to

1. Have students successfully complete the pre-engineering curriculum
2. Assist with first-year retention and equip students with knowledge to persist in engineering
3. Build community with a diverse profile of engineering students
4. Incorporate professional development to ensure the scholars are ready for the STEM workforce
5. Develop students' character and accountability
6. Impart a sense of pride and confidence to create an engineering identity

Components of the Engineering LLC

The FAMU-FSU College of Engineering is a joint engineering college, between a historically black university, FAMU, and a research 1 doctoral university, Florida State University (FSU). FAMU has a disproportionally lower engineering student enrollment than FSU at the college. As such in 2014, there was a push by the engineering dean to determine a way to increase the population of FAMU engineering students through recruitment and retention. The following year, the Engineering Living Learning Community (LLC) was established to serve approximately 25% of the incoming FAMU freshman engineering students. The cohorts are

created by placing students in the same STEM courses, program seminars, study sessions, and activities. The Engineering LLC is led by a faculty liaison, who also served as the First Year Engineering Lab instructor up until 2018. Additionally, there are learning assistants, who are upper-level college students that assist with the Engineering LLC scholars' needs, such as academic development, academic issues, and personal life. These components together create a safe space for the students to succeed at the college.

Student Selection

Unlike some student support programs for underrepresented students, this program was not limited to just students with a preparation gap or the exceptional students that were "engineering ready," which is starting their math curriculum in Calculus I. The Engineering LLC program purposefully is a mixture of both types of students, which allows for an inclusive environment. The decision creates a larger potential pool of applicants instead of eliminating any particular groups. Additionally, the diverse pool allows student's best skills to assist other students in the program, instead of being limited to one type. As evident in Table 1, the student demographics are easy to model and replicate at other universities to set the stage for an inclusive student support program.

Before each academic year, multiple virtual meetings occur after a student is admitted into FAMU, but before they are selected for the program. This is an opportunity for prospective students and parents to learn about the Engineering LLC and ask questions about the program and application process. The requirements for entry into the Engineering LLC is an application that includes an essay. The students are reviewed not just on academics and/or test scores but also on their motivations for joining the Engineering LLC. Students answer the below prompts about themselves to ensure an inclusive application process that focuses on the whole student, not just their academics.

Essay Prompts in Application
Why are you interested in an engineering degree and your plans once you earn that engineering degree?
Please explain why you would be a good addition and/or would add value to the Engineering LLC.

The faculty liaison evaluates the application to ensure a spread of students academically, state residency, and gender. This ensures that there is not just one type of student, which achieves the goals of the program. FAMU is an HBCU, so most of the students in the Engineering LLC program are Black/African-American. Additionally, the historic nature of an HBCU creates an environment that generations of African-Americans have attended the university since the late 1800s. This usually results in a lower percentage of first-generation students.

Program Elements

The Engineering LLC program spans the fall and spring semesters of the freshman academic year. In addition to the students living on the same floor of the residential hall, there are program elements that bind the students as a cohort. All of these were selected to help achieve the goals of the program.

- a. *First Year Engineering Lab*: The First-Year Engineering Lab (FYEL) provides an introduction and overview of the study and practice of all the engineering disciplines offered at the FAMU- FSU College of Engineering. Students are introduced to success strategies, including time management, study skills, learning styles, and test-taking strategies. There are engineering projects designed to motivate students to become active learners, responsible students, and ethical engineering professionals. Each student will learn what to expect from his/her studies as an engineering major. All Engineering LLC scholars are enrolled in the same section that includes students in the general FAMU and FSU population. From 2015-2018, the students were enrolled in the faculty liaison's section of the course. This allowed students to interact with the faculty in a formal academic setting, as well as the informal academic setting during the Engineering LLC programming.
- b. *Math Courses*: All FTIC students at FAMU must take the ALEKS math assessment. The assessment determines the math course students take in their first semester, unless they have dual enrollment and/or AP credit. Based on their ALEKS scores or credit, students are placed into either College Algebra (30-60), Trigonometry (61-75), Calculus I (76-100) class. Engineering LLC scholars are placed into a section of their respective assigned courses together, so they can form study groups and a shared sense of experience within these math courses. The class is open to the general FAMU population. The Engineering LLC students are a subset of the class. The math professors are handpicked by the faculty liaison and math chair.
- c. *Science Courses*: Because FAMU limits a students' entry into Physics I and General Chemistry courses by their math enrollment/credit, Engineering LLC students are not necessarily in the same science course. The students are encouraged to enroll in the same science course. However, the respective science departments do not place Engineering LLC students in the same section like the math department.
- d. *Engineering Seminar*: Engineering LLC students attend seminars covering a range of topics to help with their transition to college. Additionally, there are invited guests from industry and engineering departments to have open dialogue with the students about potential engineering pathways and the STEM workforce.
- e. *Study Sessions*: Congruently with the STEM courses, students participate in study sessions for their respective science and math courses. Upper-level students are hired to lead the study sessions for the Engineering LLC scholars. Students utilize active learning

techniques to work on math and science problems and concepts. Additionally, there are study hours that are completed each week. Students can utilize any of the tutoring labs on campus, faculty office hours, or the community room on their floor of the residential hall. This component of the program assists with getting students through the pre-engineering courses.

- f. *Community Service*: Engineering LLC students are empowered to help others. Woven throughout the program is the concept of community building and the responsibility to help others in the community. They help with local non-profit organizations, ranging from a food share to senior living. This component of the program provides students with an opportunity to utilize engineering in the real world.
- g. *One-on-one meetings*: Each semester, students meet with the faculty liaison to discuss their academic progression at the college.

Demographics of Engineering LLC Students

Over the years, the program has had between 20 - 47 students participate each academic year based on available residential hall space and the applicant pool. An effort is made to ensure that a variety of student demographic profiles are selected (e.g., high school GPA, ACT score, etc.). As the data is depicted in Table 1, it is not just the top academic students that are selected for the program. The students are comparable to other FTIC FAMU engineering students. For instance, Engineering LLC students' first math course range from College Algebra to Calculus II, so some are not considered "engineering ready."

Table 1. Comparison of Engineering LLC and General population Engineering Students Demographics and High School Performance Profile, 2015-2019.

	Engineering LLC Students	General Engineering Students
	Cohort Size	
	168	468
	Demographics	
Gender (Female)	36%	28%
First Generation	17%	33%
Pell Eligible	47%	66%
Florida Residency	61%	79%
Race (Black)	90%	88%
Race (Hispanic)	5%	3%
	Performance Profile	
HS GPA	3.4	3.4
SAT Math	566	544
ACT Math	23	22
ALEKS (Highest)	61	46

The data in Table 1 shows FTIC engineering students entering FAMU, between 2015 and 2019. There are a few differences between the two groups. There is a higher percentage of female engineering students that participate in the Engineering LLC. Additionally, there is a higher percentage of first-generation and Pell grant eligible students in the general population student cohorts. The aspect that is similar in the two groups are a high percentage of underrepresented minorities (> 90%). There are comparable high school GPAs, 3.4, and both the math ACT ($\Delta 1$) and SAT ($\Delta 22$) test scores. Please note that an ACT score of 22 is considered College Algebra ready [12], and engineering curriculum starts with Calculus I. The groups have similar demographics and high school profiles, but the main difference is that the Engineering LLC students participate in a program that incorporates safe spaces, and the general population does not necessarily have those opportunities.

The Assessment and Learning in Knowledge Spaces (ALEKS) math assessment scores are significantly higher for Engineering LLC students than the general population students, but that does not come from initial high school preparation. Some Engineering LLC students were afforded the opportunity to participate in a summer bridge program the semester before their admissions into FAMU and others participated in self-paced preparatory and learning modules that worked on their math skill set that resulted in higher ALEKS scores [13]. The summer bridge program details will be addressed in a later paper.

C. Results

The outcome of the above program components creates a safe environment that produces favorable academic performance.

First Semester GPAs

The five (5) cohorts represented between 2015 and 2019 first term average GPAs were compared amongst the two groups. As shown in the demographics section, both Engineering LLC students and the general engineering student population start with similar high school preparation. However, with the student support programming described in section B, the Engineering LLC students outperform the general engineering students in their first term GPA by nearly 25%, as shown in Figure 1. The maximum average GPA of general population students is never higher than the minimum average GPA of the Engineering LLC students.

ALEKS Math Assessment

Based on the College of Engineering curriculum maps, Calculus I in the first semester is considered engineering ready, but the majority of the Engineering LLC students started in a math course - College Algebra, 50%, Trigonometry/Pre-Calculus, 22%, - that would not render them

engineering ready as shown in Figure 2. As a comparison, 90% of the general student population ALEKS assessment placed them in a math course lower than Calculus I. It should be noted that students that have dual enrollment and/or AP math could potentially be placed in Calculus I from their credits. The higher Engineering LLC ALEKS math placement than the general population is not because the high school academic profile is higher, but students in the Engineering LLC participate in the Engineering Concepts Institute (ECI) summer bridge program and other summer programming to increase their ALEKS scores before the fall semester starts. This summer programming yields 17 percentage points more Engineering LLC students being “engineering ready” than the general engineering population.

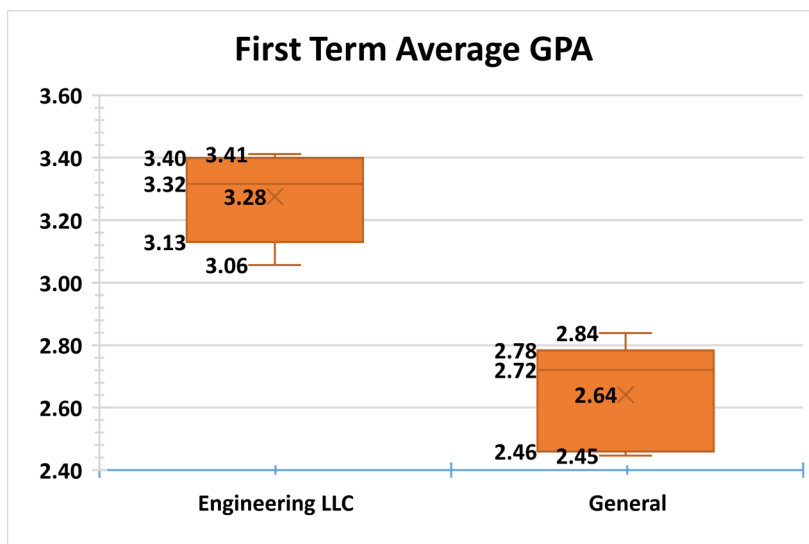


Figure 1: The first term average GPA of engineering students

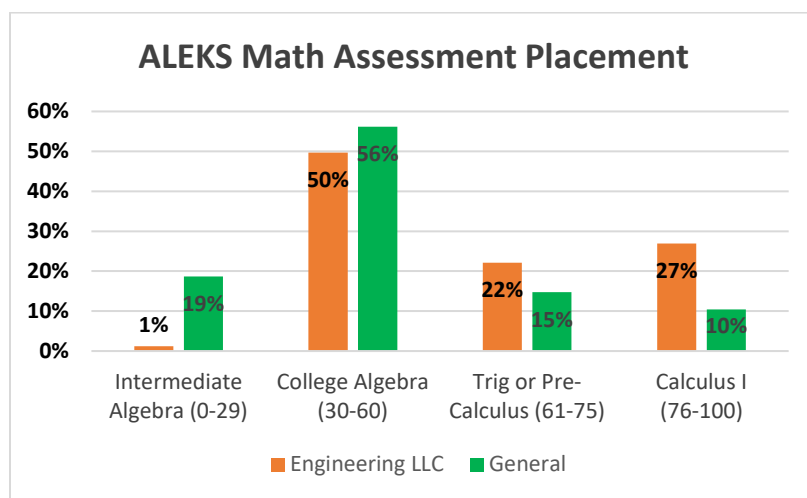


Figure 2: Highest ALEKS Math Assessment Scores of FTIC students between 2015-2019

First-Time Pre-Engineering Grades

For this study, in addition to the first term GPA as an academic performance indicator, the success of the pre-engineering courses were evaluated. In 2004, the FAMU-FSU College of Engineering created the pre-engineering program requirements based on courses that were in all engineering students curriculum: First Year Engineering Lab (FYEL), Calculus I, Calculus II, General Physics I, and General Chemistry I. These courses were always required in the engineering curriculum. However, now the successful completion of the courses were used to grant permission into the engineering major. All FAMU students are granted entry into the FAMU-FSU College of Engineering as pre-engineering majors. After passing all four (4) of the pre-engineering required courses, they become engineering majors depending on their major. Students can only fail a total of two times and/or two courses. In this case, the students can be considered for entry with other course evaluations. However, if a student fails three times and/or three courses, they must choose another non-engineering major. A previous study found that the FYEL first-attempt course grade was more of a significant predictor of completing pre-engineering than the SAT math or verbal scores [14]. As a result, students earning a 4.0 on the first attempt in FYEL is more likely to graduate in engineering.

Those engineering students who are placed in College Algebra or Trigonometry have the added constraint of starting their pre-engineering courses slightly later than their "engineering ready" peers. The Engineering LLC showed success with these students as well. Figure 3 depicts both the first-attempt success rate (bar height) and average GPA (number inside bar) for students that successfully passed the course with a C or above. Even though, College Algebra and Trigonometry are not part of the pre-engineering courses, over 70% of FAMU FTIC engineering students start in a math class below Calculus I. As such, it is necessary to evaluate those courses as well. It should be noted that even though the Engineering LLC and general population students have similar success rates in Calculus I, the average GPA in the course of an Engineering LLC student is substantially higher. In the previous section, it was noted that Engineering LLC students are not necessarily placed in the same science classes. As such, they have a similar success rate and average GPA as the general population students in those two courses.

The most significant difference between the performance of the Engineering LLC versus general population students can be seen in the FYEL course, which is taken in the student's first semester regardless of the math and/or science course placement. For the first four (4) years of the Engineering LLC, the students were all in the same section of the course (with general population students) taught by the faculty liaison of the program. The success rate of 99% of the Engineering LLC population is substantially higher in the FYEL course, while nearly 40% of the general population students either failed or dropped the course. Remember from the pre-engineering requirements that a certain amount of fails results in the student not being allowed to stay in the engineering major. A previous study showed the correlation in a student's grade in FYEL with the prediction that they would graduate in engineering or any other major [14]. Since

this course was determined as a significant indicator, it follows suit with the results in the next section.

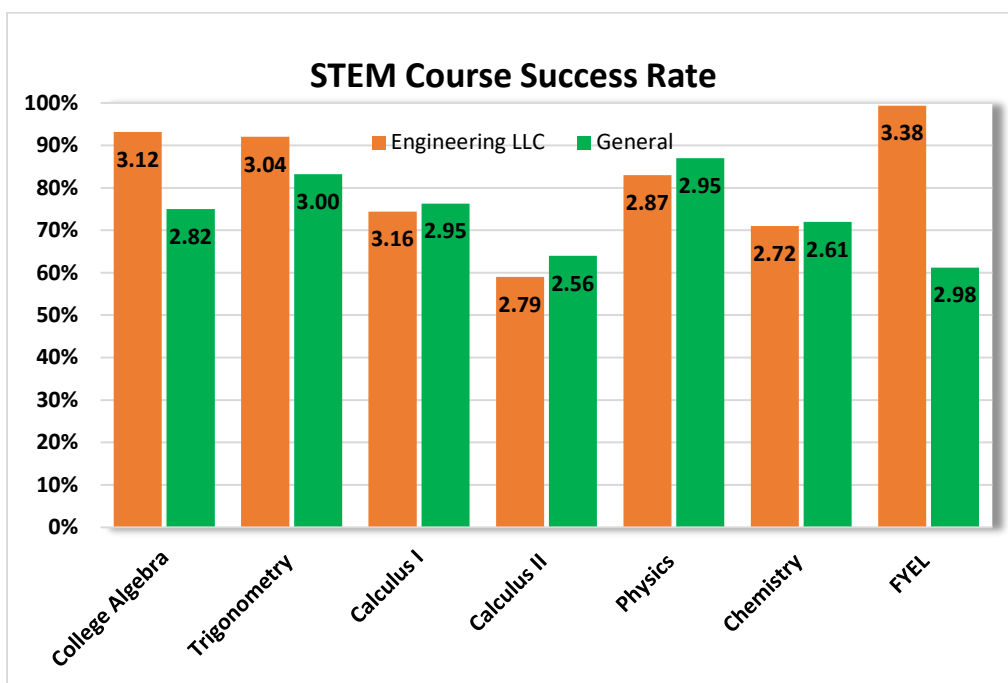


Figure 3: STEM Course Success Rate (bar height) and Average GPA (number in the bar) in Course.

Retention Rates

The last comparison of academic performance is student retention from fall to fall. For example, a student in the 2015 cohort is considered a successful retention if they are enrolled in school in fall 2016 by the 5th day of classes. If they are enrolled as an engineering major, it is coded differently than if a student is enrolled in another STEM major or Non-STEM major. FAMU has a joint college of engineering with Florida State University. As such, some majors that are typically part of a college at another HBCU are not included at the FAMU-FSU College of Engineering, such as computer science, engineering technology, and biological agricultural systems engineering. Those majors are in three different colleges at FAMU. This fact and the realization that some students were guided towards engineering by a high school administrator and/or family member, where engineering may not have been a good fit for them, not that they could not handle an engineering curriculum, led us to also consider retention rates overall at FAMU.

In Figure 4, the first tier (orange) are students that were retained in engineering majors offered at the FAMU-FSU College of Engineering (COE). Those majors include electrical, computer,

mechanical, industrial, civil, environmental, chemical, and biomedical engineering. The second tier (yellow) are students retained in STEM majors other than those offered at the FAMU-FSU COE. The combination of tier 1 and tier 2 is the retention of students in a STEM major. The third tier (green) are students enrolled at FAMU, but in a Non-STEM major. The total of all three tiers are students that are retained at FAMU in any major.

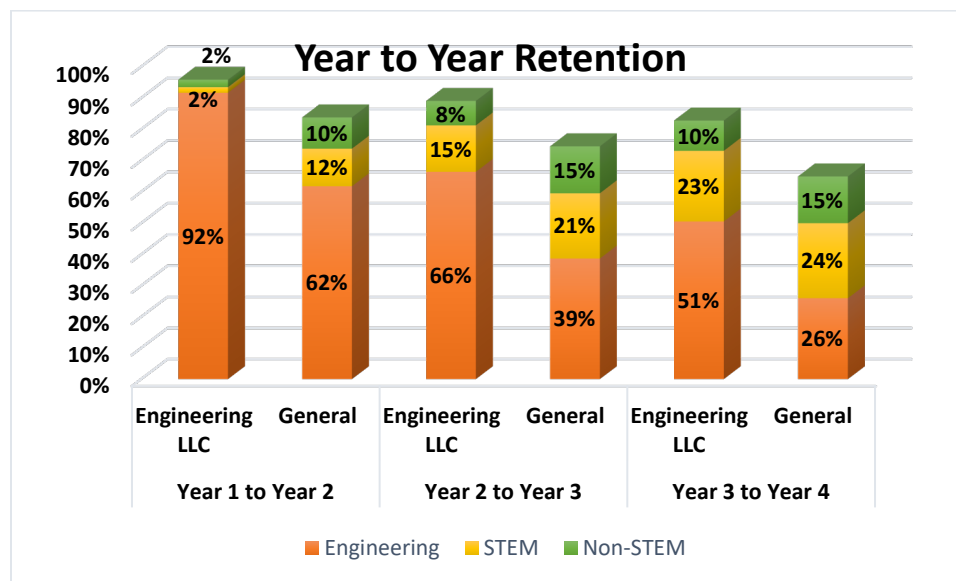


Figure 4: Fall-to-Fall Retention of Engineering Students

There is a noticeable difference in the first-year retention of Engineering LLC students and general population students. In total, 96% of Engineering LLC scholars return to FAMU the next fall in any major, 92% of those in engineering. The general population student retention is 84% in any major and only 62% in engineering. By year three, there are 84% FAMU Engineering LLC students still enrolled at the university and 51% of them still in an engineering major offered at FAMU-FSU COE. While general population students, 65% are still at FAMU in some major and 26% are still in the engineering major.

D. Discussion

Although the quantitative data was able to show that the Engineering LLC positively impacted participants academically compared to the general population, it was the qualitative results – the students' responses to the open-ended survey questions – that demonstrated how the Engineering LLC affected their self-identification, mindset about engineering and persistence. When asked what motivated them to persist, one-third of the participants cited the Engineering LLC specifically as being the reason they continued. When referencing the Engineering LLC, students

mentioned the support they received in terms of tutoring, professional development and mentoring, but they also referenced the shared experience of struggling together as a motivator. The concept of the Engineering LLC as a “family” came up as this participant described, “The family you make along the way with other students. The amount of help available by students themselves, because everyone’s struggling”. Other motivating factors that students mentioned outside of the Engineering LLC were their goals of having a high paying job, to make a difference, or because engineering was so tied to their identity that they could not see themselves doing anything else.

When students were asked to reference specific aspects of the Engineering LLC that positively influenced their choice for their engineering major, the most cited programmatic structures were the first-year engineering course wherein they learned about various engineering majors and meetings with faculty from each department to learn more about the majors (49%). The other most referenced programmatic aspect was the shared space and struggle with peers (30%). One student described the impact as:

I've kept my discipline simply because of the interactions with those of the same discipline within the LLC. Being able to tackle assignments and problems together has been an important factor in retention, it became a realization that if we keep this mentality then we can help each other pass in the future. The introduction of the departments also helped me solidify that my true interests lie within Biomedical.

Students were asked to describe their favorite component of the Engineering LLC. The top three cited program aspects were the shared living space and culture (28%), study sessions (26%), and seminars where bonding took place (23%). Table 2 includes the top-cited aspects of the Engineering LLC and a quote to highlight why the students valued the program.

Table 2: Engineering LLC Top Cited Most Liked Program Aspects

Program Aspect	N (94)	Quote
Shared Space/Culture	26	"The fact that everyone lived together. It caused us to get closer and closer day by day make us more like a family."
Study Sessions	24	"The community room was one of the most helpful and convenient places for me this year. It is close, easily accessible, and a large meeting space that we almost always have access to. Here I met people, made friends, got help with work from both peers and mentors, and more. It truly does bring that sense of family/community to our living space."
Seminars	22	"I would say keep the meetings, because they allowed for us to bond with each other and learn a lot."
National Conference	4	"BEYA should definitely be kept, it was an overall great experience networking and meeting new people and

		interacting with companies were the best part of the BEYA trip.”
Everything	4	“Keep everything! It's a recipe for success so why change it if it was very successful for many people in the program including myself.”
Faculty Liaison	4	“Dr. Caldwell, she's the best thing about the program. It cannot run without her skills at the helm.”
Professionalism	4	“The teaching of professionalism in clothing, actions, and speech. This was very important because your presentation is definitely a deciding factor of many important things in life (jobs, school, internships, etc.) so it is important that we know how to do it properly.”

When students were asked to describe their overall experience in the Engineering LLC, 95% of the participants referenced a positive experience. Twenty-nine students referenced the professional and networking skills that they learned along with engineering skills that made the Engineering LLC so influential. One student summarized this best as:

The Engineering LLC required a lot of work from me that I wasn't accustomed to. It taught me how to work along my peers better, and showed me how to be professional at STEM/Career fairs by helping me to develop my resume and how to dress properly for the occasion. Within all the Engineering LLC meetings, I gained the knowledge of all the resources made available for me by my main campus and by the College of Engineering.

Another student built on this by describing the family atmosphere:

Within the LLC program, I have learned firsthand the true meaning of professionalism and success over the course of the last school year. From going on trips to engineering conventions to local bus rides of college of engineering, everywhere we went had an opportunity to teach us something new. Not only did I pass all my classes but I also was able to make family type bonds with those in the LLC that contributed to my success. Overall the LLC program has made me a better version of myself in all aspects of college life and I know who's ever fortunate to become part of it will forever be grateful.

There were 3% of the Engineering LLC students that identified having a negative experience. One student in particular referenced the rigor and demands of the program being too high. Like previous research has shown, two students referenced cliques but in different ways. One student referenced their disappointment in not making more friends outside of the Engineering LLC. The other talked about the cliques that formed during the ECI summer bridge program before the Engineering LLC meetings began, making it harder to bond.

E. Conclusion

Even though FAMU undergraduate student population is only a fourth of FSU undergraduate student population, the ratio of FAMU engineering students at the joint college is disproportional (15%). Several issues surround this entity which includes funding, college climate and logistics. Those deficits lead to the faculty liaison creating the six (6) goals of the Engineering LLC, resulting in a sense of community "family", which has been known for years as a quality held at HBCUs, while also incorporating professionalism and character building, to ensure student persistence in engineering. Throughout the five (5) years examined in this paper, the program was assessed each year to determine the practices that best addressed the program goals. As shown in the quantitative results, goals (1) and (2) were accomplished for students in the Engineering LLC, 92% first-year retention in engineering is more than other general population HBCU students and comparable to PWI students.

A previous study has shown that a significant indicator of student persistence, whether a student attended FSU or FAMU, was their grade in the First Year Engineering course. The persistence of the Engineering LLC students is no surprise since the participants have more students than the general population successfully completing the FYEL course with a higher grade. However, the qualitative findings show a side of the program that cannot be detailed in the quantitative numbers. The qualitative findings show the program satisfied goals (3) through (6); the Engineering LLC program was able to help students persist in ways that the general population could not through the shared living space that created a sense of shared struggle and motivation. Students were able to feel like a family and be confident in their skills and choice of major, all while developing their character to ensure the student was professional and accountable. As the years went on, the university saw the importance of the FAMU Living Learning Communities on university performance. As a result, more LLCs were developed for other colleges/schools at FAMU. Furthermore, funding was provided in 2018 that allowed an increase in students served by the Engineering LLC and the experiences. Even though the Engineering LLC is only for first-year students, the factors and skillsets participants learn stay with them their remaining time at FAMU.

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