From Struggle to Success: Improving Math Readiness for Engineering and Engineering-Technology Students

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From Struggle to Success: Improving Math Readiness for Engineering Technology Students

Mathematics continues to serve as a critical barrier in the progression of Engineering Technology (ET) students, limiting timely graduation and constraining preparedness for upper-level coursework and professional practice. To better understand this challenge and identify effective solutions, we conducted a multi-institutional survey across 13 institutions offering Mechanical Engineering and Mechanical Engineering Technology (MET) programs. Although the number of responses is limited, initial findings reveal a consistent pattern: many incoming students are moderately to significantly underprepared in foundational areas such as algebra, pre-calculus, and calculus, and often struggle to apply mathematical concepts in engineering contexts.

While common support structures, such as tutoring centers, supplemental instruction, and peer mentoring are available, many faculty responses emphasized the need for more applied engineering-contextualized math instruction. Drawing on survey findings and implementation examples from participating institutions, this paper highlights a few innovative approaches such as modularized and applied math sequences taught by engineering faculty, enhanced coordination with mathematics departments, targeted math bootcamps, and integration of computational tools like MATLAB and Excel. The paper also identifies persistent barriers and proposes practical strategies for reform. By synthesizing empirical insights and best practices, this work will offer a set of actionable guidance for redesigning the math experience in ET programs to improve readiness, retention, and student success.

1. Introduction

Engineering Technology (ET) programs prepare students for applied engineering careers requiring strong analytical, computational, and practical problem-solving skills. Across the United States, however, many ET programs report that mathematics remains the most significant barrier to student success, retention, and on-time graduation. National research consistently shows that mathematics placement, foundational skill gaps, and traditional abstract math instruction contribute to delays in progression, course failures, and attrition in engineering pathways [1-6].

For ET programs specifically, the challenge is uniquely complex. Mathematics required in ET often differs from traditional engineering mathematics. Many ET students are first-generation, transfer, adult, or returning learners whose math preparation varies widely. High school preparation is inconsistent, and math anxiety can impede performance and persistence [7-10]. Programs often lack tailored, applied math pathways that connect mathematical principles to engineering problems, equipment, measurement, modeling, and common industry tasks.

To address these issues, this study investigates the state of mathematics preparation, instruction, and support in ET programs across the country. Using a multi-institution survey of department chairs (4), program directors (3), and faculty (6) across several ET disciplines, such as mechanical, electrical, mechatronics, and integrated technology programs, this paper analyzes structural challenges and identifies effective models for redesign.

2. Background and Literature Review

2.1 Challenges with Mathematics in Engineering Technology

Research consistently shows that ET students often enter college with weaker preparation in algebra, trigonometry, and pre-calculus compared to traditional engineering majors, undermining their ability to succeed in subsequent technical coursework [7-8]. This challenge is exacerbated when students encounter traditional calculus-heavy sequences, which are primarily designed for engineering science majors rather than ET programs [11–12]. Gaps in foundational mathematics can hinder performance in core technical courses and contribute to lower retention rates in ET programs.

To address these challenges, multiple studies highlight the benefits of contextualized, hands-on mathematics instruction that directly links mathematical concepts to engineering applications, such as fluid mechanics or materials design. This approach fosters deeper understanding and greater engagement compared to abstract exercises [13–15]. For example, Wentworth Institute of Technology implemented a split-calculus strategy, restructuring a 14-week calculus sequence into shorter, modular courses that embed algebra and pre-calculus review within engineering-relevant contexts. Preliminary data from this program indicates improved retention and success rates among ET and underprepared students [16].

Similarly, research at the University of Western Australia demonstrated that students' mathematical background strongly influences both academic performance and program completion at undergraduate and master's levels. Survey and focus group findings revealed that many students perceive mathematics as a major obstacle, and logistic regression analyses confirmed its significant association with success in engineering courses. These results underscore the critical role of mathematics and statistics in engineering curricula and suggest that inadequate preparation can impede both persistence and achievement.

2.2 Math Placement

Mathematics placement exams play a pivotal role in shaping student trajectories in engineering programs. Research indicates that placement tools, such as ALEKS, strongly influence enrollment in gateway courses like Calculus I and can significantly affect student persistence, particularly for those with diverse levels of academic preparation. Studies suggest that an 80% ALEKS threshold optimally predicts success in Calculus I, while students near the cutoff benefit from targeted remedial interventions to support their progression [17]. Complementing these findings, research at the University of Tennessee at Chattanooga demonstrated that first-year engineering student retention is closely linked to initial math placement, with lower-level placements correlating with decreased persistence during the first year. Together, these results underscore the importance of reevaluating placement strategies and implementing tailored support mechanisms to enhance both retention and equity in engineering education [18].

2.3 Applied Mathematics Instruction

Research highlights that engineering students benefit from contextualized mathematics instruction delivered through workshops and laboratory modules that directly connect mathematical concepts to engineering practice, resulting in improved retention and stronger competency in applying mathematical reasoning [19]. Instructional models employing interactive computer simulations further support this approach by guiding students to integrate mathematical reasoning with scientific understanding in STEM coursework; such simulation-based activities have been shown to significantly enhance students' ability to formulate and apply equations in engineering-relevant contexts, while fostering deeper sense-making and cognitive complexity [20]. Additionally, flipped-classroom pedagogies in first-year engineering calculus courses have led to statistically significant improvements in students' self-reported confidence, competence, and conceptual knowledge [21].

These approaches emphasize measurement, modeling, and application-oriented tasks, strengthening students' connection to engineering content, and boosting academic performance. Across simulations, hands-on measurements, CAD integration, and active-learning frameworks, contextualized instruction consistently prepares students for upper-level technical courses by developing both mathematical competence and confidence.

2.4 Importance of Support Structures

Instructional support, peer mentoring, and math laboratories have been shown to significantly enhance student outcomes in STEM and engineering programs. For instance, in engineering education contexts, attendance at Supplemental Instruction sessions has been linked to 20–35% higher graduation rates and 20–40% lower dropout rates in rigorous engineering courses, highlighting the value of early, peer-led support [22]. Similarly, peer mentoring initiatives contribute to measurable academic gains, with participants experiencing a 0.4 GPA increase during their first term [23]. At Wright State University, an engineering mathematics redesign—incorporating lab-based problem-solving, recitations, and instruction by engineering faculty—effectively aligned mathematics learning with ET program objectives, resulting in enhanced student motivation, engagement, and retention [24].

Despite the strong evidence supporting these interventions, research focused specifically on mathematics redesign within ET programs remains limited. This gap underscores the need for more systematic investigation into how support structures can be implemented early and consistently in ET mathematics curricula nationwide. Embedding these strategies early and consistently within ET mathematics curricula has the potential to strengthen foundational competencies, increase engagement, and improve overall student progression and retention. A more intentional integration of applied mathematics, engineering-relevant examples, and structured peer-led academic support may offer a scalable model to elevate math preparedness for ET students nationwide.

3. Methods

3.1 Survey Instrument Design and Purpose

To better understand institutional perspectives on mathematics preparedness within ET programs, the ASME-METLC (Mechanical Engineering Technology Leadership Committee) team developed a comprehensive survey instrument to capture program-level practices, faculty observations, and perceived student challenges. The goal of the instrument was to identify common trends in math placement, curriculum design, instructional models, and support structures that shape ET student success in foundational mathematics.

The survey collected data across several key domains, beginning with program demographics, which provided contextual information on institutional type, program scale, ET concentrations offered, and faculty composition. Respondents were then asked to report on math entrance requirements, including whether their institution required standardized test scores, high school GPA thresholds, prior coursework, or internal readiness benchmarks.

Because placement into the correct math course is critical for ET student retention, multiple items addressed math placement processes, including the use of placement exams (e.g., ALEKS), advisor-led placement, transfer articulation, and optional or mandatory preparatory modules. Additional questions examined the structure of required math courses, including the sequencing of algebra, trigonometry, pre-calculus, and calculus, as well as whether ET programs offered contextualized or engineering-focused math pathways.

Respondents were also asked to indicate who primarily teaches math courses for ET students, mathematics department faculty, ET faculty, or a hybrid model, to explore potential differences in instructional alignment with ET curriculum goals. Several items targeted faculty perceptions of observed student skill gaps, focusing on algebraic manipulation, trigonometric reasoning, applied problem-solving, and the ability to transfer mathematical knowledge into technical coursework.

To assess institutional readiness to address these issues, the survey documented existing intervention mechanisms, such as supplemental instruction, tutoring centers, summer bridge programs, co-requisite remediation, modularized math curricula, and embedded mathematics within ET courses. Finally, respondents were invited to provide open-ended responses describing the most significant barriers their students face and recommendations for improving math preparedness in ET pathways.

The survey instrument employed a combination of multiple-choice, checkbox, Likert-scale, and open-ended items. This structure allowed the collection of both quantitative data, suitable for identifying broad trends, and qualitative insights that revealed nuanced institutional challenges and innovative practices. Collectively, the survey data created a foundation for examining national patterns in ET math preparedness and identifying actionable strategies to strengthen student success.

3.2 Participants

A total of 13 institutions participated in the survey, providing a diverse cross-section of programs involved in ME and ET education. The responding institutions represented a range of ET and engineering pathways, including:

- Mechanical Engineering Technology (MET) programs.
- Electrical Engineering Technology (EET) programs.
- Mechatronics and Automation programs.
- Integrated or multidisciplinary ET programs that combine mechanical, electrical, and manufacturing technology.
- Mechanical Engineering (ME) programs with significant curricular overlap or shared service courses with E.T
- Mathematics departments that provide service courses for ET curricula.

This distribution reflects the interdisciplinary nature of ET programs and highlights the range of mathematical preparation needs across different technical specialties.

The survey received responses from individuals holding key academic and administrative roles, ensuring that feedback reflected program-level decision-making and direct instructional experience. Respondents included:

- Department chairs who oversee program structure and resource allocation.
- Program directors and coordinators responsible for curriculum design and accreditation compliance.
- Curriculum committee chairs who guide course sequencing, outcomes alignment, and curricular reform.
- Faculty members, including engineering and mathematics instructors, and who offer first-hand insights into student preparedness and classroom challenges.

Collectively, these respondents, representing a modest sample size, brought institutional knowledge regarding student performance trends, placement practices, and the effectiveness of existing support structures. Their perspectives offer valuable insight into national patterns in math readiness among ET students, and the systemic challenges programs face when addressing foundational mathematical deficiencies. Additional institutions are being recruited, and the survey will remain open to allow for ongoing data collection and periodic updates to strengthen the robustness and generalizability of the results.

3.3 Data Analysis Procedures

Quantitative and qualitative data were analyzed using complementary approaches to examine institutional practices and perceptions of mathematics preparedness in ET programs.

Quantitative responses (multiple-choice, checkbox, and Likert-scale items) were summarized using descriptive statistics, including frequencies, percentages, and mean values, to identify common patterns in math placement, course sequencing, instructional models, and support structures.

Qualitative, open-ended responses were analyzed using thematic coding to identify recurring patterns related to student skill gaps, placement challenges, curricular alignment, and institutional support. Responses were reviewed and grouped into overarching themes, providing context to the quantitative findings, and highlighting key institutional concerns and strategies.

Together, these analyses provide a comprehensive view of mathematics readiness in ET programs and inform the identification of actionable strategies for improving student success.

4. Results

4.1 Program Characteristics and Enrollment

Respondents were also asked to estimate the number of students enrolled annually in their respective programs. Although the sample size is small (n = 13), the responses reveal a wide range of program sizes, illustrating substantial variation in scale across ET and related engineering programs.

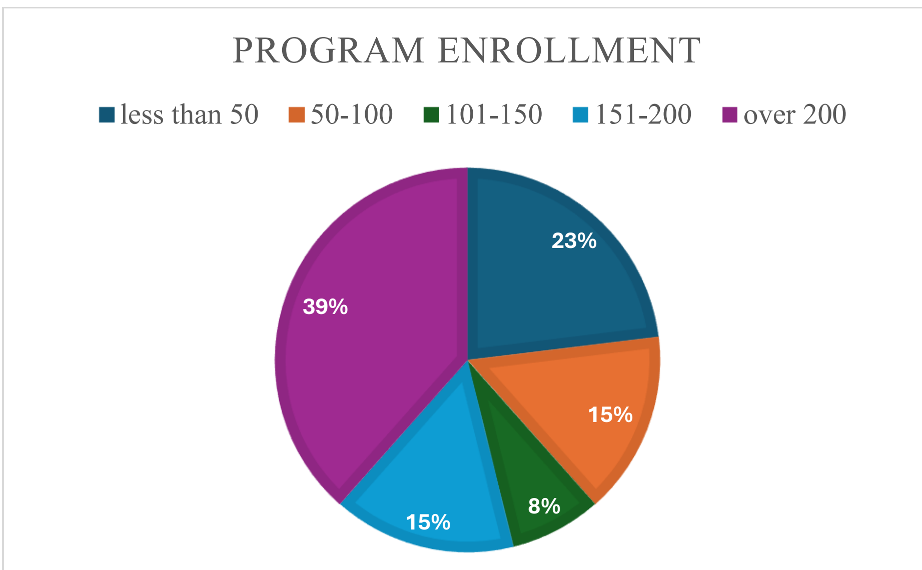

Figure 1. Program Enrollment Data for ET Programs

Five respondents (39%) reported enrollment greater than 200 students per year, indicating that several institutions operate large, high-volume ET or engineering programs. Additionally, two respondents (15%) reported annual enrollment in the 151–200 range and one respondent (8%) in the 101–150 range, further reflecting the presence of medium-sized programs within the dataset.

At the same time, smaller programs were also represented. Three respondents (23%) indicated enrollments of fewer than 50 students, and (15%) reported enrollments in the 50–100 range. This distribution highlights meaningful diversity in program size, spanning small, specialized ET programs to large, comprehensive engineering and technology departments.

This variation in enrollment provides important context for interpreting challenges related to mathematics preparation and curriculum support, as program size can influence advising structures, placement models, resources for mathematics support, and the scalability of interventions. As with other survey items, we recognize that the current number of respondents is limited; however, we are continuing to collect additional responses and will update the dataset to strengthen the robustness of these findings in future reporting.

4.2 Math Entrance Requirements for Program Admission

Participants were asked to identify the mathematics entrance requirements used for admitting students into their programs. Responses indicate substantial variability in institutional expectations. Across the 13 respondents, the most reported criterion was "No formal math requirement beyond general university admission," which appeared six times. This suggests that a notable proportion of ET and related engineering programs rely primarily on institutional admissions standards rather than program-specific mathematics prerequisites.

The second most prevalent requirement was the use of an institutional or state-level placement exam, reported four times. This mechanism allows programs to assess incoming students' mathematics proficiency and place them directly into an appropriate starting course (e.g., college algebra, pre-calculus, or calculus). Requirements involving prior mathematics achievement, such as completion of pre-calculus (reported two times) or a minimum high school GPA in math courses (reported once), were less common in this dataset.

Overall, the responses highlight a spectrum of math entrance requirements, from highly flexible (no formal requirements) to more structured approaches relying on placement metrics or demonstrated prior achievement. This diversity underscores the differing philosophies and constraints across institutions regarding mathematics preparation, particularly for ET programs that often serve broad and varied student populations. As with earlier findings, the limited number of respondents (n = 13) constrains generalization; however, additional responses will be incorporated as they become available to strengthen the robustness of the emerging patterns.

4.3 First Math Course in the Curriculum

Respondents were asked to identify the first mathematics course that students typically take upon entering their programs. The results show clear clustering around two primary entry points: Pre-Calculus/College Algebra (62%) and Calculus I (38%). This aligns with the broader observation that many ET programs enroll students with varied mathematics backgrounds, often requiring them to strengthen algebraic and trigonometric foundations before progressing to higher-level mathematics. As with other findings, these results are based on a small sample size (n=13) and ongoing data collection is expected to provide a more comprehensive national picture in future analyses.

4.4 Mathematics Curriculum Requirements for Engineering Technology Students

Mathematics requirements across engineering technology programs vary widely, reflecting differences in curricular emphasis and institutional philosophy; the respondents were asked to select all that apply. Survey data indicate that while Calculus I is universally required, subsequent higher-level coursework diverge significantly. This reflects the consensus that a solid understanding of introductory calculus is essential for students to engage successfully with subsequent engineering technology coursework, including statics, dynamics, and foundational engineering analysis.

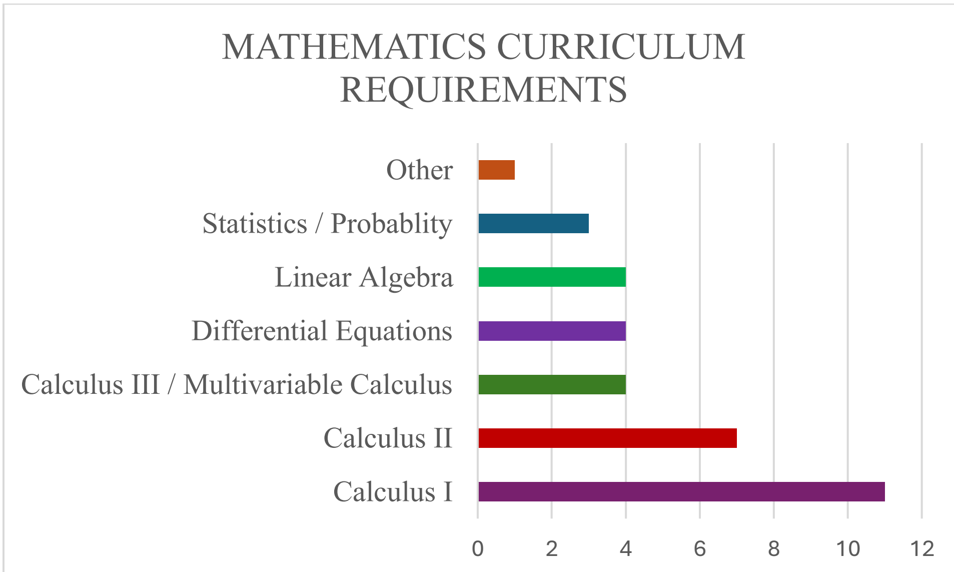

Figure 2. Mathematics Curriculum Requirements for ET Programs

Beyond Calculus I, there is diversity in required mathematics courses. Calculus II is required in most programs, though a few programs allow students to progress without it, particularly in curricula emphasizing applied or context-specific mathematical tools rather than a traditional calculus sequence. For students continuing in the standard calculus pathway, many programs extend requirements to Calculus III (Multivariable Calculus), Differential Equations, and/or Linear Algebra, indicating an expectation that students will develop multi-dimensional problem-solving skills, modeling abilities, and familiarity with matrix operations crucial for systems analysis and engineering computations. Some programs include Statistics or Probability, which aligns with the increasing importance of data analysis, quality control, and experimental design in engineering technology disciplines.

Overall, this dataset illustrates a spectrum of mathematical preparation within ET programs: while all students engage with Calculus I, the depth and breadth of higher-level math requirements vary.

4.5 Instruction of Mathematics Courses in Engineering Technology Programs

An analysis of the faculty teaching assignments for required mathematics courses in ET programs reveals a clear distinction between traditional mathematics courses and program-specific applied mathematics offerings. The data indicates that the majority of standard mathematics courses, such as Calculus I, Calculus II, and other higher-level courses, are taught by mathematics department faculty. In contrast, customized mathematics courses designed specifically for ET students, and often labeled as Engineering Mathematics or similar, are taught by ET faculty. These courses typically integrate applied topics such as differential equations, linear algebra, Laplace transforms, and other mathematical techniques selected to directly support engineering technology coursework and practice. They provide a contextualized, hands-on approach, emphasizing problem-solving and applications relevant to ET, rather than abstract mathematical theory.

To follow up, the extent to which mathematics courses incorporate engineering applications varies across ET programs. Survey responses to the question “Are the math courses designed or delivered with engineering applications (e.g., modeling, problem-solving, engineering examples)?” indicate a spectrum of implementation. The most common response (38%) is “rarely”, followed by “sometimes” (23%), while one responder mentioned “Only the one taught by ET faculty”

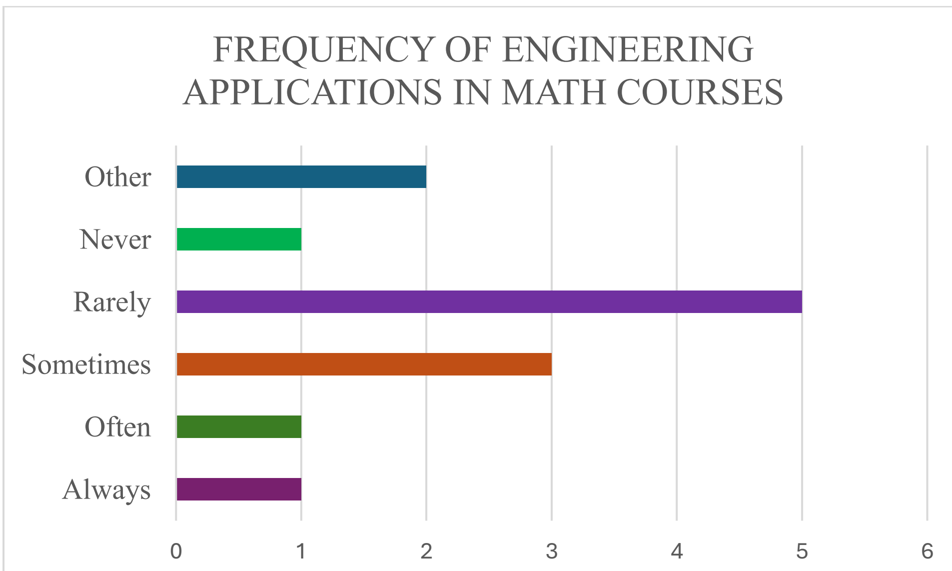

Figure 3. How Often Are Math Courses Designed with Engineering Applications

4.6 Student Struggle to Pass Math Courses

Survey responses reveal notable differences in how frequently students struggle to pass key mathematics courses required in ET programs. The data indicate that challenges are more commonly observed in early and mid-sequence courses, with significant variation across the curriculum.

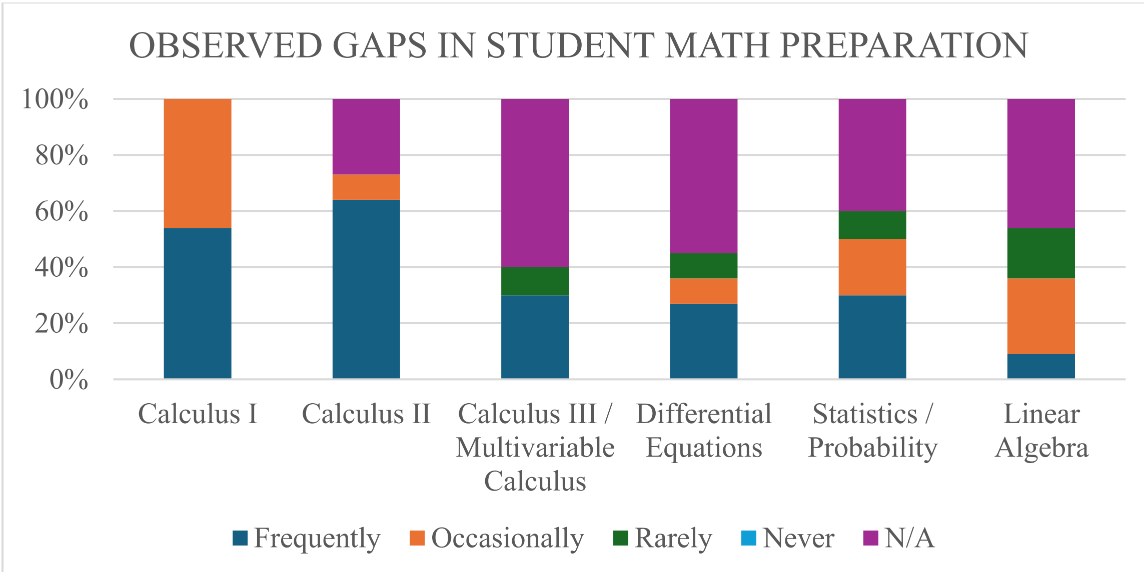

Figure 4. Observed Gaps in Student Math Preparation

Calculus I was identified as a frequent challenge, with 54% of respondents reporting that students frequently struggle to pass and the remaining 46% noting occasional difficulties. Calculus II showed an even stronger pattern, with 64% reporting frequent struggles and 9% reporting occasional struggles, and 27% selecting N/A. For Multivariable Calculus (Calculus III), 30% of respondents indicated that students frequently struggle, while 10% reported rarely while 60% selected N/A. A similar trend emerged for Differential Equations, where 27% of respondents reported frequent struggles, 9% noted occasional struggles, 9% noted occasional rarely, and 55% selected N/A. Statistics/Probability showed a wider distribution of challenges, with 30% indicating frequent struggles, 20% reporting occasional struggles, 10% reporting rarely struggles, and 40% selecting N/A.
This high “N/A” rate may indicate that many ET programs do not require this course or that respondents do not have direct visibility into student performance.
Taken together, the findings indicate that student difficulties are most pronounced in Calculus I and II, which serve as critical gateways for success in the engineering curriculum. Struggles in these early courses can impede student progression and ultimately delay graduation. These results highlight the importance of enhanced support systems, well-timed intervention strategies, and stronger alignment between mathematics instruction and engineering program requirements to ensure students can successfully navigate the required math sequence.

4.7 Engineering Faculty Observations of Gaps in Students’ Math Skills

The survey also asked if the faculty teaching core engineering courses observe gaps in students’ mathematics skills, an issue that directly affects students’ readiness to engage with foundational core engineering concepts. Responses indicate a strong consensus that such gaps are both present and consequential.

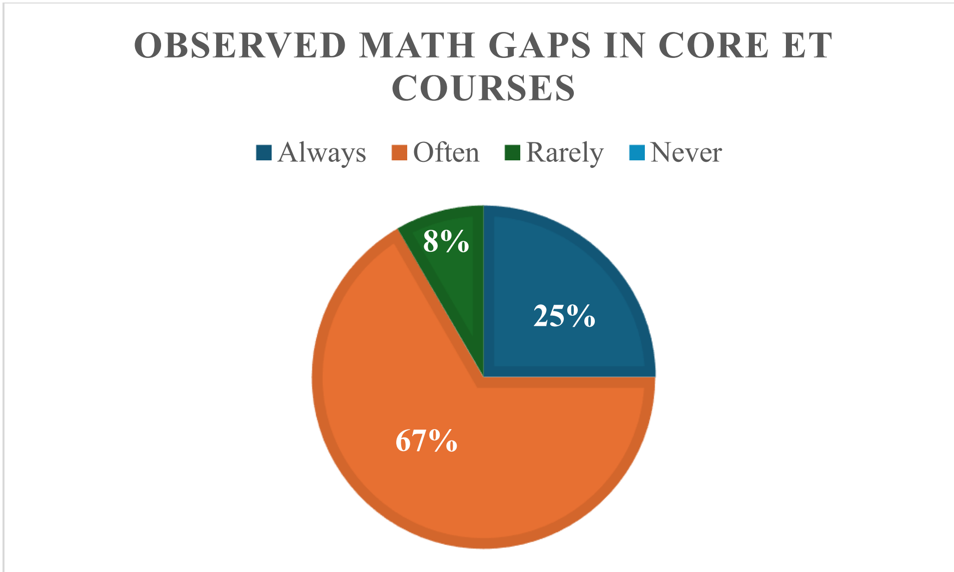

Figure 5. Observed Gaps in Students' Math Skills in Core ET Courses
("Never" option is 0%)

Many respondents reported that they often observe deficiencies in students' math preparation, with 8 faculty selecting "Often". An additional 3 faculty indicated that they "always" encounter such gaps in their courses, while only 1 respondent reported "rarely, suggesting that math readiness concerns are widespread across the curriculum. The prevalence of observed gaps underscores the need for intentional coordination between mathematics and engineering programs. Strengthening prerequisite alignment, developing targeted review modules, and expanding early academic support may help ensure that students enter engineering courses with the mathematical foundation necessary for success.

Overall, the survey results reinforce that math skill gaps are not isolated or occasional concerns; rather, they represent a recurring challenge that directly impacts student performance and progression in ET programs.

4.8 Institutional Support Structures

Across participating institutions, a variety of academic support is currently in place to assist students who struggle with required mathematics courses. Respondents identified a range of commonly used resources, with several institutions offering multiple layers of support, such as tutoring centers, math learning labs, supplemental instruction, online resources, and peer mentoring; a select all that apply option was on the survey.

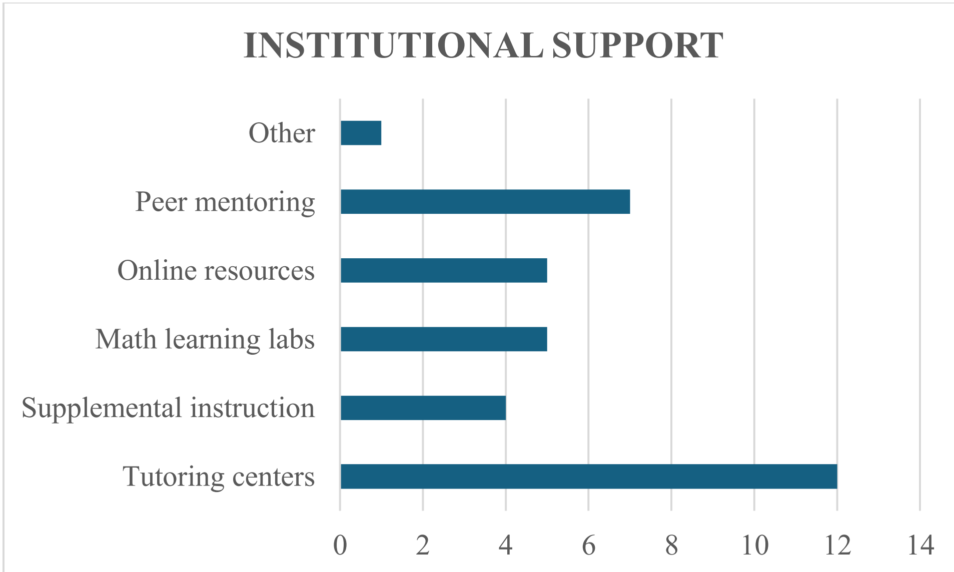

Figure 6. Institutional Support Structures

Tutoring centers were reported as the most widely available resource and serve as the primary mechanism for addressing recurring student difficulties. These centers typically provide drop-in assistance, scheduled appointments, and targeted help for high-enrollment math courses such as Calculus I and II. Peer mentoring and study groups emerged as another key support strategy. A peer-led environment often reduces the intimidation associated with seeking help and promotes stronger engagement, especially for first-year students adjusting to the rigor of college-level mathematics.

Supplemental instruction (SI) was also cited as an effective model. SI sessions, usually facilitated by trained upper-level students, provide structured opportunities for collaborative learning, problem-solving practice, and exam preparation. Several institutions reported offering math learning labs where students can work through assignments with access to real-time support from tutors or graduate assistants. Five responders selected the online resource. These tools provide flexible support for students who may not be able to attend in-person sessions or who need just-in-time reinforcement of specific topics.

Overall, the survey results highlight that many institutions have already implemented a broad spectrum of effective math support mechanisms, demonstrating a strong commitment to helping students succeed in foundational courses. By continuing to expand coordination among support services and increasing their visibility to students, institutions have a valuable opportunity to strengthen math readiness and promote smoother progression through engineering and engineering technology programs.

4.9 Responders Recommendations to Improve Math Preparedness

Recommendations from faculty emphasize the importance of making mathematics more applied and relevant to engineering contexts. Suggested approaches include integrating math concepts directly into engineering coursework, developing applied math courses taught by engineers for engineers, and offering preparatory or pre-calculus classes for students entering the program.

Several programs also recommended enhanced admission criteria and early-intervention strategies to identify and support students who may struggle, as well as efforts to collaborate with feeder schools through math camps or dual enrollment courses to strengthen readiness prior to college.

More systemic initiatives were also suggested, including tailoring mathematics curricula to meet specific program needs, collaborating with mathematics departments to ensure alignment with engineering and technology courses, and leveraging grants or partnerships to improve math education at the high school level. These recommendations reflect a recognition that effective support requires a combination of institutional resources, curricular alignment, early intervention, and applied instruction, all aimed at reducing course failures, strengthening foundational skills, and better preparing students for the rigor of engineering and engineering technology programs.

5. Discussions

The survey findings provide a primary snapshot of mathematics preparation, instructional practices, and support structures across ET programs. Collectively, the data illustrates a consistent theme: mathematics readiness remains a critical factor influencing student success, progression, and retention in engineering and engineering technology curricula.

Program characteristics and enrollment patterns (Section 4.1) reveal substantial diversity, ranging from small, specialized programs to large, high-volume departments. This variation has implications for designing scalable math support strategies. Larger programs may have the resources to implement multiple interventions simultaneously, while smaller programs may require more targeted or integrated approaches.

The analysis of math entrance requirements (Section 4.2) and first math courses (Section 4.3) highlights that many programs admit students with varied mathematical backgrounds, often relying on general university admissions standards, and might contribute to differential preparedness.

Findings from Sections 4.4 to 4.6 demonstrate that gateway courses such as Calculus I and II consistently present the greatest challenges for students, with high frequencies of observed struggles reported by both mathematics and engineering faculty. These early struggles can hinder progression through subsequent courses, delaying graduation and increasing attrition risk. The data also indicates that math gaps persist beyond introductory calculus, with students facing difficulties in upper-level math courses, such as Multivariable Calculus and Differential Equations.

Faculty observations discussed in Section 4.7 reinforce that math skill gaps are persistent and consequential. Across core engineering courses, nearly all respondents noted frequent or consistent deficiencies in students' math skills, highlighting the ongoing need for alignment between mathematics instruction and program-specific engineering competencies.

Institutional support structures (Section 4.8) reveal that many programs have implemented a broad spectrum of effective interventions, from tutoring centers to peer mentoring, supplemental instruction, learning labs, and online resources. These mechanisms provide multiple access points for students to reinforce mathematical skills. Programs that systematically integrate support services and encourage early, consistent engagement are better positioned to mitigate math-related challenges.

Findings from faculty recommendations discussed in Section 4.9 emphasize making mathematics more applied and relevant to engineering contexts, developing preparatory or pre-calculus courses, enhancing admission criteria, and implementing early-intervention strategies. Broader systemic initiatives, such as aligning math curricula with program needs, collaborating with feeder schools, and leveraging external partnerships or grants, were also suggested as strategies to strengthen foundational skills and improve student outcomes.

Taken together, these findings suggest several key implications:

a. Early and applied interventions are critical. Strengthening support in gateway math courses and integrating engineering applications can help students see the relevance of mathematics and increase persistence in engineering.
b. Coordination with Math Departments to ensure that curricula, instruction, and support services address the skills students need to succeed in their programs.
c. The need for scalable, multi-layered institutional support and a combination of peer mentoring, tutoring, active learning, and online resources to reach diverse student populations and reduce course failures.
d. Continuous evaluation and adaptation are required, and the programs should monitor outcomes, adapt interventions, and explore innovative strategies to address evolving student needs.

Overall, the survey results indicate that while many institutions have developed promising strategies to support math readiness, opportunities remain to enhance coordination, align instruction with program expectations, and increase the visibility and impact of support structures.

6. Conclusions

This survey of thirteen ET programs underscores enduring challenges in students' mathematical preparedness. Our findings suggest that variability in entrance requirements, ranging from general university admission to more structured prerequisite math assessments, contributes to uneven student readiness and may exacerbate performance issues in core gateway mathematical courses like Calculus I and II.

Institutions are responding with multifaceted support initiatives aimed at strengthening student mathematics preparation. These efforts align with research demonstrating that targeted academic support, active learning strategies, and contextualized, applied instruction can enhance student outcomes, particularly by improving mathematics self-efficacy and first-year retention [25-26]. Our data also supports integrating engineering-relevant math instruction, where concepts are contextualized with practical applications and reinforced through collaborative, peer-supported learning environments that promote deeper understanding and skill development [27].

Looking ahead, a coordinated, institution-wide strategy may have the greatest impact. Key recommendations include:

a. Strengthening diagnostic assessment and placement systems to identify students who would benefit from preparatory math courses.
b. Collaborating across mathematics and engineering departments to co-design applied math curricula that directly reinforce engineering concepts.
c. Scaling peer-led support, such as mentoring and supplemental instruction, to reach more students early in their academic careers.
d. Investing in pre-semester and summer bridge programs that both bolster math skills and build community, thereby promoting first-year retention.
e. Continuously evaluating these interventions through longitudinal tracking, collecting data on persistence, course success, and graduation outcomes.

By leveraging evidence-based practices and aligning interventions with institutional contexts, ET programs can meaningfully improve mathematical preparation, thereby helping students progress more confidently and persist successfully in the engineering program.

This study draws responses from 13 institutions, and the findings may not be fully generalized to all ET programs. The survey results discussed herein primarily capture faculty and program leaders' perceptions rather than direct measures of student performance. Future research should expand the sample to include a broader range of institutions and to incorporate quantitative student performance data to validate and extend these insights.

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