Community-Based Strategies for Improved Retention In Engineering Programs

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Joseph B. Herzog is an Associate professor in the R.B. Annis School of Engineering at the University of Indianapolis. He chose to come to the University of Indianapolis because he is passionate about teaching, is excited about the direction of the new R.B. Annis School of Engineering, is glad to return to his engineering roots, and is happy to be close to his extended family. Previously he was an Assistant Professor in the Department of Physics at the University of Arkansas. He is truly grateful for his time at the University of Arkansas, and enjoyed his department, students, and the campus. While in Fayetteville, he also served as a faculty in the Microelectronics-Photonics Program and the Institute for Nanoscience and Engineering. He received his PhD from the University of Notre Dame working in the Nano-Optics Research Lab with J. Merz and A. Mintairov. After this he was a Welch Postdoctoral Research Associate, researching plasmonic nanostructures at Rice University with Douglas Natelson in the Department of

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Abstract

This Complete (Evidence-based practice) Paper will share various evidence-based practices which focus on building community to improve student retention in engineering. At a small, private university in the Midwest, first-year retention rates for first-year full-time students have significantly improved over the past four years. Various strategies have been implemented, most with a community-building-focused approach. The implemented strategies include a peer mentor program and a Math Accelerator program for incoming students. The peer mentor program focuses on bringing students together for fun social activities (rather than tutoring) in smaller groups. The Math Accelerator program targets students who do not place into calculus, and teaches them college success skills, along with giving them time and support to improve their math placement scores before the semester begins. This program allows students to move in earlier, allowing them to start socializing and getting acclimated to university life. Further, the program uses the universities' learning management software extensively, giving these students an edge in learning the online course tools and procedures. This work will also look at math course placement and report how it factors into graduation success. Other initiatives and strategies include an expanded engineering living community, weekly community nights, expanded engineering-focus student groups (IEEE, ASME, SWE, NSBE, etc.), and a new dedicated engineering advisor. Additionally, there have been curriculum changes to aid in first-year success. This includes integrating new changes into our first-year orientation course, including peer mentor program participation and service requirements. Moreover, the first-year design course has undergone a significant overhaul to incorporate a year-long team-based project where students compete in a variety of robotics competitions aimed at integrating technologies from all majors within the school. This work will analyze retention numbers over the past four years by examining retention data as students matriculate through the university. For future work, initial and recurring costs to implement each of these initiatives, along with the student impact, will be reviewed and discussed with the goal of sharing what may have the greatest influence on student retention.

Introduction

This work summarizes implemented programs and initiatives aimed to improve student success in engineering programs and retention rates. This study examines an engineering school at a small, private university in the Midwest, and some initial findings are reported in [1], [2], [3]. These programs provide students with a way to meet each other and form bonds outside the classroom, develop leadership skills, and create strong relationships with faculty and staff. This current study adds additional retention data, improvements to existing strategies, and discusses new interventions recently implemented in the program.

Attrition rate is not linear; it is front-loaded. According to the National Student Clearinghouse Research Center, approximately 31% of students will not return for their second year [4]. Therefore, resources allocated to supporting first-year students provide the highest return on investment (ROI). Additionally, programs that target social and academic integration are shown to be most effective in retaining students [5]. Following Tinto's insights, these programs are designed to support students' internal motivation and sense of belonging rather than focusing on retaining them as a benefit to the university [6]. Several of the programs discussed integrate upper-level students, faculty, and staff in informal social events outside of the classroom to help facilitate a student's transition into university life [7].

In many engineering programs, the curriculum is usually structured around a rigid prerequisite chain where Calculus I is the primary anchor course. As is common in ABET-accredited programs, Calculus I is a direct prerequisite for Physics I and Core Engineering courses (e.g., Statics, Circuits). Consequently, students who do not place into Calculus I in their first semester fall behind in the standard four-year graduation cycle [8]. This delay forces students into delayed graduation or summer classes. Both of these options increase the student attrition rate due to an increased financial burden [9] and burnout [10], [11], [12]. Therefore, academic support structures are needed to help struggling students recover and ensure successful students maintain their momentum.

Program Overview

This paper provides a comprehensive summary of retention strategies implemented at a small, private institution, over a nine-year period. Numerous support structures were developed to increase retention during the first-year engineering program. These strategies are categorized into three primary domains: academic support (Math Accelerator, Learning Assistants, and new curriculum), social and community building (Living Learning Communities, weekly cookouts, and student clubs), and advising support. The timeline of programs implemented in a nine-year period is shown below in Figure 1.

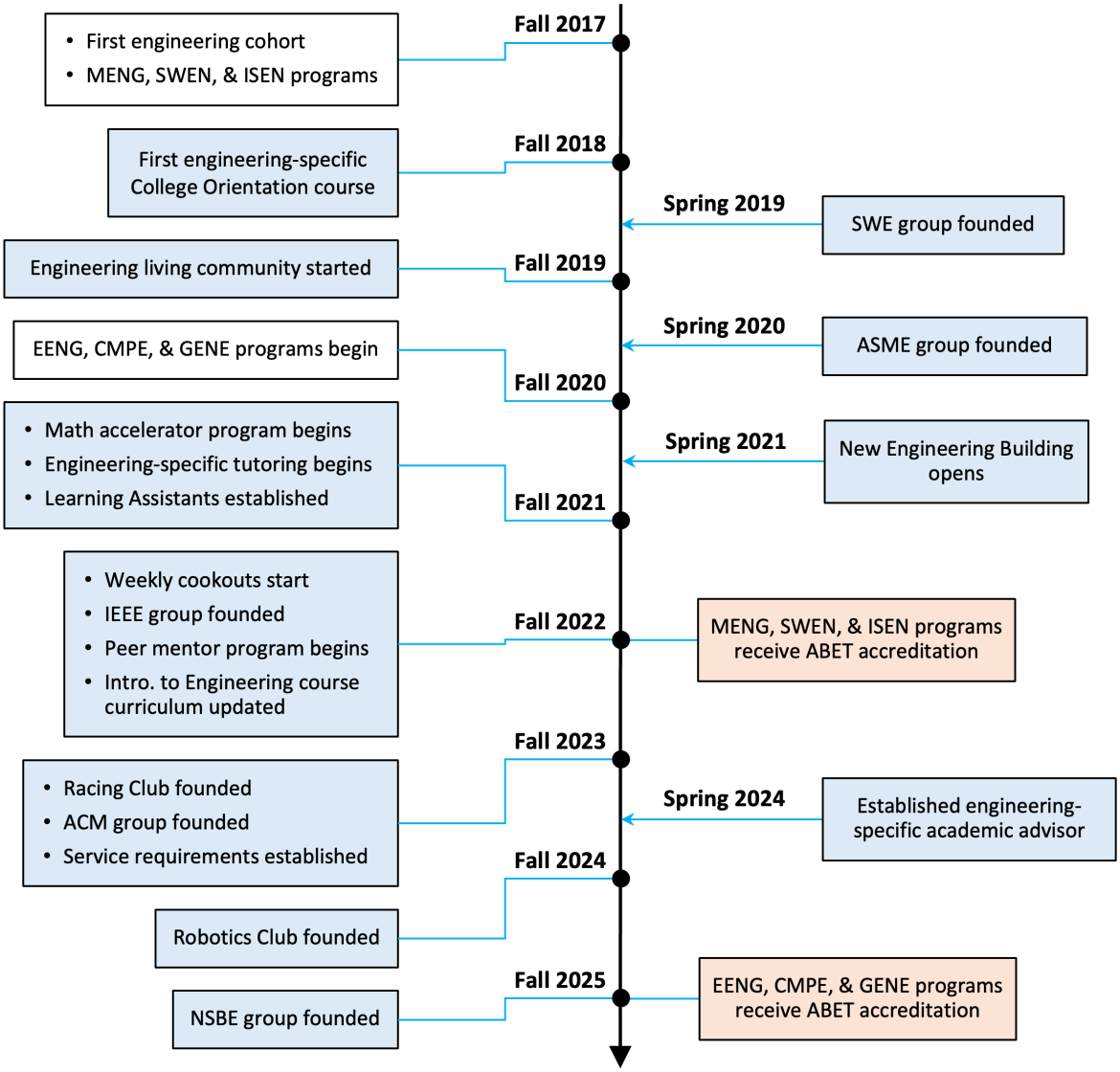

Figure 1. Timeline showing when each program or initiative began or was established.

Academic

Math Accelerator Program: Implemented in Fall 2021, the Math Accelerator Program is a three-day intensive program held immediately prior to the start of the fall semester. The program targets incoming students who did not place into Calculus I on their first math placement exam. The camp runs from 9:00 AM to 5:00 PM daily, providing approximately 21 hours of instruction before students retake the placement test. The curriculum uses an individualized approach, targeting specific weak areas identified during the student's first placement attempt. Beyond the primarily academic aim of Calculus I placement, the program integrates content review with institutional integration. This includes orienting students to the university's Learning

Management System (LMS) and facilitating early socialization to create a sense of belonging within the engineering department. To reduce barriers to entry, the program is offered at no cost; participants are provided with meals and are encouraged to move into university housing one week early.

Learning Assistances: A high student to instructor ratio in engineering labs can negatively impact the individual student's ability to learn the material efficiently and effectively. However, learning assistants can help lower this ratio and provide a better experience for the students. The learning assistants for each course are students who have already completed that course to a high level of proficiency. The advantage for the learning assistants is that they are paid hourly and it helps reinforce their understanding of the course. Furthermore, this benefits the students in the form of faster response to their questions and additional meeting hours outside of the lab. The learning assistant positions were created in Fall 2021 for lower-level courses (first or second year).

First-Year Program Changes: Providing a welcoming and strong foundation of first-year engineering courses is essential for retention purposes. Starting Fall 2022, there have been substantial changes to our first-year curriculum. A key one being our "Introduction to Engineering" course, which was completely revamped with the integration of a wide array of active learning activities, including hands-on labs (Electronics, CAD, Drafting, Simulations, Programming) and a design-centered, semester-long project where students build autonomous robots. The semester-long project was a key component of this overhaul as it required students to design, manufacture, assemble, code, and operate a robot for a series of classroom competitions. This project is designed to showcase the integration of multiple engineering disciplines – Mechanical, Electrical, and Computer Engineering – while fostering teamwork, time management, and technical communication, all of which are core outcomes of the first-year engineering program. The course is now structured as a series of building blocks; as new material is presented, students immediately apply those concepts to their robot project, reinforcing their learning through hands-on application. Throughout the semester, students iteratively modify and improve their robots for various competitions. The course content is now structured to introduce essential skills – e.g., CAD, 3D printing, manufacturing principles, circuit design, and Arduino programming – to prepare them for the various competitions happening throughout the semester. Competitions are normally a three-hour event during lab hours, where students showcase their designs and compete for first place. Competition days are highly active and energetic events. Beyond the technical challenges, the competitive experience facilitates team-building and collaborative engagement within the School of Engineering.

Social

While academic preparation is a primary driver of student success, social integration and a sense of belonging are critical for retention in engineering programs [6]. To complement the academic interventions described above, several social initiatives were created to reduce student isolation

and create a strong relationship between students and faculty outside of the classroom. These initiatives aim to lower the intimidation barrier often associated with engineering faculty and boost their relationship with upper-level students. The primary social interventions implemented include a peer mentor program, weekly cookouts, a Living Learning Community (LLC), student organizations, and service events.

Peer Mentor Program: Beginning in the Fall of 2022, a peer mentor program was established to support first year students [1], [2], [3]. The program pairs incoming first-year engineering students with upper-level engineering students to provide guidance and support on navigating university life. The program focuses on bringing students together, socially, to form community, such as off-campus dinners and group activities. First year students are expected to participate and connect with their peer mentors during the first semester of their first year. In the second semester, participation is optional. This peer mentor program focuses on social connections, not tutoring. Peer mentors can help direct first year students to tutoring academic support, and other university support systems.

Weekly Community Cookouts were created in Fall 2022 by faculty and staff; the weekly cookout serves as a central hub for departmental culture. The event is held every Thursday at 5:30 PM in the engineering project build space, with attendance managed through a weekly email signup system. While anchored by a shared meal, the event functions as a multi-purpose co-curricular event involving students from all grade levels. The setting is strategic: by hosting the event in the project build space, the department creates a natural environment for students to work on independent projects, hold Registered Student Organization (RSO) meetings, and receive training on new equipment. This structure facilitates multidimensional mentorship; students interact with faculty and staff on a personal level, reducing academic intimidation, while simultaneously receiving technical support. This program also occasionally features guest speakers and workshops, further integrating professional development into a social environment.

Engineering Living Learning Communities (LLC): Complementing the department's daytime activities, the Engineering LLC extends the cohort model into the residential environment. Established in Fall 2019, the LLC designates specific floors within a university residence hall exclusively for first-year engineering students. While participation is voluntary, all incoming engineering students are invited to join. The program is structured to provide both social and academic support. A key component is the selection of an upper-level engineering student to serve as the Resident Assistant (RA). This RA functions as both a residential supervisor and a peer mentor, curating social events specifically relevant to engineering majors. Furthermore, by co-locating students who share a common schedule of first-year courses, the LLC design naturally fosters study groups and peer-to-peer academic support during evening and weekend hours.

Engineering Registered Student Organizations (RSOs) play a pivotal role in professional development and applied experience. The RSOs act as a critical extension of the classroom, offering leadership opportunities and technical skill acquisition. The organizations span three distinct categories: professional societies (IEEE, ASME, and ACM), support for underrepresented groups (SWE and NSBE), and technical project teams (Racing Club and Robotics Club). To ensure sustainability, each RSO receives university funding and is paired with an engineering faculty mentor for guidance. Recruitment is integrated into the first-year student experience, with RSO leaders actively engaging students during the annual "RSO Fair" in the fall semester. Joining an RSO allows first-year students to interact with upper-level students and faculty within their discipline; consequently, this builds a support network where students feel more comfortable seeking academic assistance. Furthermore, RSOs promote diversity, which can help form community and support underrepresented student groups.

Service Events: In Fall of 2023, service events were integrated into engineering curriculum across all cohorts. Each student must participate in two of these events every semester they are enrolled in engineering design course (eight total semesters). The motivation for this program is two-fold: to ensure assistance with setting up events and cleaning up events, and to increase student involvement in the department. The service events are communicated to the students through announcements in class and emails. The events can range from cleaning a workshop to setting up tables for the annual end-of-year potluck. Furthermore, it is intended to foster a more collaborative and social environment, giving students a chance to meet others they might not normally interact with since students from all years and engineering majors participate.

Advising Support

New Engineering Advisor: The university implemented a new campus wide advising system in 2024. Before this year, all first-year students went to a general first year advising center for academic advising. A new change created program specific advisor. This new change has multiple advantages. First, the advisors get to know the engineering student more personally, and secondly, the engineering advisor can have more focused knowledge with the engineering program. Also, the engineering advisor is physically located in the engineering building and has more direct contact with engineering faculty, so the engineering faculty can communicate directly with the engineering academic advisor about student concern, class scheduling, and future program changes. Additionally, the engineering academic advisor has also helped teach the 1 credit college orientation course for first year students. One learning outcome of this course is to connect students with campus resources, something the advisor is very knowledgeable about. This is also a good way for students to get to know the engineering advisor and vice versa.

Results

This section details the quantitative results of the programs and interventions implemented between 2017 and 2025.

Figure 2 shows School of Engineering numbers for first-time full-time starting freshmen from each fall along with the School's total enrollment of all students who started at the University as a first-time full-time student from 2017 to 2025. The total enrollment has continued to increase after the COVID-19 pandemic at a steady rate. Additionally, the first-year student enrollment has also increased at a steady rate following 2020 until 2023 where it has remained relatively stable. The difference between the increasing overall enrollment with no increases to starting students highlights the positive effects of improved retention.

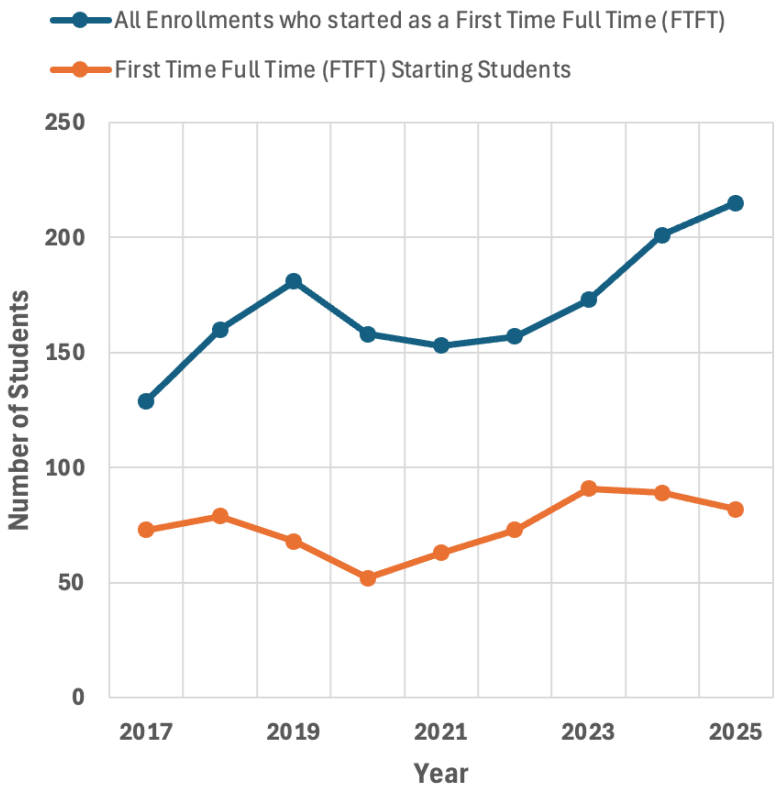

Figure 2. School of Engineering total enrollment compared with first-year enrollment trends within the School of Engineering.

Figure 3 compares the first-to-second year retention rate of engineering students and the university average retention rates from 2021 to 2024 for full-time first-year students. We show this comparison to reduce the effects of outside factors that could impact the overall retention number, such as COVID-19's impact in high school to college readiness for first-year students. Before 2024 the engineering retention rate was 2.5% to 7.5% lower than the university average.

Over the last three years, when many of these initiatives were established, the retention rate has trended up with an overall increase in the difference of +13.8%. In 2024, there was a significant increase to over 5% higher than the university average.

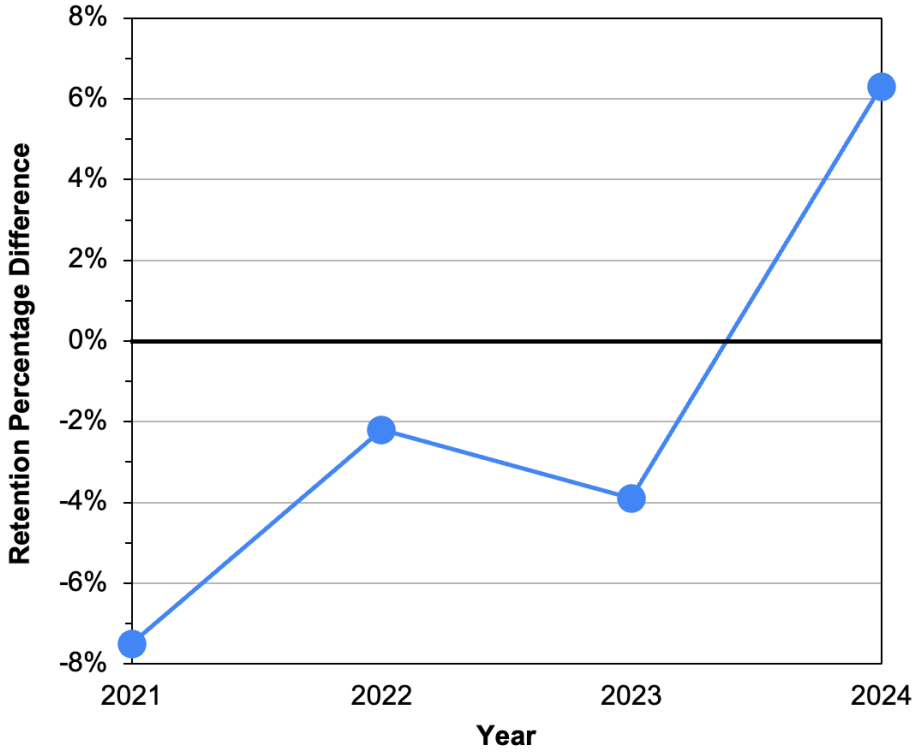

Figure 3. Difference in School of Engineering retention percentage compared to the overall university retention rate. Values are from first-to-second year retention rates for full-time first-year students.

Conclusion and Future Work

This study demonstrates that a multi-layered, community-focused approach can increase first-year retention in engineering programs. By integrating academic readiness tools with social initiatives, the school has successfully fostered a sense of belonging essential for student persistence. These recurring strategies show that investing in social-academic integration can help first year students transition effectively into college, leading to improved retention

This work is limited because it is difficult to tease apart the effects of each program individually. Future work will review these individual initiatives to carefully review the potential benefits of each specific program. More review will be needed to determine which of these programs have the greatest influence on student retention.

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