WIP: Preparing First-Time College Students for Engineering Success: Implementation and Evaluation of the STEP Program

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Abstract

This work in progress paper will describe the **Successful Transition to an Engineering Program (STEP)** initiative designed to support first-year students during the summer prior to their initial semester in engineering studies. STEP is part of the Texas A&M University Engineering Academy, a first-of-its-kind dual-enrollment initiative that provides an innovative pathway to an engineering degree in partnership with ten two-year colleges across the state. Unlike traditional transfer programs, students admitted into an Engineering Academy are dually enrolled at both Texas A&M University and a partner community college. While completing core curriculum courses at the community college, such as math, science, history, writing/literature, and more, the students simultaneously enroll in Texas A&M University engineering courses taught by Texas A&M University faculty embedded at the partner institution. This unique model enhances **access**, **affordability**, and degree **completion**—three critical goals of the program. (See appendix 1 for program description).

This paper presents an analysis of Fall 2023 - 2025 student outcomes, comparing academic performance between STEP participants and non-participants across math, programming, and chemistry. Key performance indicators include course success rates (defined as a grade of C or better), academic persistence, and self-reported confidence levels. Implementation strategies, including instructional design, student engagement techniques, and lessons learned over three years of iteration, are discussed.

A 2024 survey of prior Engineering Academy participants revealed areas of underperformance among first time-in-college (FTIC) students, particularly in Precalculus and Calculus readiness, Python programming, and Chemistry for Engineers. The findings informed refinements to the STEP curriculum, including the addition of a Chemistry module in Summer 2025. The current program now consists of three core components:

1. Introduction to Engineering Math – a foundational module focusing on algebra and pre-precalculus concepts.
2. Introduction to Python Programming – an applied module covering logic, syntax, and problem-solving fundamentals.
3. Introduction to Chemistry for Engineers – a conceptual refresher and preparatory course aligned with the Texas A&M University chemistry curriculum.

Delivered in hybrid format to accommodate students across the state, the program includes asynchronous content, diagnostic assessments, and peer mentoring. There are ten partner two-year institutions across the state.

Preliminary data suggest that STEP participants demonstrate improved performance in first-semester STEM courses, higher levels of academic preparedness, and increased retention. These findings highlight the critical role of pre-college interventions and community college

partnerships in broadening access and success in engineering education, offering a scalable model for other institutions seeking equity-centered, data-informed first-year support programs.

Introduction

First-time-in-college (FTIC) students entering engineering programs frequently encounter academic and transitional challenges that affect early performance and persistence in STEM majors. National longitudinal analyses have shown that early academic momentum, particularly successful completion of mathematics coursework, strongly predicts degree attainment [1]. Similarly, national data on STEM attrition indicates that many students leave STEM fields during the first year, often due to academic difficulty in foundational courses [4].

These findings have contributed to the growth of structured pre-college and summer bridge programs designed to improve college readiness prior to matriculation. A comprehensive review of STEM summer bridge literature found that such programs commonly aim to strengthen academic preparation, increase students' sense of belonging, and support transition into rigorous college environments [2]. More recently, a meta-analysis of university STEM summer bridge programs reported a statistically significant positive effect on first-year GPA and retention, indicating that structured pre-college interventions can measurably improve early academic outcomes [3].

The theoretical foundation for these interventions aligns with student persistence research, which emphasizes the importance of academic and social integration during the first year of college [5]. Early preparation programs can contribute to both dimensions by reinforcing foundational knowledge while fostering confidence and institutional connection before students encounter the full rigor of their coursework.

Grounded in the literature on early STEM intervention, the STEP initiative within the Texas A&M University Engineering Academy was developed to address preparation gaps in mathematics, programming, and foundational science coursework prior to the first fall semester. By situating STEP within established research on summer bridge and transition programs, this study contributes to the growing body of evidence examining how structured pre-college support influences first-year academic performance, persistence, and student confidence in engineering pathways.

Launched in 2022, STEP was created in response to an identified need for enhanced student support and retention within the rigorous discipline of engineering. The program was specifically designed to mitigate gaps in academic preparedness frequently encountered by FTIC students as they begin their studies. Early institutional data—including course performance metrics, end-of-semester surveys, and structured feedback from engineering faculty—indicated that many incoming students were underprepared for the demands of first-year mathematics and introductory programming coursework.

STEP recognizes that successful transition into engineering requires more than content readiness alone. Students must also adapt to new academic expectations, develop effective learning strategies, and build confidence within a highly structured and performance-driven environment.

In response, the initiative evolved to provide a comprehensive suite of targeted academic and transitional support delivered prior to matriculation. The program's central objective is to strengthen early academic performance, foster a sense of belonging, and equip students with the foundational competencies necessary to navigate the engineering curriculum successfully.

From its inception, STEP has been guided by continuous assessment and responsiveness to student needs. Through iterative evaluation and data-informed refinements, the program has expanded its scope and adapted its instructional components to ensure relevance and measurable impact before students begin their first semester.

In Summer 2023, STEP leadership began exploring opportunities to extend its impact beyond the Engineering Academy cohort. Recognizing broader implications for STEM student success, the initiative established strategic partnerships with EdReady and the Texas A&M University Data Science department to enhance curriculum delivery in mathematics and programming. With these collaborations in place, the Engineering Academy prepared to support a Fall 2023 cohort of 545 incoming students, each entering their engineering program with structured preparation and guided support.

Project Approach

The STEP initiative was developed using a data-informed framework grounded in student performance metrics, end of semester survey responses, and faculty feedback collected during the 2022 and 2023 academic years. Anonymous university surveys provided insight into first-year student experiences, while discussions with faculty across all ten Engineering Academy partner locations highlighted recurring academic challenges.

In addition to academic performance data, collaboration with the engineering advising department enabled deeper analysis of course grades, probation statistics, and early retention indicators. This cross-functional partnership was essential in evaluating potential correlations between participation in STEP and first-year academic persistence.

The primary areas of concern identified through this analysis were consistent underperformance in pre-calculus and Calculus I during that first semester, along with widespread unfamiliarity with coding or programming in the university's predominant language chosen, Python. As the 2024 academic year progressed, the advising data further revealed elevated struggles in the introductory chemistry courses, based on grades and probation statistics.

In response to these findings, STEP was expanded to include a chemistry preparation component beginning the following summer. This addition reflected the program's ongoing commitment to aligning preparatory instruction with demonstrated areas of academic need. Through data review and stakeholder collaboration, STEP continues to refine its curriculum to better support first-year engineering students across foundational STEM disciplines.

Results and Discussion

A key partnership supporting the evolution of STEP was established with the university's Institute of Data Science. Together, the teams developed a specialized preparatory course introducing incoming engineering students to Python programming. Within the Texas A&M University engineering degree plan, students are required to enroll in at least one engineering-specific course each semester during their first year. For most, this includes an introductory Python coding class in their first semester, a fundamental skillset in modern engineering. Although students typically anticipate the rigor of math and science requirements, many underestimate the centrality of coding in modern engineering practice and arrive with limited or no prior exposure.

The STEP Python module was therefore designed not only to introduce foundational programming concepts—such as logic, syntax, and problem-solving—but also to reduce anxiety and increase self-efficacy among students new to coding. By providing early exposure in a lower-stakes environment, the initiative sought to mitigate the intimidation often associated with entering a first programming course without background knowledge.

In 2023, STEP also formalized a partnership with EdReady, an adaptive online learning platform designed to strengthen college-level math readiness. Although implementation required institutional investment, the platform provided a personalized learning pathway based on diagnostic assessments. A customized pre-engineering math module allowed students to progress at their own pace while tracking skill mastery. Among the 545 students who began in Fall 2023, first-year retention reached 77%, suggesting a positive association between early academic preparation and persistence.

2024 Modifications

Following the academic year for the Fall 2023 cohort, STEP enrollment increased by approximately 30.5%, rising from 545 to 711 students in Fall 2024. This substantial growth required both logistical expansion and instructional refinement. One major modification included transitioning the Python module to LinkedIn Learning, leveraging industry-developed content to enhance instructional quality and scalability.

The LinkedIn Learning model provided structured coursework taught by industry experts, supplemented by certifications and digital badges upon completion. These credentials offered students tangible professional benefits while reinforcing engagement and accountability. The dual academic and career-development value of this approach aligned with STEP's broader objective of preparing students for both coursework and workforce readiness.

For mathematics, the partnership with EdReady continued, maintaining adaptive, personalized skill development. At the conclusion of the academic year, first-year retention for the Fall 2024 cohort was recorded at 74%. While slightly lower than the previous year, retention remained above national averages for first-year college students in STEM disciplines, suggesting continued program effectiveness despite rapid enrollment growth.

Retention trends since the implementation of STEP in 2022 indicate measurable gains relative to the 2021 baseline year, prior to program launch (Figure 1). Although first-year retention for the

Fall 2025 cohort is not yet available at the time of this writing, preliminary academic performance indicators suggest continued positive momentum.

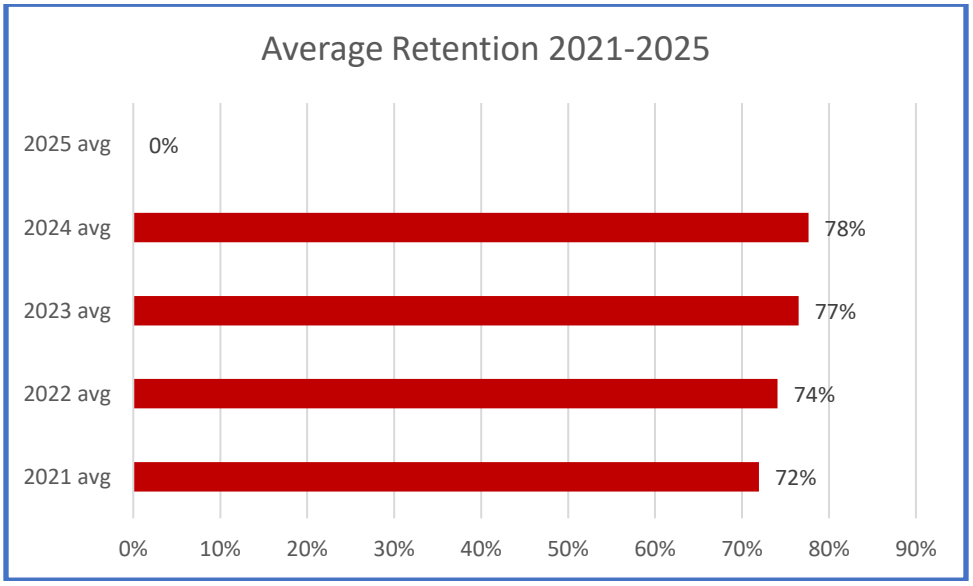

Figure 1. Average Retention 2021-2025

2025 Updates

Fall 2025 marked a record enrollment of 875 Engineering Academy students. In response, STEP expanded its infrastructure and formed a partnership with the Texas A&M Engineering Experiment Station's EDGE Program, a state-affiliated initiative within the College of Engineering that provides professional education and workforce development programming. Through this collaboration, a dedicated Python programming course was developed specifically for Academy students, incorporating structured assessments and culminating in a certificate of completion. This model further strengthened alignment between academic preparation and professional credentialing.

For mathematics instruction, STEP transitioned to a scalable online classroom model utilizing Khan Academy's comprehensive college-level math resources. The decision reflected both cost-efficiency and the need to support a rapidly growing student population while maintaining access to high-quality content.

Recognizing persistent challenges in first-year chemistry performance, STEP introduced a chemistry preparation component in 2025. Engineering Academy students are required to enroll in Chemistry for Engineers; however, many have limited recent exposure to chemistry coursework. By integrating preparatory materials aligned with the university's chemistry department expectations, the program aims to reduce knowledge gaps and improve course outcomes in this foundational science area.

With these enhancements, STEP continues to monitor academic and retention outcomes for the record-breaking Fall 2025 cohort. Given the structured refinements and expanded academic support systems, the program anticipates sustained or improved first-year retention rates.

Looking Ahead - 2026

For Summer 2026, the Engineering Academy has appointed two faculty members to lead a comprehensive redesign of STEP. These faculty members bring direct experience teaching first-year engineering courses and will integrate discipline-specific pedagogical strategies into the program. The revised model will incorporate insights from Fall 2025 student surveys, with particular emphasis on increasing faculty engagement, strengthening academic integration, and fostering a sense of belonging prior to matriculation.

This next iteration reflects STEP's evolution from a preparatory intervention to a fully integrated academic transition model. By embedding experienced engineering faculty into the summer bridge experience, the program seeks to deepen alignment with first-year coursework and enhance early academic identity formation among participants.

Appendix 1

Program Introduction

The Texas A&M University Engineering Academies were launched in 2015 as part of the institution's broader land-grant mission to expand access to high-quality engineering education across the state. By enabling students to begin their academic careers at nearby two-year partner institutions while maintaining direct entry into the university's College of Engineering, the Academies established the first dual-enrollment engineering pathway of its kind. The inaugural cohort included 38 students across two sites—one urban and one rural—demonstrating an early commitment to geographic access and regional inclusion. This model was intentionally designed to advance three primary objectives: increased access, improved affordability, and strengthened degree completion outcomes.

Following early success, the program expanded strategically to additional locations statewide. Now, after a decade of implementation, the Engineering Academies encompass ten partner sites and serve 875 first-year students as of Fall 2025. Across all locations, the average first-year retention rate is approximately 75%, reflecting consistent student persistence within a distributed, co-enrollment structure.

The Academies serve a student population whose demographic and financial characteristics differ meaningfully from those who begin directly at the main campus. Approximately 29% of Academy students identify as first-generation college students, and 34% are Pell Grant eligible. More than half of participants work over 20 hours per week, and many rely substantially on financial aid to support their education. For these students, the opportunity to remain within their home communities during the first one to two years of study significantly reduces financial burden while preserving access to a nationally recognized engineering curriculum.

In the context of growing statewide and national demand for engineering professionals, scalable and financially accessible pathways are essential. The Texas A&M University Engineering Academies address this need by reducing geographic and economic barriers while maintaining academic rigor. Through sustained partnerships with two-year institutions, the program continues to expand educational opportunities, strengthen regional workforce development, and advance the university's public mission.

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