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An Engineering Summer Bridge Program Utilizing a Safe Space to Increase Math Efficacy

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Dr. Roxanne Hughes is the Director of the Center for Integrating Research and Learning (CIRL) at the National High Magnetic Field Laboratory (MagLab). She has also directed the MagLab's Diversity and Inclusion Programs from 2014 to 2019. She brings a breadth of experience in science teaching and informal science education to her position. Her research interests include programs and policies that attempt to increase the number of women and marginalized populations in science, technology, engineering, and mathematics fields by changing the climate within these fields. In her research, she focuses on STEM identity (one's belief that they fit the perception of a scientist and can be successful in their chosen field). Her research has been presented at national conferences and in international journals. She has been a part of the panel discussion of the American Association of University Women's Solving the Equation report (2015) and recently the SciGirls national program's redesign of their strategies for engaging girls in STEM. In addition to her work at the MagLab she also served on multiple boards and advisory commissions, including: the American Physical Society's Committee on the Status of Women in Physics, the FSU Diversity and Inclusion Council, the FSU National Coalition Building Institute, and the MacArthur Foundation's 100&Change Review panel.

An Engineering Summer Bridge Program Utilizing a Safe Space to Increase Math Self-Efficacy

A. Introduction

Summer Bridge programs have been around for decades to assist students in transitioning from high school to college. There are two types of summer bridge models. One is a degree credit model that requires students to take one or more courses that count towards graduation, while the second model requires students to participate in a non-credit preparatory program that builds students' skill sets. The advantage of the second model is the program is not tied to an academic term, so the program has more flexibility in the time and duration of the summer bridge program. There are STEM summer bridge programs that have had success with relatively short time frames. One in particular, Louisiana State University (LSU) BIOS has conducted a five-day boot camp for students to succeed in an introductory biology course for nearly 15 years [1]. The idea is to create a short course that provides students with the same experience of their first semester in college. This program resulted in increased retention and graduation rates for participants.

This paper focuses on Black engineering students at a Historically Black College and University (HBCU) that participate in a 5-day summer bridge program that creates a safe space for students to close the mathematics knowledge gap. The study will focus on students' math knowledge and performance in their first entry math course as a measure of the impact of the program. This paper provides best practices of a non-credit short engineering summer bridge model.

B. Engineering Concepts Institute History

The Engineering Concepts Institute (ECI) Summer Bridge program has been around off and on at Florida A&M University (FAMU) for students matriculating through the FAMU-FSU College of Engineering since 1987 [2]. The program was created to help minority students' transition to college and retain them specifically in engineering. There have been several model variations of the summer bridge programs throughout the years. In 2014, a new program director changed ECI from a "camp" style program to a six-week program, where students must be enrolled in classes towards degree completion. One course in particular, the first-year engineering lab was a requirement. The pool of students came from those self-enrolled at FAMU in the summer term. In 2016, the ECI program opened up to all first time in college freshmen. The program model was the same, but the student pool changed. During the past ECI Summer Bridge program, students engaged in skill development to make them successful engineering students: worked on engineering design projects, participated in skill workshops, took math and science preparatory courses, and team building activities. Additionally, the ECI scholars were provided with an upperclassman peer mentor.

In 2019, with changes in funding and a new direction by the administration, it was necessary to change the model of the ECI Summer Bridge program. Instead of a six-week program, the new model would be a five-day program that mainly focused on developing students' math skills, teamwork, and ensuring students were acclimated to campus. The goal for the change was to create a shorter in-person interaction that was more cost-effective, while still providing similar math placement and success outcomes.

C. ECI 5-day Summer Bridge Overview

Since an engineering student's first term math course can affect the student's time in college, academic performance, and retention, an emphasis was placed on making sure math knowledge was a core aspect and outcome in the new five-day program model. The program uses the Assessment and Learning in Knowledge Spaces (ALEKS) math assessment and adaptive learning program as a focal point [3]. Students take the initial assessment at least two months before arriving on campus for the program. The ALEKS software determines the math areas - out of 280 topics – in which each student may have a deficiency. Within that timeframe, students can work within the online ALEKS Preparatory and Learning Modules (PLM) to practice and gain math knowledge. Before students arrive on campus for the 5-day program, they commit time in their individualized ALEKS plan to improve on concepts they may have forgotten and/or practice new concepts. Upon completing their initial ALEKS math assessment, ECI students are provided specialized goals/milestones to achieve over the summer. When they arrive on campus, the students participate in intensive math preparatory sessions led by upper-class students. Additionally, interwoven between the math preparatory sessions are team building and study skill components. At the end of the program, students retake the proctored ALEKS assessment.

Math Preparatory Sessions

There are four math preparatory courses provided during the program: College Algebra, Pre-Calculus, Trigonometry, and Calculus I. Each math session contains topics that students typically have difficulties with understanding. The session consists of an everyday example, which is a concept anyone could relate [4]. Then a math concept is reviewed while incorporating active learning techniques. Finally, an engineering example is utilized to further explain the math concept. The curriculum model is meant to help students recall ideas that will increase their math aptitude. Each student is given an exit exam at the end of the day that is reviewed the next day.

Team Building

Typically, engineering includes quite a bit of teamwork and project-based learning. This was one principal concept that was retained from the previous six-week summer bridge model. The team-building activities are specifically developed to be inclusive to all participants. There are opportunities for students to work together to solve problems and challenges.

Skill Building Seminars

Students participate in a couple of seminars that prepare them for the ALEKS math assessment retake while also giving them a foundation of study skills to better navigate their freshman year. They learn study skills and test preparation that is particularly geared to STEM majors.

D. Results

For this paper, there are four cohorts of students compared. The ECI six-week program and ECI five-day program are described above. The Engineering Living Learning Community (LLC) students participate in the online self-paced ALEKS PLM with specialized goals; unlike the ECI program, students do not participate in any in-person math preparatory courses. Additionally,

they can choose to participate in post-math student support during the academic year. The general student population does not: participate in in-person math preparatory courses; have specialized goals set; or participate in post-math assessment group support.

Cohort Demographics

Between 2015 and 2020, engineering students entering FAMU had the option of participating in the ECI program, the Engineering LLC program or stay in the general engineering population. As data in Table 1 shows, an effort is made to create program cohorts comparable to the general population. The students participating in the ECI and Engineering LLC programs have similar demographics and high school performance as the general engineering student population.

Please note that the information in Table 1 is self-reported by the students, while the high school performance is obtained from official reporting sources. Reflective of most engineering departments, each program has a majority of males but ranges from 21% females in the ECI 6-week summer bridge to 35% in the Engineering LLC. The demographic that varies most over the four cohorts are first-generation, for example, the ECI 5-day summer bridge has less than 10%, and the general population has almost a quarter self-reported students. More than 40% of all groups had students on free or reduced lunch, and over 80% Black students in each cohort. Because these aspects were self-reports, some students chose not to answer "blank" or selected "I don't know." The high school performance in each cohort was similar for GPA (3.11-3.26), the math portion of the SAT (546-571), and the ACT (22-24).

Table 1. Comparison of ECI, Engineering LLC, and General population Engineering Students Demographics and High School Performance Profile, 2015-2020.

	ECI 6-weeks	ECI 5-day	Engineering LLC	General
	2015-2018	2019-2020	2015-2020	2015-2020
	Cohort Size			
Cohort	58	32	136	495
ALEKS Cohort	58	32	133	482
% ALEKS Retake	91%	91%	69%	33%
	Demographics			
Gender (Female)	21%	25%	35%	27%
First Generation	21%	9%	15%	24%
Free/Reduced Lunch	55%	44%	46%	59%
Race (Black)	95%	91%	88%	83%
	Performance Profile			
HS GPA	3.11	3.26	3.22	3.14
SAT Math	564	553	571	546
ACT Math	23	22	24	22

ALEKS Preparatory and Learning Modules (PLM)

The students in all cohorts had similar demographics. However, the time they spent in the ALEKS PLM varied. After the students take their first ALEKS assessment, the software determines their initial mastery of various math concepts (over 11). They have the opportunity to

work in the PLM to increase their mastery before retaking the ALEKS assessment. Out of the eligible students taking the ALEKS assessment, Figure 1 depicts the time they spent in the ALEKS PLM, the change in math mastery, and proctored ALEKS placement change. Over 90% of ECI students retook the assessment, while the general population had only about 33% retake the assessment, as shown in Table 1. Of those students, the group that spent the most time, over 65 hours, in the learning modules were the ECI 5-day students. The ECI 6-week and Engineering LLC students spent a similar amount of time, about 35 hours, while the general student population spent nearly 17 hours. In addition to the number of hours in the PLM, the figure shows the average increase in mastery of math concepts in the ALEKS PLM. Similar to the time spent in PLM, the participants in the ECI-5 day program had the highest change, 55 percentage points, in math mastery, while the general population had the lowest at 29 percentage points.

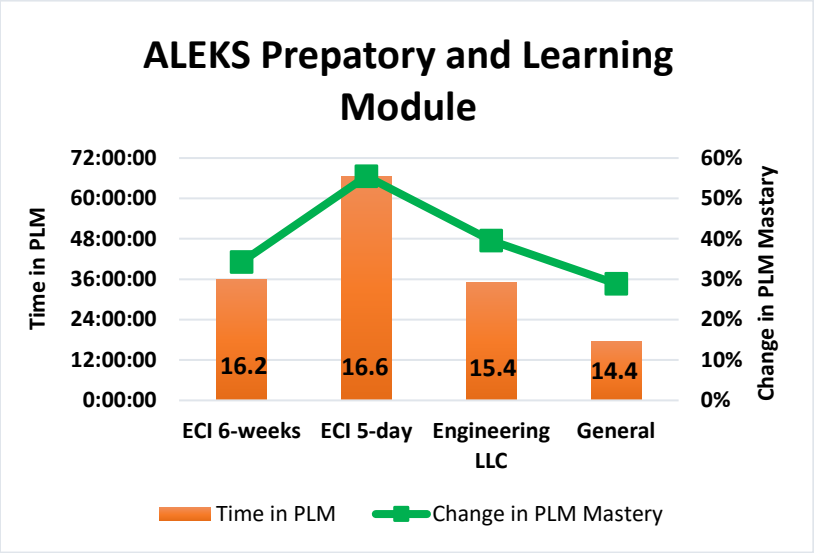

Figure 1: **ALEKS PLM, Time Spent (orange bar, left-axis), Change in Master (green line, right-axis) and ALEKS assessment change (orange center bar number) for all cohorts.**

Even though the students increased their math concept mastery within the self-paced learning modules, that does not necessarily mean an increase in the final proctored ALEKS math placement when the students are retested. Some factors can affect students on the final test day that are beyond the scope of this paper. The ECI 5-day program had a 16.6 average percentage point increase on their ALEKS math placement when they retook the assessment. This was 15% higher than the general population and marginal 2% higher than the ECI 6-week program.

ALEKS Course Determination

The increase in proctored ALEKS assessments only serves as one viewpoint of student success outcomes. The ALEKS assessment places students into specific math courses based on their scores: Intermediate Algebra, 0-29, College Algebra, 30-60, Pre-calculus/Trigonometry, 61-75, or Calculus, 76-100. Even with the increases shown in Figure 1, a general population student could have scored a 14 on the first ALEKS assessment and increase their score to a 28 the second time taking the assessment. Even though the student increased their score by 14 points, they would still be enrolled in Intermediate Algebra. As such, it is also essential to show the

students that changed their first math course entry point, which would mean a shorter number of semesters to graduation. A student starting in Intermediate Algebra would be three semesters behind in the engineering curriculum, College Algebra, two semesters behind, etc.

In Figure 2, the lowest course a student can be placed in based on the ALEKS assessment, Intermediate Algebra, and the highest course, Calculus I are explored for the initial proctored assessment then again after students have participated in some sort of remediation. For students who participate in either the ECI 6-week or 5-day summer bridge, the final participants that had to take Intermediate Algebra based on the ALEKS assessment is 0%. The Engineering LLC cohort is slightly higher at 2%, while the general population has nearly 20% of the students start in Intermediate Algebra. For Calculus I, the general population students went from 7% assessed in Calculus I in their initial assessment and increased to 11% of the students by the final ALEKS assessment. The ECI 6-week cohort had 33% of the participants that retook the assessment to finally place in Calculus I, ECI 5-day was 22%, and Engineering LLC was 30%. The final placements were different, but it is important to investigate where the students in those respective cohorts initially started. Both the ECI 6-week and ECI 5-day summer bridge programs more than doubled the number of students who would have their first math entry point in Calculus I, from those initially assessed for Calculus I based on ALEKS.

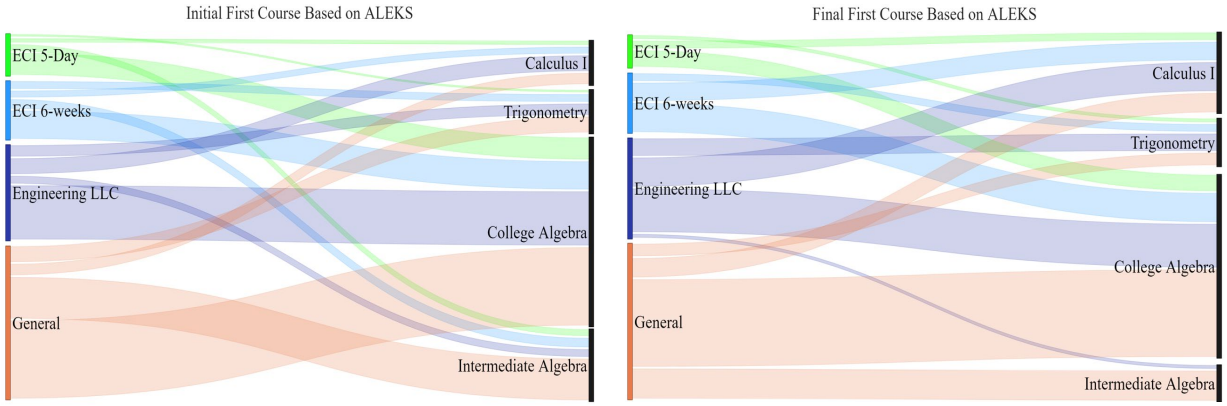

Figure 2: ALEKS assessment course change for all cohorts.

First Math Course Success

The last result that is compared is the students' performance in their first math course. Once the students are placed in their first course at FAMU, it is ideal to make sure students perform well. In Figure 3, the plot shows the average student GPA for College Algebra, Trigonometry, and Calculus I. ECI students were not enrolled in Intermediate Algebra, so it is not shown on the plot. Additionally, it should be noted that ALEKS is used to assess student's math proficiency. However, the State of Florida allows any student to use dual enrollment and/or AP/IB credit to place in their first math course. As such, the results in Figure 3 are based on students' first math placement by ALEKS or high school credits.

The students who participated in the ECI 5-day summer bridge outperformed the other cohorts in both the College Algebra and Trigonometry course grades with an average GPA of 3.45 and 3.73, respectively. The Engineering LLC cohort had the highest Calculus I average of 3.47, while the ECI 5-day cohort was close behind at 3.33.

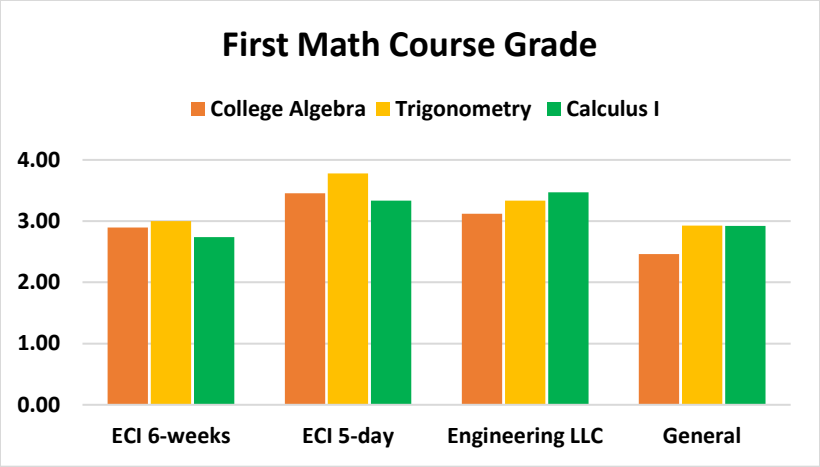

Figure 3: First Math Course GPA for each cohort.

E. Conclusion

There were concerns when the decision was made to decrease the summer bridge program from a six-week model to a five-day model, a cut of nearly 90% of the original in-person time. This paper shows by focusing on a couple learning objectives and incorporating pre and post-program support, a 5-day program can succeed with less time, resources, and physical in-person contact. The students who participated in the ECI 5-day program had a slightly higher high school GPA, but a marginally lower math ACT/SAT than the ECI 6-week participants. Even with this profile, the ECI 5-day participants outperformed the latter group in two outcomes: change in math mastery and first math course GPA. The ECI 6-week program did have a slightly higher number of students who entered into Calculus I based on ALEKS after completing the program.

There are tradeoffs for decreasing the number of in-person program days, but the essence of the safe space was maintained. In the future, it would be valuable to determine if the new model still aids in underrepresented minority student retention and graduation.

References

[1] S. Wischusen and E.W. Wischusen, (2019) A One-Week Freshman Boot Camp That Increases Second Year Retention Rates by 5% and 4-Year Graduation Rates by 10%. Proceedings of the 14th Annual National Symposium on Student Retention. Norman, OK: The University of Oklahoma.

[2] M.W. Ohland, G. Zhang, F. Foreman and F. Haynes, (2000). The Engineering Concepts Institute: the foundation of a comprehensive minority student development program at the FAMU-FSU College of Engineering, 30th Annual Frontiers in Education Conference: Building on a Century of Progress in Engineering Education, Kansas City, Mo., pp. 17-20.

[3] Research Behind ALEKS https://www.aleks.com/about_aleks/research_behind

[4] Everyday Examples in Engineering (E³s): Increase student understanding by using Everyday Examples to teach technical concepts https://www.engageengineering.org/e3s/whyitworks