Implementing an Engineering Math Curriculum Sequence: Lessons Learned Over Five Years

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Abstract

This complete, evidence-based practice paper provides an updated evaluation of the engineering math curriculum at Clemson University, incorporating additional years of data (2019-2022) on student demographics, performance, and progression. The curriculum was designed to improve math readiness for engineering students, addressing the challenge of integrating mathematics with engineering concepts. The course aims to enhance student engagement, foster critical thinking, and improve retention in engineering majors by connecting math skills to real-world engineering applications through lab activities and problem-solving exercises. The evaluation examines the impact of this engineering math course on students' subsequent success in both math and engineering courses, particularly their progression through the required math sequence. The results show a clear correlation between performance in the engineering math course and continued enrollment in engineering programs. Specifically, students earning grades of C or higher in the engineering math course are more likely to declare an engineering major and progress toward completing the necessary prerequisites for advanced coursework. In contrast, students who perform poorly, particularly those earning D or F grades, face significant barriers to progressing in the engineering curriculum, often delaying or preventing their entry into higher-level courses.

The analysis also identifies trends in student outcomes across various cohorts from 2019 to 2022, revealing challenges in the 2020 and 2021 cohorts due to the disruptions caused by the COVID-19 pandemic and the shift to online and hybrid learning environments. Despite these challenges, the modifications made to the engineering math course, such as a greater focus on calculus preparation and the introduction of hands-on lab activities, have improved outcomes in the more recent cohorts. For instance, the 2022 cohort, despite entering with lower levels of math preparedness, showed improved performance compared to previous years. These findings suggest that with targeted curriculum adjustments and integrated support structures, students can overcome challenges related to math readiness and succeed in engineering education. The paper concludes by offering recommendations for practitioners at other institutions aiming to replicate similar programs, such as identifying at-risk students early, providing a focused math curriculum with engineering applications, and ensuring strong institutional support to enhance student retention and success in engineering programs.

Introduction

This complete, evidence-based practice paper provides an update to “Implementing an Engineering Math Curriculum Sequence: Preliminary Results and Lessons Learned” [1]. This follow-up will offer an additional three years of data related to course content, course materials, student demographics, and grades. Student’s progress and performance in future math courses and performance in continuing in engineering courses will be evaluated over 2019-2022. Notably, the last two years evaluated in this study (2021 – 2022) represent a fully in-person experience compared to the hybrid cohort of 2020.

The first-year engineering math curriculum at Clemson University was designed to help students understand the relevance of basic math skills in engineering and strengthen mastery of prerequisite math learning outcomes to improve preparedness for engineering. While engineering

programs and professional industries expect students to grasp course concepts, relate their learning to real-world scenarios, and develop a versatile knowledge base, many students tend to approach their studies in a more fragmented way [2], [3]. Artificial divisions between disciplines and a lack of connection between course material and real-world experiences can hinder engineering students' ability to apply their knowledge effectively, especially early in their studies. Many first-year students without prior exposure to advanced mathematics find it challenging to integrate engineering and math concepts, often perceiving their math training as abstract and disconnected from practical applications [4], [5]. Introductory math courses often serve as gatekeepers for progression in engineering programs, and this disconnection can lead to decreased motivation, poorer academic performance, and lower retention rates in engineering majors. The differing foundations and expectations between mathematics and engineering departments can frustrate faculty. To address these issues, an integrated engineering math curriculum—typically taught by engineering faculty—has been proposed and implemented at various colleges and universities, led by Wright State University [5], [6].

At Clemson, the General Engineering Learning Community (GELC) was established in 2017 to improve retention rates for engineering students who enter the University with limited calculus readiness. Students identified as “not calculus ready” based on their Clemson math placement exam or math SAT scores are invited to participate during summer orientation and can voluntarily enroll in the program as they begin their studies in the fall. Clemson’s approach is more comprehensive than previous initiatives at other institutions, offering a holistic experience with several innovative components. Key elements of the program include grouping students into cohorts for their STEM courses during the first year, co-enrolling them in a learning strategies and professional skills course, and creating a long runway for the first-year engineering sequence [7]. The GELC aims to enhance student retention in engineering majors while developing students' skills for future careers as engineers. To further support these objectives, an engineering math course was introduced in Fall 2019, as a C or better in Calculus I is required to declare an engineering major at Clemson.

Class Description

The engineering math course aims to prepare first-year engineering students for calculus who did not qualify to begin their calculus sequence upon admission to Clemson. The course is designed to teach students the math skills they will need in their future math coursework and to relate these mathematical concepts to engineering applications through hands-on lab activities, some of which utilize PASCO sensors to collect, analyze, and interpret data.

The primary text for the course is Miller and Gerken’s 2nd edition of *Precalculus*. Students are also required to have access to Assessment and Learning in Knowledge Spaces (ALEKS) for the semester, which is the same system used at Clemson to administer the math placement test. Students are required to work through nine modules in ALEKS to help them learn math concepts while also allowing them to become familiar with the system used to administer the placement test. By the end of the course, students should be able to demonstrate a proficiency of 80% or higher, matching the grade needed on the placement test on each of the course ALEKS modules listed in the topical outline in Table 1 below.

Table 1. Current Class Topical Outline

	Course/ ALEKS Modules	Course/ ALEKS Topics		
Exam 1	**Real Numbers** (1 class day)	Order of Operations	Percentages	
		Math with Fractions	Sales/ Original Price/ Percent Increase or Decrease	
	Equations and Inequalities (2 class days)	Solving Linear Equations	Mixture (rate) problems	Solving Linear Inequalities
		Systems of Linear Equations	Absolute Value Equations	Compound Inequalities
	Exponents and Polynomials (2 class days)	Rules for Exponents	Factoring	Roots of Quadratic Equations
		Multiplying Polynomials	Quadratic Equations (General vs Vertex Form)	Complete Square/ Vertex Formula
	Lines and Systems (1 class day)	Slope-intercept Form	Finding Equations of Lines	Distance, Rate, Time Problems (System of Equations)
		Find x and y-intercepts	Elimination Method	Graphing Systems of Linear Inequalities
	Functions and Graphs (2 class days)	Domain/ Range	Relations vs Functions	Combining/ Inverse Functions
		SteBuilder/ Interval Notation	Graph Transformations	Composition of Two Functions
Exam 2	**Radical Expressions** (1 class day)	Domain/ Range (Square Root Functions)	Simplify Radical Expressions	Rationalize Denominator (Including Use of Conjugates)
		Rational Exponents	Solve Radical Equations	Complex Numbers
	Rational Expressions (2 class days)	Inverse Rational Functions	Polynomial Long Division	Graph Rational Functions
		Simplify Rational Expressions	Solve Rational Equations	Word Problems (Direct/ Inverse Variation)
	Exponentials and Logs (3 class days)	What are Logs?	Convert Between Log and Exponential Form	Solving Logarithmic and Exponential Equations
		Rules for Logs	Simplify Log Expressions	Change of Base
Exam 3	**Trigonometry** (4 class days)	Pythagorean Theorem	Unit Circle	Law of Sines
		SOH CAH TOA	Reference/ Coterminal Angles	Law of Cosines
		Solving Right Triangles	Arc Length/ Area of a Sector	Decompose and Add Vectors
		Degrees vs Radians	Trig Identities	Plotting Trig Functions

While the students must demonstrate proficiency in basic math to enter calculus, it is more important for them as engineers to identify and apply the appropriate mathematical concepts needed to solve specific engineering problems. The engineering math class introduces these skills through written homework and hands-on lab activities.

The written homework requires students to use math concepts learned in the class to document and effectively communicate a solution to engineering problems. The written homework and lab activities both provide opportunities for students to exercise critical thinking and problem-solving skills through the practical application of mathematical concepts, which improves student understanding of these topics and helps to answer the common question, "When am I ever going to use this?" Sensor-based data acquisition is also introduced at the first-year level, exposing students early to essential engineering tools and the challenges associated with working with real data. The group-based lab activities also promote teamwork and collaboration and allow students to develop the interpersonal skills necessary to thrive as engineering professionals.

Class Evolution

In the six years that the math course has served as an integral component of the first-year engineering program, lessons have been learned, and modifications have been made to fit the students and curriculum at Clemson better. The students in the cohort must take and meet the required score on the math placement test to enter the calculus sequence. When the math course was first introduced, the Klingbeil book was used as the primary focus of topics and questions. The topics in the book include algebra, trigonometry, and introductory calculus. In the first year of the math course, the Klingbeil book was used along with the preparatory materials for the math placement test, focusing on the topics in the textbook. The students were expected to work

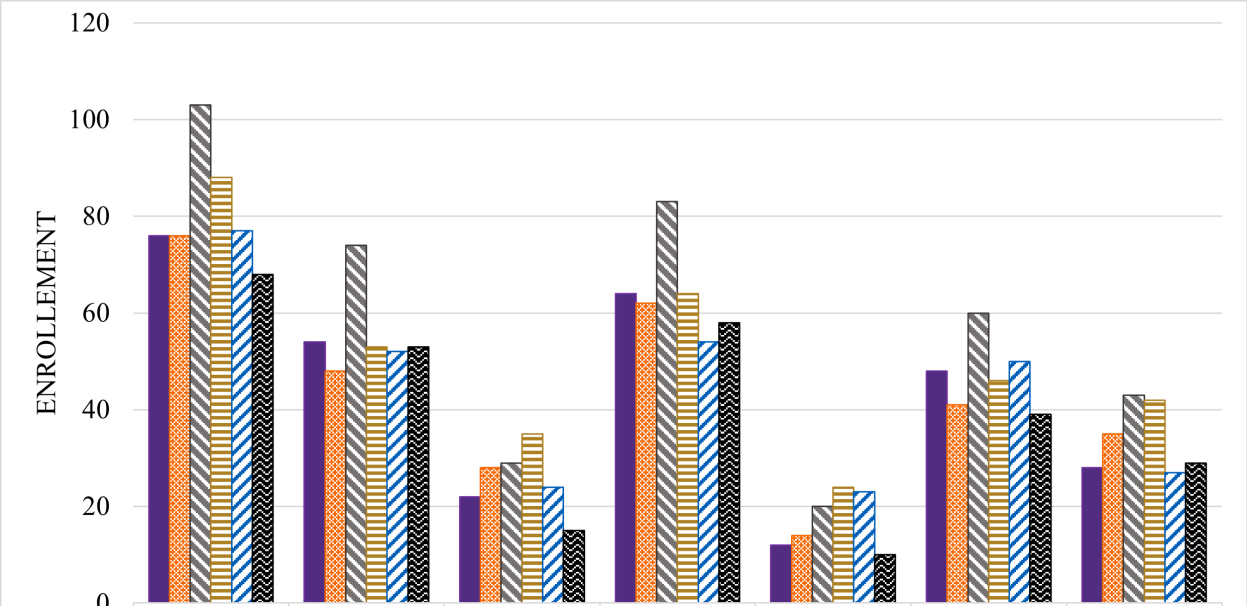
through the preparatory materials individually to pass the placement test. During the semester, the book material through calculus was covered, and deadlines were set for the placement test materials. Students found it difficult to work through the placement test materials without guidance. The Klingbeil book was still utilized in the following two years, but more emphasis was placed on the placement test preparation materials with more direct guidance from the instructor. This allowed the course to focus on preparing for the placement test while providing the engineering context to the problems and questions. During these years, the calculus topics were removed with more focus on algebra and trigonometry based on the needs of the students and assessments of their performance.

During the fourth year of the course, the Klingbeil book was removed to focus on the ever-evolving needs of the students. Additionally, recruitment efforts evolved to focus recruitment on students who were least prepared for calculus based primarily on their math placement scores. This changed the makeup of the students placed in the GELC, ensuring it was available to students who would benefit the most from the level of support provided. This change meant more time was needed to prepare for the math placement test and help the students understand the use of mathematics as an engineering tool. The current course focuses on preparing students for placement in calculus, with the problems in the course providing an engineering context to familiarize the students with the way mathematics is used in engineering.

The primary aim of this paper is to assess whether the engineering math curriculum at Clemson has continued to contribute to students' subsequent success, defined as retention in engineering majors and performance in math and engineering courses following completion of the engineering math course. The following questions are addressed: 1) How does performance in the engineering math course relate to students' continuation at the university and their enrollment in an engineering major? 2) What is students' progression in math courses after completing the engineering math course? 3) What is the relationship between final grades in the engineering math course and final grades and success in subsequent math courses?

Methods

The cohort year is defined as the Fall semester when the students took the course. As shown in Figure 1 below, the average enrollment is 84 students per cohort, with an average of 66.8% male and 33.0% female. The cohorts average 77.8% in-state students, 33.0% out-of-state students, and 41.5% underrepresented minority students (URM).



	Total Enrollement	Male	Female	In State	Out of State	Not URM	URM
2019	76	54	22	64	12	48	28
2020	76	48	28	62	14	41	35
2021	103	74	29	83	20	60	43
2022	88	53	35	64	24	46	42
2023	77	52	24	54	23	50	27
2024	68	53	15	58	10	39	29

Figure 1. GELC Enrollment and Demographics per Year

Fall 2019, 2020, 2021, and 2022 program years will be included in the analysis. All students who enrolled in the engineering math course and who did not drop before the drop/add date are included in the program evaluation. Additionally, the average incoming math SAT data is presented for each cohort in Figure 2 below.

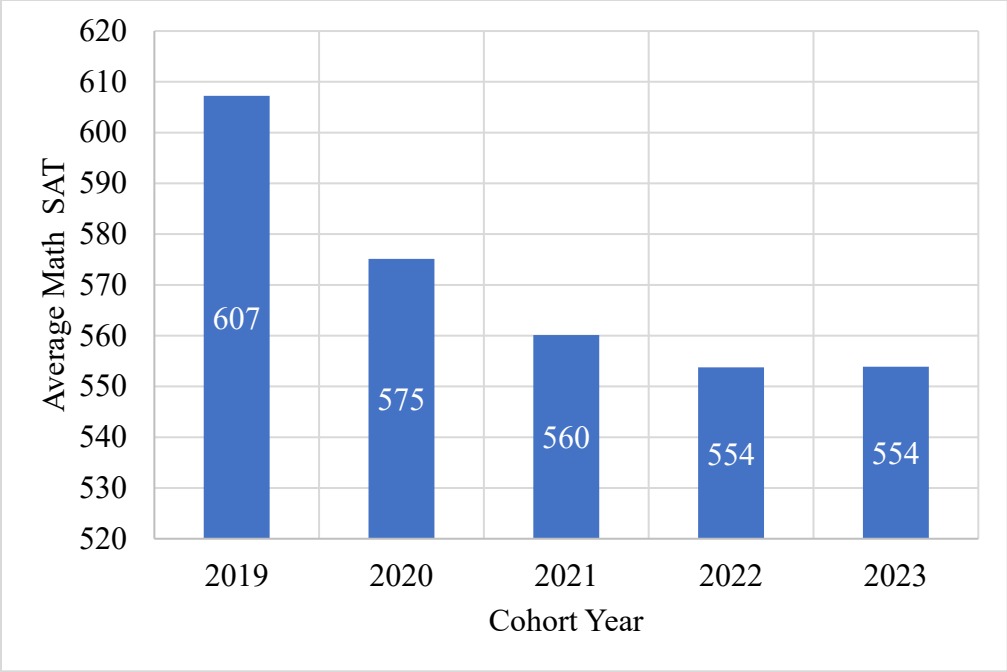


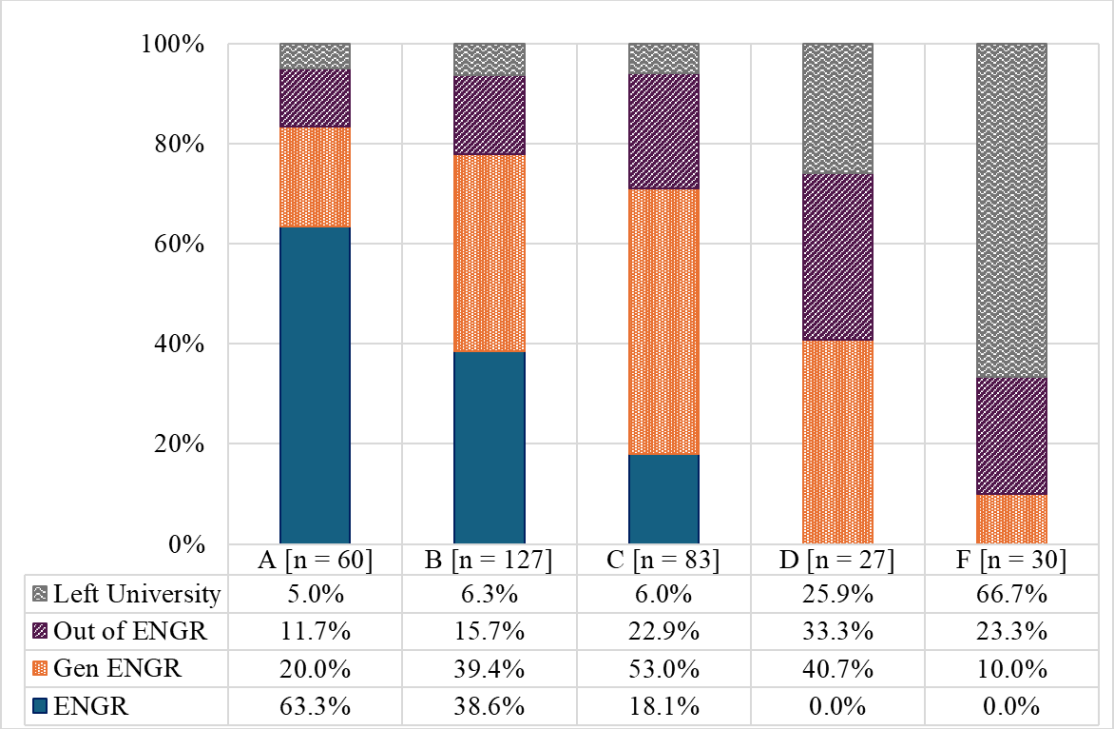
Figure 2. GELC Average Incoming Math SAT

Data on continued enrollment based on the final grade of the engineering math class with an accompanying contingency table will be used to answer research question one. To address research question two, enrollment rates into each available course of the calculus sequence will be presented. Lastly, research question three, Tukey's HSD, is performed to determine if there are significant differences in future success in mathematics courses based on student's final grades in the engineering math course.

Results and Discussion

Performance in the Engineering Math Course

Figure 3 below shows the percentage of students in the categories of left Clemson University altogether, transferred out of engineering but are still enrolled at University in another major (Out of ENGR), remaining in General Engineering (Gen ENGR), and in a declared engineering major (ENGR) based on the grades they earned in the engineering math course. This figure includes all cohorts from 2019 – 2022. At the start of year 2, the goal is to be declared into an engineering major, as general engineering is a non-degree granting department.



	A [n = 60]	B [n = 127]	C [n = 83]	D [n = 27]	F [n = 30]
Left University	5.0%	6.3%	6.0%	25.9%	66.7%
Out of ENGR	11.7%	15.7%	22.9%	33.3%	23.3%
Gen ENGR	20.0%	39.4%	53.0%	40.7%	10.0%
ENGR	63.3%	38.6%	18.1%	0.0%	0.0%

Figure 3. Continuation at the Start of Year 2 based on Engineering Math Grade

The trends shown in Figure 3 indicate that students who perform better in the engineering math course are more likely to declare their engineering major at the start of their second year, as students who perform well in the engineering math course have a better chance of being able to catch up in the engineering curriculum. Students who scored a D or F in the class show a 0% rate of enrollment as the completion of the needed sequence that would allow a student to declare by the following Fall is highly unlikely.

Table 2 below displays a contingency table for the Chi-squared independence test for enrollment status based on engineering math grade for 2019-2022. The top number of each cell is the count, the middle is the expected count, and the final number is the cell Chi-squared value as calculated by JMP [8].

Table 2. Contingency Table for Enrollment Status at the Start of Year 2 based on Engineering Math Grade

Grade	ENGR	Gen ENGR	Out of ENGR	Left University
A	38	12	7	3
	18.716	22.018	11.376	7.890
	19.870	4.558	1.683	3.031
B	49	50	20	8
	39.615	46.606	24.080	16.700
	2.224	0.247	0.691	4.533
C	15	44	19	5
	25.890	30.459	15.737	10.914
	4.581	6.020	0.677	3.205
D	0	11	9	7
	8.422	9.908	5.119	3.550
	8.422	0.120	2.942	3.351
F	0	3	7	20
	9.358	11.009	5.688	3.945
	9.358	5.827	0.303	65.340

The overall Chi-square calculated using the Likelihood Ratio method is *132.667* (*p<0.0001)* or using Pearson is *146.983* (*p<0.0001*) [8], indicating that grade and enrollment status are not independent of each other and there is a significant association between the two variables. Figure 4 below shows the percentage of students able to move into their degree major based on their final grade in the engineering math class separated by cohort.

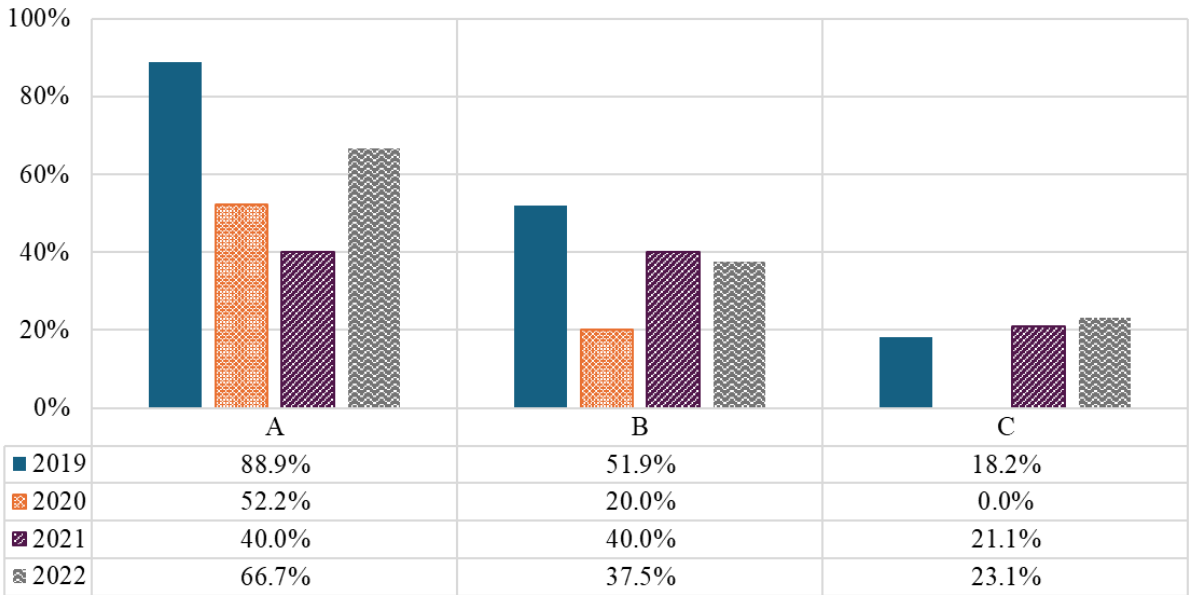
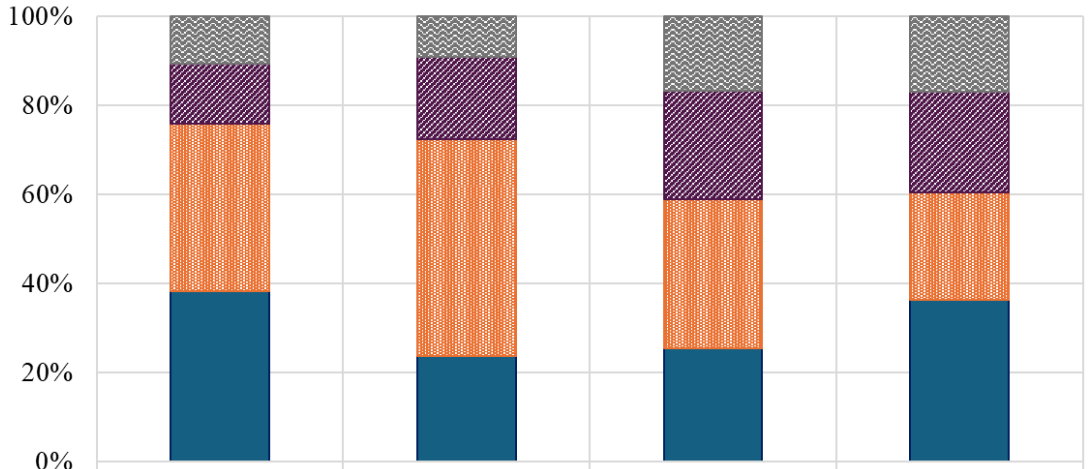


Figure 4. Declared Engineering Major at the Start of Year 2 based on Grade in Engineering Math Class

The first year of the program, 2019, had students who were more math-prepared than in later years, as evidenced by the average cohort Math SAT (607). As identification of the students needing the program has improved, later cohorts show more unpreparedness for calculus. The 2020, 2021, and 2022-year cohorts were also affected by online and hybrid math classes in high school due to COVID-19, potentially influencing the noticeable dip in math preparedness as evident in the Math SAT scores (575, 560, 554, respectively) and affecting the rate of declaring a major for those years.

Even with these challenges, the 2022 cohort of students is beginning to show similar performance to the 2019 cohort, while having the lowest average Math SAT (554). The students in the program in 2022 had similar preparedness issues to the previous years, but the engineering math course was modified to focus the content on preparing the students to enter calculus. The Klingbeil book was removed from the course, and the focus was placed on mathematical topics in ALEKS. Several hands-on engineering activities using PASCO sensors for data collection were created to enhance the student's understanding of the connection between mathematical concepts and the physical world, which may be influencing this performance.

Figure 5 below shows the enrollment at the start of year 2 for each cohort regardless of grade in the engineering math course. These results show that roughly 24% to 38% of the engineering math course students are able to declare their major (ENGR students) at the start of year two, but about 60% to 75% are retained in engineering (Gen ENGR + ENGR) going into their second year. Without the engineering math class, most students in the GELC would have been required to take Precalculus as their first math course. The results in Figure 5 show a historical improvement when compared to engineering students who begin in Precalculus, given that approximately 50% of Precalculus students typically change majors or leave the university before reaching their second year [9].



	2019 [n = 76]	2020 [n = 76]	2021 [n = 103]	2022 [n = 88]
Left University	10.8%	9.2%	16.7%	17.0%
Out of ENGR	13.3%	18.4%	24.5%	22.7%
Gen ENGR	37.5%	48.7%	33.3%	23.9%
ENGR	38.3%	23.7%	25.5%	36.4%

Figure 5. Enrollment at the Start of Year 2 based on Cohort Year

This enrollment by cohort year is further examined in Table 3 below, showing the Chi-square independence test results. The top number of each cell is the count, the middle is the expected count, and the final number is the cell Chi-squared value as calculated by JMP [8]. The actual counts in each cell generally agree with the expected values, with the largest differences occurring in the General Engineering groups in 2020 and 2022, indicated by cell Chi-squared values of 3.73 and 3.35, respectively.

Table 3. Contingency Table for Enrollment Status at the Start of Year 2 based on Cohort Year

Cohort Year	ENGR	Gen ENGR	Out of ENGR	Left University
2019	46	45	16	13
	37.927	42.591	23.316	16.166
	1.718	0.136	2.296	0.620
2020	18	37	14	7
	24.021	26.974	14.767	10.238
	1.509	3.726	0.040	1.024
2021	26	34	25	17
	32.238	36.202	19.819	13.741
	1.207	0.134	1.355	0.773
2022	32	21	20	15
	27.813	31.233	17.098	11.855
	0.630	3.353	0.492	0.834

The test statistic Chi-squared values of about 20 are slightly larger than the critical Chi-squared value of 16.92 for a significance level of 5% and nine degrees of freedom, and the probability of achieving a Chi-squared value larger than shown above is close to 2%, suggesting some possible association of continuation in engineering and cohort year however less so than grade in the engineering math course (Table 2).

Some association is expected for the 2020 and 2022 cohorts. The 2020 cohort occurred during the height of COVID-19 with online and hybrid modes of instruction, resulting in the number of General Engineering students at the start of year two being higher than the expected cell value and the number of students in an engineering major being lower than expected. Beginning in 2022, the class had a larger emphasis on math preparation, leading to a number of General Engineering students at the start of year two being lower than the expected cell value and the number of students in an engineering major being higher than expected. However, comparing these results to the results shown in Table 2 indicates that where students end up at the start of their second year is more significantly associated with their engineering math grade than their cohort year. This result is expected as students who demonstrate higher effort and/or academic performance should be more likely to enter an engineering major at the start of year two. Students who do not pass their engineering math class are typically set back a semester, making it difficult to declare their engineering major on time.

Math Course Progression

In Table 4, math progression beyond the engineering math course is tracked for the students in the program who were enrolled past the drop/add date from 2019-2022, where the asterisk represents the expected sequence.

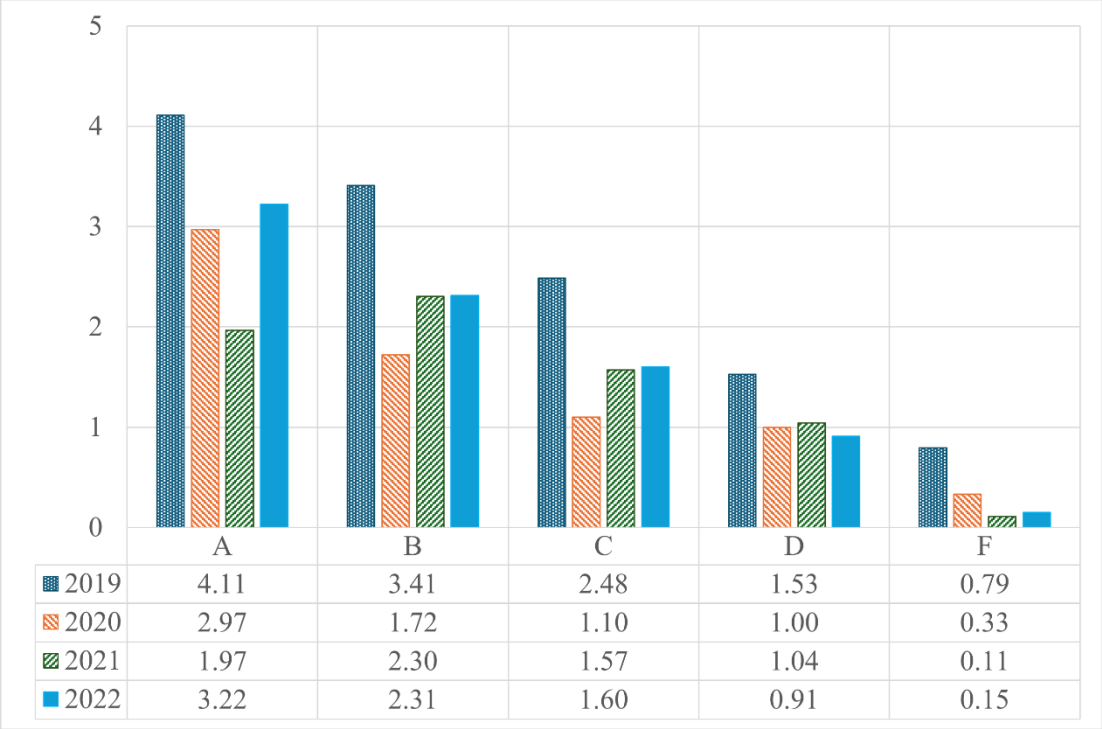
Table 4. Math Course Progression for Cohort Years 2019-2022

		Fall Year 1	Spring Year 1	Summer Year 1	Fall Year 2
	Engineering Math	336 *(100%)			
	Precalculus/ Elementary Functions		50 (14.9%)	0 (0%)	4 (1.2%)
Year-long Calculus	Precalculus and Introductory Differential Calculus		73 (21.7%)	6 (1.8%)	6 (1.8%)
	Differential and Integral Calculus		0 (0%)	41 (12.2%)	20 (6%)
Standard Calculus Sequence	Calculus of One Variable I		158 *(47%)	39 (11.6%)	17 (5.1%)
	Calculus of One Variable II		1 (0.3%)	92 *(27.4%)	85 (25.3%)
	Calculus of Several Variables		1 (0.3%)	0 (0%)	93 *(27.7%)
	Not Enrolled in Math Course Relevant to Engineering		53 (15.8%)	158 (47%)	110 (32.7%)

The 2019 cohort shows higher numbers of students making expected or on-time progress in the math sequence than in later years [1]. In the 2020 and 2021 cohorts, along with improved selection methods, the general preparedness of the entire engineering cohort was weaker due to online and hybrid course offerings due to COVID-19. The above table shows that students' progress through the math sequence was not as consistent as in the first year due to these issues. As we measure progress through the math sequence for the more recent cohorts, we hope to see improvements in enrollment in and through Calculus III.

Engineering Math Course Grades and Subsequent Math Success

Figure 6 below shows the average Math GPA based on engineering math grade by cohort year. When students are not enrolled in a math course, they are calculated as a 0. An A is a 5, and an F is a 1.



	A	B	C	D	F
2019	4.11	3.41	2.48	1.53	0.79
2020	2.97	1.72	1.10	1.00	0.33
2021	1.97	2.30	1.57	1.04	0.11
2022	3.22	2.31	1.60	0.91	0.15

Figure 6. Average Math GPA (0=not enrolled, A=5) Based on Engineering Math Grade by Cohort

Figure 6 shows that the higher the grade in engineering math, the higher the expected average Math GPA. After a significant Oneway ANOVA ($F=42.93$, $p<0.0001$), the average GPA is further analyzed in Table 5 using the Tukey-Kramer HSD test as calculated using JMP [8].

Table 5. Tukey's HSD for Mean Math GPA by Engineering Math Grade, where letters not connected by the same letter are significantly different at $\alpha = 0.05$

Grade					Mean	Standard Error
A	a				3.11	0.141
B		b			2.46	0.103
C			c		1.68	0.129
D				d	0.95	0.215
F				d	0.38	0.205

The results of Table 5 indicate that a letter grade of A, B, or C results in statistically significant mean Math GPA scores compared to each other. Additionally, letter grades of D and F differ from those of the A, B, and C groups but do not differ in terms of mean Math GPA. This is consistent with requirements that show a C is needed in the engineering math course to continue in the GELC.

In tracking subsequent math course grades for all program years, there are a couple of items of interest. The dip in 2020 and 2021 was significant due to incoming math preparedness. The rebounding of the subsequent course grades is not due to declining math preparation (lower average Math SAT) but appears to be due to the changes made to the engineering math course. Mainly focusing on the course topics to strengthen the student's preparation for calculus while still showing the connection between the math concepts and their use to solve problems in engineering. Showing the connections between math, engineering, and problem-solving has been and will continue to be a cornerstone of the course.

Comparison to Previous Studies

A dissertation study done at Clemson found that for engineering students who begin in Precalculus, approximately 50% would change majors or leave the university before reaching their second year [9]. This program, however, is able to retain more students in engineering, around 60% to 75% going into their second year (Figure 5). From another research-intensive university in the South of the United States, 6 year graduation rates were analyzed for students enrolled from 2011-2022. They found "a strong correlation between grade in preparatory math coursework and either receiving an engineering degree or leaving college with no degree" [10, p. 1293]. That is supported by the results of this study shown in Figure 4, where students with higher grades in the engineering math course are more likely to have declared an engineering major in year 2.

Another study at the University of Arkansas, a land-grant public university, with data from 2007 to 2015 found that "starting math class is a significant factor in graduation rates" [11, p. 1] and reported 37% of students who start in Precalculus graduated in engineering in 6 years compared to 57% for students who start in Calculus 1 [11] . This was echoed in another study done at a large Midwestern university from 2005 to 2011 showing that calculus eligibility was a significant predictor of graduation rate [12]. Calculus-eligible students had odds of graduating three times higher than their non-calculus-eligible peers [12]. Again, it is promising that 60 to 75% of

students in the GELC are retained in engineering going into their second year. The engineering math class was introduced in Fall 2019, so 6-year graduation rates remain to be determined. However, the 5-year graduation rate for the 2019 GELC cohort is 36.7%, compared to 73% for the calculus-eligible students, indicating an improvement over outcomes reported in previous studies.

At West Virginia University, a R1 land grant university, researchers found that 61% of students who start at the college algebra level were persisting in engineering at the start of year two [13]. This is comparable to what was found in this study for the 2021 and 2022 cohorts, but the 2019 and 2020 cohort rates were higher. They also showed that **"**during the fourth semester, 14% of the students were enrolled in Calculus 2 and 12% were enrolled in the second part of Calculus 1" [13, p. 4]. Table 2 shows how the engineering math course in the GELC program is able to get 27% of students into Calculus 3 and another 25% into Calculus 2 by the start of year 2.

Recommendations for Practitioners

Those wishing to create a similar program at their institution should consider the following recommendations:

1. Target students whose math preparation would exclude them from studying engineering at the start of their first year or limit their chances to graduate with an engineering degree. Any additional university requirements that may act as roadblocks for first-year engineering students should also be considered.
2. The engineering math class should focus primarily on math preparation.
3. The engineering math class should have components that connect the mathematical concepts learned in class to engineering applications (e.g., hands-on lab activities, engineering-related word problems).
4. The engineering math class should be one component of a more extensive program that may include grouping students into cohorts for their STEM courses during the first year, co-enrolling them in learning strategies and professional skills course, and creating a long runway for the first-year engineering sequence [7] .

Conclusions

The engineering math course performance analysis and its impact on students' continuation and success within the engineering curriculum reveals several key insights. First, students who perform well in the engineering math course are significantly more likely to declare an engineering major by the start of their second year. The data shows a clear relationship between higher grades in the engineering math course and continued enrollment in engineering programs, with those earning grades of C or higher showing stronger progression toward their intended degree paths. Students who struggle with the course, particularly those earning D or F grades, face significant barriers to remaining in the engineering major, often delaying or preventing their entry into more advanced courses.

Second, the progression through subsequent math courses demonstrates that students who perform well in the engineering math course generally show better success in their future mathematics courses, with a positive correlation between engineering math grades and future math GPAs. However, the data also highlights the challenges faced by cohorts affected by lower incoming math preparedness, particularly in the 2020 and 2021 cohorts, which were impacted by

the shift to online and hybrid learning during the COVID-19 pandemic. Despite this, modifications to the engineering math course, including a greater emphasis on calculus preparation and connections between mathematical concepts and engineering applications, have helped mitigate some of these challenges, improving student performance in subsequent courses, particularly for the 2022 cohort. The engineering math class has contributed to improved retention in engineering, accelerated progression through the math sequence, and is likely to result in higher graduation rates for GELC students compared to outcomes reported in previous research. These findings provide valuable insights for practitioners seeking to design similar programs at other institutions, emphasizing the need for early identification of at-risk students, a focused curriculum, and integrated support structures to ensure student success in engineering education.

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