FIRST-YEAR

FYEE

ENGINEERING EXPERIENCE

Welcome from the Conference Organizers

In light of the on-going public health crisis, the FYEE Steering Committee and 2020 Conference Team have made the difficult decision not to hold a 2020 conference. An in-person event was not deemed to be a prudent course of action at this time and, given the community focus of FYEE, a virtual format did not seem to make sense without compromising the core identity of the conference. Delaying to this fall or into the spring seemed to be a disruptive gamble at best, if not impossible given requirements of the conference facilities.

We have continued with the paper submission and peer review process as promised and have published a conference proceeding for 2020. A digital copy of those proceedings will be distributed to the FYEE community around the time of the originally planned conference. We invite all authors to present this year's work at the 2021 conference.

Additionally, we are hosting an unconference on July 27th, from 2pm-4pm Eastern Time, to facilitate discussions around teaching and supporting students in the current COVID-compliant environment. More details on that event are being distributed via email through various channels and are posted on EngineeringUnleashed, on the forums of the First-Year Engineering group: https://engineeringunleashed.com/group/9/topic/14643.

With appreciation for the flexibility of all of our conference hosts and in fairness to our colleagues at MSU, we are also making a change to the upcoming conference sites. The 2021 conference will continue as planned, hosted by the University of Maryland. All other announced hosts will be delayed by one year to allow MSU to be inserted as the 2022 host. The full listing of upcoming sites is as follows:

2021 - University of Maryland (as planned)
2022 - Michigan State University
2023 - University of Tennessee - Knoxville
2024 - Northeastern University
2025/2026 - Call for hosts now open! See https://sites.asee.org/fyee/ for more information!

While the change in plans is a great disappointment to all of us, we are confident that the First-Year Engineering community will continue our tradition of open collaboration and community support as we all navigate the ongoing crisis. Many of us sit on the front lines of higher education, helping our incoming students navigate an already challenging transition made all the more challenging by the current situation. Good luck, good health, and see you all in Maryland!

--Blake, Krista, and Tim, on behalf of the FYEE Steering Committee and 2020 Conference Team

<u>2020 Conference Team</u>
Krista Kecskemety (Program Chair)
Tim Hinds (Conference Host)

<u>FYEE Steering Committee</u>
Blake Hylton (Chair)
Tim Hinds (Sponsorship Chair)
Kevin Calabro (Publications Chair)
Mara Knott
Rich Whalen
Kris Kraven
Sean Brophy
Sheila Youngblood

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FIRST-YEAR PROGRAMS DIVISION

Future Conferences

Year	Location	Dates
2021	University of Maryland	July 25-27
2022	Michigan State University	August 7-9
2023	University of Tennessee – Knoxville	TBD
2024	Northeastern University	TBD

Want to host FYEE in 2025 or 2026?

We are presently recruiting hosts for the 2025 and 2026 conferences. Review **the FYEE Host Proposal Guidelines** and prepare a **FYEE Host Proposal Form**. Submit your proposal through the FPD website **https://sites.asee.org/fyee/about/** by 5:00 pm Eastern DST, May 31st, 2021.

Full Papers

32050: Using Chatbots as Smart Teaching Assistants for First-Year Engineering Students

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As the artificial intelligence (AI) field advances, more research areas within AI are emerging including machine learning, neural networks, fuzzy systems, and much more. In the last decade, chatbot technology has emerged as a new area of AI. Chatbot use-cases are surfacing across various sectors including banking, customer services, medicine, and e-commerce. Recently, chatbots have begun being used in education, and the potential advantages are notable.

In this paper, we are reviewing related literature and presenting a mobile application system, named Alpha, that utilizes chatbots as smart teaching assistants. The system consists of an artificially intelligent (smart) chatbot, cloudbased database, speech recognition, and web services. We conducted a student survey and a usability assessment of the implemented system. We have integrated our system into a first-year engineering course, and more courses will be added in the future. The system aims to support students' learning processes and engagement in addition to providing real-time 24/7 assistance to students.

32097: Harvesting tweets for a better understanding of Engineering Students' First-Year Experiences

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Twitter, a popular social networking and microblogging platform, harvests and stores large amounts of data about myriad topics through millions of short messages (tweets). Among this array of topics, some tweets can contain valuable information related to engineering education and first-year engineering experiences. Unfortunately, despite the existence of such related tweets, the engineering education community writ large typically does not have adequate background and statistics on their number and content in order to glean information from this corpus of tweets. In general, data from tweets can be very useful for both qualitative and quantitative studies focusing on first-year engineering experiences. By incorporating data collected from Twitter, we can have the opportunity to discover interesting patterns and themes.

In this paper, we report on the results of a study in which we collected and analyzed tweets related to engineering education and first-year engineering experiences. Additionally, we present the implemented pipeline used in our study. The pipeline uses the Twitter application programming interface (API) to pull tweets that contain specific key terms related to our topic of interest and then extracts the tweet content along with other metadata before storing the information in a central online database. Researchers can have access to a web-based interface where they can use the harvested tweets in their studies and get the latest tweets and news feeds.

32070: Re-Engineering a Mini-Drone as a Project for First-Year Engineering Students

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This full paper will explore a novel idea of re-engineering or redesigning a mini-drone in a first-year engineering design course at our mid-size technology university. Reverse engineering has been used to teach the design process to first-year students for a long time. This project takes it a step further, where students not only reverse engineer the drone but also redesign the drone to make it better. Using a drone as the product makes the project relevant and interesting to the students. The students start by measuring the parts of the unassembled drone, design all components in a 3D modeling software, assemble all parts to create the complete drone in the 3D modeling software. The drone is then physically assembled by putting all the original pieces from the kit together. A workshop is organized to help students learn soldering, as the motors and LEDs have to be soldered onto the circuit board. Finally, students are asked to come up with a new design for the drone. The newly designed model has to fit the battery, the circuit board, and the motors. This part will then be 3D printed and attached to the original drone. The goal is to make the drone fly with this new design. This also helps expose students to our makerspace in the very first semester and encourages them to use the facility for future projects. This paper will include details on how the project was implemented in our class and an assessment to show the effectiveness of this new teaching technique.

32039: Full Paper: Effects of a Computational-Based First-Year Engineering Course on Student Preparation

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This full paper presents research on the effects of a computational-based first-year engineering course on student preparation. In engineering education, there is significant discussion on what first year introduction content is most appropriate and useful for students in their academic and professional careers. In addition, how that content should be delivered is also of interest. Some engineering programs provide a conceptual framework of content to be delivered to new students. Other engineering programs may provide an interface platform for students to connect with practicing professionals to learn about their future careers. Some programs provide content that is computational-based, which exposes first year students to relevant calculations that are used in later courses. Additionally, there are some programs that incorporate elements of all three of these sets of content. If the computational-based content has a more direct relation to the engineering profession and later engineering courses, students would be exposed to basic concepts of future courses and have an early understanding of these relevant engineering topics. This research aims to present data which shows the effects that a computational-based first-year engineering course can have on student preparation for later engineering courses. This research is based on four years of data collection regarding how the computational-based spring semester first year course CE 113 (Civil Engineering Analysis) has impacted student performance in Physics 1, Statics, and Mechanics of Materials. This research also provides an outline for how other engineering programs can develop their own unique first-year computational-based courses that can have a positive impact on students' performance in later engineering courses.

32060: First-Year Engineering - Deciding on a Major

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At SUNY Binghamton, first-year engineering students have a shared year as Watson School of Engineering and Applied Science majors and do not declare their specific engineering major until later. In order to track interest and assess program impacts, the students are given a survey in the first week of their fall classes. This survey asks just two questions: 1) What is your intended engineering major and 2) How certain are you of your intended major. Typically, about one-half of first-year students indicate that they are very sure of their intended engineering major and the other half is only somewhat sure or not at all sure.

Along with an introduction to general engineering concepts, one of the primary objectives of the introduction to engineering course that the students take in their first semester at SUNY Binghamton is to familiarize them with the engineering majors offered at the university: biomedical, computer, electrical, mechanical, and industrial and systems engineering. Throughout the course students are given lectures, assignments, and laboratories that are representative of the engineering majors offered. The majors are also introduced in many other forms, including: departmental visits, student organization presentations, visits from industry representatives, and visits from engineering based student service offices on campus. The laboratory classes are also instructed by graduate teaching assistants from the different engineering departments.

During the last week of the fall semester, students are required to declare their majors although they are free to change their decision up to the start of their second year. Since the 2014-2015 academic year, the percentage of students who declare an engineering major has ranged between 90.3% and 94.5% (meaning 5.5% - 9.7% of students leave our engineering programs for non-engineering degrees at SUNY Binghamton or leave the university). Of those that declare an engineering major, it is found that some number of students go on to declare a major different from the one they initially indicated.

This paper will present detailed data of the intended major given in the first week of class, the strength of their intention, and their final major declaration. An in-depth description of the methods used to introduce the engineering majors will also be provided. Finally, the authors will provide their insight into the reasons for any changes in intended major from the first week to final week of the semester.

32084: Three Years After Rollout: A Report on Systemic Changes in a First-Year Engineering Program

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This report focuses on an overview and preliminary results for a project to update the first-year engineering program (FYEP) at with an enrollment base of approximately 1,000 students. We are now three years out from the rollout of an updated FYEP that dates from the fall semester, 2017. The goal we have for this paper is to economically describe at the 10,000-foot level (a) our reasons for the systemic changes we established, (b) the core architecture of our revised FYEP, (c) a selected subset of our preliminary findings and observations regarding our revised FYEP, (d) a special observation concerning the ease of transition from face-to-face operation over to complete internet operation of FYEP while maintaining the integrity of our revised operational model all in the context of a global pandemic (coronavirus), and (e) a thumbnail description of our plans for the future.

32052: Implementing Embedded Control into Projects Designed by Students With Little or No Programming Experience

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This is an abstract for a full paper and describes an approach to providing students in a hands-on, first-year engineering design class who have little or no computer programming experience, with the opportunity to implement embedded computer control into their projects. The design class introduces students to Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), design for manufacturing, three-dimensional (3D) printing, and embedded computer control. Because of time constraints imposed by the length of a semester, instruction focuses on CAD, 3D printing and the engineering design process, leaving insufficient time for an in-depth discussion of computer programming and other matters pertinent to embedded control. Because of a desire to provide students with a rudimentary understanding of embedded control, a new initiative was begun in the fall 2019 semester where embedded control capability can be incorporated into projects by students with little or no programming experience. In order to bridge the gap between the desire for providing an understanding of embedded control and the lack of time for in-depth instruction of pertinent skills, a set of "Standard Embedded Control Modules" have been developed for student use. These modules consist of a set of standard electrical/electronic hardware components along with the standard software modules which provide the intelligence to exercise control of those hardware components. Undergraduate teaching assistants, along with the instructor, help student teams in selecting the modules required depending on the selected project. It is then incumbent upon the student teams to design appropriate mechanical interfaces, follow electrical build instructions, and define required functionality for implementation into their projects. This initiative was introduced in a handful of projects during the fall 2019 semester and has had a positive impact on making projects more realistic, on capturing student interest, and generating enthusiasm among students. This paper will provide an overview of our approach and lessons learned.

32056: First Year Engineering Student Success Enhancement Through the Support of Undergraduate Teaching Assistants

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This informational paper describes an approach to utilizing undergraduate teaching assistants (UGTAs) in addressing challenges posed by using Computer Aided Design (CAD) and three-dimensional (3D) printing in a hands-on, first year engineering design class. At Wayne State University, we began using CAD and 3D printing tools to introduce design principles to first-year engineering students in the fall 2017 semester. This was prompted by the desire to involve students with CAD at an earlier stage of their academic careers. Assisting in instructing these principles, UGTAs provide hands-on support for students both during and outside of class and contribute significantly to the operation and maintenance of the 3D printing lab. Near the beginning of the semester, in-class support is focused on helping students during lectures. Near the middle of the semester, their in-class focus becomes more of a project management role as class activities transition to final project design and development. As project managers, each UGTA is responsible for two or three teams and provides guidance with navigating through engineering challenges that may arise. Outside of class, office hours are provided at least once per day by the UGTAs where students can receive help on assignments or other questions related to this course. In addition to providing direct support to students, UGTAs carry the bulk of the load in ensuring designed parts are 3D printed and provided to students with minimum latency. In addition to reviewing component suitability for printing and starting new print jobs, the performance of routine maintenance is primarily performed by the UGTAs. Lab support during the project assembly phase and training in-coming UGTAs are also tasks performed by the UGTAs. This paper will provide an overview of our approach to incorporating the efforts of undergraduate teaching assistants into a first-year engineering design class to assist other institutions with integrating that same practice.

32032: Facilitating Pathways to Engineering: First Year Summer Experience

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The A. James Clark School of Engineering (Clark School) is a limited enrollment program at the University of Maryland College Park (UMD). Unfortunately, not all students who are interested in studying engineering are directly admitted into the Clark School, but instead are admitted into UMD's Division of Letters and Sciences (L&S). There are many students of minoritized identities (such as women and racial/ethnic minoritized students) who are not directly admitted into the Clark School of Engineering, but instead are admitted to the L&S division. Students not directly admitted will later have the opportunity to re-apply to the Clark School after strengthening their application and preparation. As such, there is a critical opportunity to promote the pathways for women and students with other minoritized identities into the field of engineering through facilitating the process for L&S students in re-applying to the Clark School of Engineering.

The 2019 First Year Summer Experience (FYSE) program was designed to strengthen and facilitate pathways into the field of engineering through assisting and supporting UMD's L&S students who are interested in studying engineering, but were not directly admitted into the Clark School. FYSE is a three-week summer orientation program focused on the development and strengthening of math-intensive engineering problem-solving skills. Equally important is the cultivation of community and a network of support among each FYSE cohort. Recruitment and selection of participants to FYSE is geared toward the inclusion of women, racial/ethnic minorities, and first-generation college students who were not directly admitted into the Clark School. The 2019 program served a diverse cohort of approximately 21 first-year women students who applied to study engineering but were admitted to the Division of Letters and Sciences.

This paper will provide a detailed overview of the components and implementation of the FYSE 2019 Program. It will also include demographic information on the participants, program evaluation outcomes from participants, and any relevant updates on longitudinal tracking the 2019 FYSE cohort.

32076: Full Paper: First Year Engineering Undergraduate Academic Co-Advising Improvement
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In this descriptive study, we examined engineering student satisfaction with academic advising in our new co-advising model as well as compared to the past faculty-only advising model. We conduct this analysis through a critical lens by examining any differences by a student's combined sex and ethnicity. In the faculty only advising model, students had separate first-year instructors and faculty advisors. In the co-advising model, students' first year engineering course instructor also served as their academic advisor. Leveraging in-class discussions, the co-advising model infused several formative topics and activities into the first-year engineering course. These included major selection; identification of peer-support mechanisms; references to available counseling, tutoring and career-planning resources; periodical reminders regarding academic deadlines; check-ins to identify students at academic and/or medical risk; and early interventions for students who experienced academic or other difficulties. Our analysis of an extensive and representative data set (n =1210) of students from academic years 2015-2016 and 2016-2017 revealed 72 percent and 73 percent of students, respectively, agreed or strongly agreed (affirmed) that their advisor took an active role in ensuring their success in engineering, as compared to previous research reporting 31 percent affirmed the same statement in 2013. Our 2016 and 2017 data, unlike the 2013 dataset, allowed us to extract survey responses from underrepresented minoritized students (URMs) in two ways: ethnicity, as categorized by the Integrated Postsecondary Education Data System (IPEDS), as well as a binary sex variable of male and female. Under the co-advising model, Black or African American males were the highest in affirming their advisor took an active role in ensuring their success in engineering at 86 percent. Comparing co-advising to faculty-only advising model, each group had a higher percentage of affirmation. These metrics, along with other data analysis, suggest adopting elements of a co-advising model may improve the advising experience for URM engineering students.

32051: Incorporating Computer Aided Design and Three-Dimensional Printing in a First Year Engineering Design Course
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This informational paper describes the methodology used to teach a hands-on, first-year engineering design class where Computer Aided Design (CAD) and Three-dimensional (3D) printing are introduced as tools to facilitate the creation, design and production of engineered products and systems. Additionally, students are provided insight into Computer Aided Manufacturing (CAM), design for manufacturing and embedded computer control. For several years, first-year engineering design was taught at this institution using the Lego R Robotics system as the vehicle for solving engineering design problems presented to each class. While that approach proved to be effective, it was desired to extend the concept of problem-based learning to encompass a variety of realistic scenarios while fostering creativity through enhanced communication and visualization enabled by CAD and 3D printing. The new approach adds two new learning outcomes and removes one from the earlier approach. Assessment of student performance is made primarily through individual assignments, quizzes, a final team project and an exam.

Two significant challenges have arisen with the CAD/3D-printing approach. The first is a compressed timeframe for instruction in the mechanics of using design tools due to 3D printing latencies. The second challenge is that additional human effort is required for the operation and maintenance of the 3D printers. These challenges have been addressed through liberal application of undergraduate teaching assistant (UGTA) efforts in combination with instructional videos. Instructional videos (generally 10 minutes or less) are provided for each topic covered during the first several lectures, to help students prepare for class. UGTAs provide individual support to students during class while new 3D modeling capabilities are introduced, help students outside of class by providing tutoring sessions, and have a large share of the responsibility for the operation and maintenance of the 3D printing lab.

This class has been met with great enthusiasm from students, instructors and administrators; and has resulted in many creative and surprisingly complex, meticulously implemented projects. An initiative was begun in the fall 2019 semester, where embedded control capability was incorporated into many of the existing projects by students with minimal programming experience. This has proven to have had a positive impact on making projects more realistic and on capturing student interest. This paper will provide an overview of our methodology in order to allow other institutions to develop a similar model.

32096: Experience of Teaching Introduction to Electrical Engineering with an Online Platform

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To engage engineering students in their field of studies, it is essential for the students to take major courses as early as possible. However, first year EE major students in our institution don't have many options as almost all major courses need physics and math courses as prerequisites. For most of our students, the Introduction to Electrical Engineering is available to them as the only Electrical Engineering course during their first semester in college. It is offered to introduce the students to such topics as electrical circuits, digital logic, and robotics. In addition to learning fundamental topics, the students are expected to be get interested in these subjects and motivated to learn more in the following years. Therefore, student success in this course is critical for retention.

It is well-understood that labs and projects with hands-on engineering experiments are indispensable in engineering training. Nowadays web and mobile technologies are playing more and more important roles in student learning. In this study, we focus on our experience of online labs. Specifically, we utilize an online FPGA platform to teach students on the introductory course's section of Digital Logic Gates The platform provides students with anywhere anytime hardware lab experience at their fingertips. It had been used for both senior level Digital Engineering class and a summer camp for high-school students in the past., Based on the student feedback, we have customized the platform usage specifically for the freshman course in four different ways: 1) as a classroom teaching demo tool for students to see real-time actions from example circuit designs 2) to provide pre-lab exercise for students to practices with logic gates and combinational circuits with instant feedback 3) as a fast prototyping tool in comparison to the traditional breadboard prototyping technique 4) to provide post-lab activities for students to learn more advanced topics outside scheduled class and lab time. Instructor observations, student surveys are used to evaluate the effectiveness of these activities. This study provides guidelines for future curriculum design based on the platform. It will also contribute to the platform design improvement for more effective online lab delivery.

32044: Addressing Global Food Security through First-Year Engineering Service Learning Projects

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First-year engineering students recently had an opportunity to participate in a service learning project with potential for global reach. In response to a United Nations Development Programme Sustainable Development Goal for zero hunger, first-year engineering students were tasked with designing and building a solar-powered food dehydrator that could be built on location with minimal resources other than the primary building materials and some basic tools. The project was targeted for implementation in regions of emerging development including areas with chronic widespread hunger and, simultaneously, lacking in material resources and infrastructure - including access to electrical power. In these regions, farming is the single largest source of income and jobs. Hence, in practice, food dehydration makes it possible to extend the period for which freshly grown food can be safely prepared and stored for later consumption when food sources are more scarce. Starting from a previous design, several new design features were implemented. Most significantly, for a similar interior volume the redesigned dehydrator used walls that were 1/2 the thickness –as compared to the previous design– to enclose the interior space. Thus, along with using less material the overall weight was reduced by nearly 29%. In the previous design, testing on a sunny 91 F summer afternoon revealed that the internal air temperature Tint was approximately 6-7 F below the minimum recommended temperature for dehydration of fruits and vegetables (i.e., 120 F Tint 140 F for fruits and vegetables). Under similar test conditions, the internal air temperature for the new design exceeded the minimum recommended temperature; i.e., Tint = 122 F for the redesigned dehydrator on a sunny 91 F day. Since the intent of the project was to introduce the dehydrator into regions of sub-Saharan Africa where average temperatures in the hottest months can exceed 103 F, efficient designs can therefore extend periods of the day –and of the season– during which the dehydrator can be used to safely process food.

32086: Efforts to Improve Mathematical Preparation for a Pre-Engineering Program at Tribal Colleges in North Dakota

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Developmental math preparation is integral in a pre-engineering pathway. This paper analyzes the efforts to improve remedial

math passing rates at two tribal colleges in North Dakota participating in a pre-engineering collaborative. Previous work in progress addressed portions of these approaches, but here a more complete set of quantitative data is presented along with further analysis using the theoretical framework of Tribal Critical Race Theory.

32077: Ready, Set, Go: Fostering Student Success in an Introductory Biomedical Engineering Technology Course

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This mixed-methods research study follows the progress of an incoming cohort of biomedical engineering technology (BMET) students as they engage in a re-designed introductory course and navigate problem-based learning (PBL) activities with a career focus. Taken collectively, our findings affirm previous studies of PBL as an effective strategy for fostering engineering habits of mind; and they further underscore how PBL can serve as a vehicle for enhancing onboarding and persistence through career-oriented degrees in engineering, with particular salience for transitioning returning or non-traditional students to the workforce

32068: Success in Engineering Study of Under-Prepared Students

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In 2014, the College of Engineering considered establishing admissions criteria beyond the basic requirements to enter the University. With the hopes of increasing second-year retention and graduation rates, the College wanted to create their own admissions criteria that would exclude students from entering the college until they were eligible to enroll in a math course of pre-calculus or higher. The dean of the college, however, championed the under-prepared and often minority students who typically require this remedial math course. In fall 2014, the faculty voted not to create additional admissions criteria but instead to create a new path that would hopefully increase the success in math and engineering academics in this under-prepared student population.

Since the First-Year Engineering Program began in 2007, the second-year retention rate has ranged from 67-71%. Four-Year graduation rates for the college of engineering averaged 30% from 2007-2013 but increased to 32% in the 2014 and 36% in the 2015 freshman classes. Five-year graduation rates average 45% from 2007-2013 and increased to 48% for the 2015 freshman class.

At our University, students are placed into a math course based on their ACT or SAT math scores or through AP or college credit for a prerequisite course. Previous to 2014, all students who wanted to major in engineering began their course of study in Introduction to Engineering I. This course covered unit conversions, dimensional analysis and basics of programming; it was assumed that students had sufficient skills in college algebra. Beginning in 2014, students who placed into a math course of pre-calculus or higher took the Introduction to Engineering Course sequence as defined by the eight-semester degree plans. Students who did not have the math requisites were required to take a remedial engineering course called Success in Engineering Study that focused on study skills and math skills development with the learning outcome of becoming successful engineering students. The students who successfully completed their remedial math course then moved on to Introduction to Engineering I.

Approximately 85% of our first-year engineering students qualify to enroll in a math course of pre-calculus or higher, and 15% qualify for college algebra. Conclusions on the success of the Success in Engineering Study course are constrained because of limited data (low n values) and some statistical analyses showed no significant improvement in retention and graduation although meaningful positive trends were observed. Thus, we continue to look for significant changes in student success as more students participate in Success in Engineering Study. We continue to consider other ways of retaining this population of students.

32099: Allowing Freshman Engineering Students to Encounter Multiple Disciplines: Discipline Oriented Labs in the First Semester Engineering Curriculum

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Anderson University is a small liberal arts university established in the Church of God movement, located in Anderson, Indiana. The engineering program started in 2013, and now has ABET accredited majors in Mechanical, Electrical, and Computer Engineering. The first semester engineering course has undergone several changes since the program's inception, and has evolved into three corequisite courses, accompanied by a 2-hour recitation section.

The first semester engineering curriculum consists of a 1-hour lecture course (ENGR 2001), a 2-hour ME lab course (ENGR 2002), and a 2-hour ECE lab course (ENGR 2003). Providing these two lab courses allows students to gain basic understanding of the engineering disciplines offered by the university and affords them tools for exploration of their practice. While lab courses of this sort are not entirely unique to the Anderson University first semester engineering program, some of the mechanisms and course structure differ from other programs. Students also meet for a two-hour recitation section in the evenings, which allows them to get tutoring for Calculus and Chemistry, as well as engage in engineering group projects with their cohort.

The current formulation of the first semester courses has been offered for two consecutive years. This work presents the course content with an emphasis on lab instruction, course learning outcomes, and assessment results for the first two years, along with lessons learned.

32109: Teaching Engineering in the General Education Curriculum

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Many engineering students are excited and motivated when they begin as freshman students, but many change majors or leave early in the first year, having limited exposure to engineering and an abundance to general education requirements. The Citadel had a very historic and outdated general education curriculum, with many courses in the Humanities, and some in basic science and math. After years of limited or no progress in students' critical thinking over four years, the school revised its general education and opted for a strand model. One of the first courses freshmen now experience is a Freshman Seminar and linked composition course. Known as a high impact practice, the Freshman Seminar has been credibly shown to improve student retention and enhance student learning. The academic Freshman Seminar now serves as the common starting point for all entering freshman. It is one of three classes that require the students to produce work that will be graded on six General Education outcomes. The overall theme of the seminar, as well as the topics of the individual seminar sections, are determined by the faculty. Based on the freshman population, there are typically 14-28 different seminar topics and 18-23 sections with approximately 20 students per section. Because of the broad nature of the General Education outcomes, each seminar section varies in its particular topic, spanning many different disciplines. The School of Engineering at The Citadel used the curriculum update as an opportunity to engage both engineering and non-engineering students with engineering topics in the freshman seminars. The new plan calls for each section of the Freshman Seminar to be matched with a three-credit-hour composition course. The composition class is an essential complement to the academic seminar. The instructor of the composition class and the instructor of the seminar develop together their reading lists and assignments. This is the first of several opportunities for interdisciplinary collaboration afforded faculty in the new GenEd plan. The freshman seminar exposes students to engineering beyond a calculated solution, allowing them to think through early decisions and consequences. For engineering students, this initiative helped them see additional pathways in engineering and their larger role. Students worked individually and in teams, and understand the types of knowledge and abilities essential to succeed. The objectives of this paper are to explain some of the Freshman Seminars that provide students with early exposure to engineering, to assess the results quantitatively and qualitatively through surveys, and to discuss the future direction of the program.

32034: An online course for freshmen? The evolution of a successful online CS1 course

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(Required first sentence: This is an abstract for a full paper.) Online courses often have drawbacks for young college students that lead to low engagement and low success. We have taught an online CS1 section at a major university every quarter since 2013, and discovered features that have led the class to evolve to have high engagement and high success. Those features include: (1) synchronous meetings with instructors projecting video/audio and students actively participating via a text chat forum (2) strong learning content/tools outside class, (3) simple class structure and assigning many small tasks rather than a few large tasks, and (4) strong instructors. The online section's overall grade performance is now excellent, and the online section's end-of-quarter evaluations are also competitive with in-person, sometimes stronger, and commonly rate the class in the 80th percentile of all classes on campus. Students often express surprise at how engaging the online class was, with comments like "I've never been so engaged in a class; I wish more classes were online." The class has served as the model for online CS classes at other universities as well.

32046: Using the free Coral language and simulator to simplify first-year programming courses

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Many engineering majors require first-year students to learn programming. Unfortunately, commercial languages like Python, C, C++, and Java were designed for professionals, not learners, and thus have nuances that can cause students to struggle. Such struggle can lead to frustration, low grades, and potentially to dropping their programming classes or even switching majors. The Coral language was created in 2017 to address this issue. Coral is ultra-simple, looking almost like pseudocode, with fewer than 10 instruction types. Coral has a free web-based educational simulator, which auto-derives a graphical flowchart, and which executes the code and flowchart visually while showing variable updates in memory. Unlike other educational programming environments like Alice, Scratch, or Snap, Coral was designed for college students, with an emphasis on leading smoothly into a commercial language. Though Coral is now used by many thousands of students in CS0 classes at dozens of universities, in Fall 2019 our university experimented with introducing Coral in

its CS1 class, where one 80-student section was taught programming in Coral for the first 5 weeks, then C++ for the second 5 weeks. Those Coral-to-C++ students did equally well on the identical C++ final exam compared to the students in other class sections who learned C++ the entire term, and their code style was better. Coral-to-C++ students' evaluations were also very positive, and teachers reported an exceptionally smooth class startup using Coral. The C++ class sections were already highly optimized with strong performance and excellent student evaluations. These Coral-to-C++ results suggest that Coral can be used to enable a simpler and smoother start to a freshmen programming class, while still achieving the desired learning of a commercial language. And, as the Coral approach is improved, one might begin to see Coral-to-C++ students outperforming C++-only students as well. The Coral simulator and tutorial are available for free online at corallanguage.org [1].

32103: Which prototyping skills should we teach in first-year design? The answer is as few as possible

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Engineering design teams are most successful when members possess a broad range of skills to tackle a project. Instructors of design courses are challenged to select and teach the most important skills they believe will be useful for students now and in the future. Some skills, including teaming and engineering design process skills, can be acquired in a short period of time by applying evidence based training models. But in terms of prototyping, since there are so many tools and machines available, the question arises of which are truly critical to student success. In first-year design at Rice University, a course that has existed for almost ten years, we aim to teach students only the prototyping skills needed to complete their projects. Students participate in just three workshops that are prototyping related, two of which are required (hand tools and electronics) and an optional third (CAD). By recording student prototyping and measuring experience gains, we have investigated how skills contribute to project completion. The results illustrate that the question for first-year design education is not how many prototyping skills can be taught, but how few an instructor can get away with.

GIFTS: Great Ideas for Teaching (or Talking With) Students

32040: GIFT Paper: Using Proactive Advising in a First-Year Introductory Engineering Course

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This GIFT paper presents information on advising students by motivating ownership of education. In recent years, the use of Learning Management Systems (LMS) and Customer Relationship Management (CRM) software packages have become widely implemented into educational programs from grade schools to doctoral programs. These software packages provide a convenient medium for students and faculty alike to check students' academic progress (time to degree completion), course progress, and even personal well-being. However, much like other forms of technology, LMS and CRM software packages can also lead to students not actively managing their own academic and course progress. Instead, students may tend to passively wait to check their grades and other academic progress. After all, why should students keep track of their progress if software can do it for them? This mentality can have further negative effects when an aspect of academic progress is overlooked, which can lead to a student earning a grade that was "unexpected". In more extreme cases, a students' graduation may be delayed because the student "didn't know" they had some additional credits they need to earn. Many events can occur leading to these unfortunate circumstances, and when a student relies solely on LMS and/or CRM software, aspects of academic well-being will inevitably become overlooked. Perhaps a course that is ordinarily offered every semester is suddenly not offered during a particular spring semester, thus delaying a student's graduation plan. Perhaps there is a delay in posting the following semester schedule at a particular institution. The possibilities are endless. While it is impossible to foresee every scenario that can influence academic well-being, this research presents a proactive advising method for faculty members and advisors to take a more active approach to advising and to encourage students from their first year to also take an active approach in educational management, thus motivating ownership of their education. This research provides a proactive method which has been implemented, for direct interfacing with students in an organized, motivating manner, to promote students keeping track of their own progress in courses and towards degree completion. This method has been incorporated into an Introduction to Civil Engineering course which is typically taken by first-year college students majoring in civil engineering. This method can easily be implemented into any course but would be the most useful for first-year students in academic programs as they would have the most to gain over their time to degree completion by continuing this practice.

32041: GIFT Paper: Potential Mechanisms to Assess the Ability for Engineering Students to Communicate Effectively to a Range of Audiences

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This GIFT paper presents potential mechanisms to assess the ability for engineering students to communicate effectively to a range of audiences. For engineers, accreditation is of paramount importance since it enables an individual to earn professional licensure. For the engineering profession, being accredited by the ABET provides a level of quality control for a university or program to meet certain standards for its students. The Criterion 3: Student Outcomes of ABET states that the program must have documented student outcomes that prepare graduates to attain the Program Educational Objectives. In 2012, the Engineering Accreditation Commission (EAC) of ABET began to review and solicit suggestions for changes to Criterion 3. Since then, several changes have been made regarding Criterion 3, which now include student outcomes (1) – (7). One such change was the re-wording of previous student outcome (g) stating "an ability to communicate effectively", which has now been re-organized as the new student outcome (3) stating "an ability to communicate effectively with a range of audiences". While student outcome (3) has been worded to be more specific compared to its predecessor, student outcome (g), there still seems to be some uncertainty on appropriate mechanisms to assess the ability of our students to communicate effectively with a range of audiences. In this research, potential mechanisms to assess the ability of engineering students to communicate effectively to a range of audiences is presented. One such mechanism was implemented in the Fall 2019 semester in a civil engineering junior project course, while another mechanism was implemented in the Spring 2020 semester in a structural analysis course. All potential assessment mechanisms are planned to be implemented in the Fall 2020 semester within an Introduction to Civil Engineering course.

32066: Pilot Program: Infusing Rubin Education into First-Year Seminar

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The purpose of this GIFTS presentation and paper is to highlight the outcomes of this pilot program, explore the benefits of incorporating an online education resource, such as Rubin Education and, areas for future improvement. In the spring 2020 we piloted the use of the Rubin Education learning resource and our experiences and assessments will be shared in this presentation. Rubin Education is an online educational platform that hosts a wealth of content related to developing student's professional skills (E.g. Networking, resume/cover letters, interview) as well as communication skills (E.g. Phone and email etiquette, concise language, body language). Over time, multiple stakeholders have identified that recent graduates of science, technology, engineering and mathematics (STEM) programs could improve their communication skills and professionalism to be better prepared to enter the workforce. In an effort to improve the communication and professional development of first-year engineering students we collaborated with Danny Rubin of Rubin Education. Our pilot program consisted of two sections of first-year seminar students throughout the spring semester. Pre-assessment data indicated that our first-year engineering students felt confident that they understood the need and importance of strong communication skills and professionalism. However, the vast majority of the cohort admitted that they lack the practical skills and/or education related to strong communication skills and professionalism. Over the course of the spring semester students in this cohort have been exposed to online learning modules as well as in-class discussions and exercises. Upon completion of the first-year seminar class, this cohort will be asked to complete a post-assessment related to communication skills and professionalism as well as an opportunity to provide general feedback on their individual experiences with Rubin Education. The aforementioned student feedback, pre and post-assessment data will be shared by the date of the presentation along with our institutions plans moving forward based off what we learned.

32048: Getting Students to Explore Engineering Ethics through Debate-Style Presentations

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Professionalism and ethics are at the core of any professional career and particularly so in engineering because of the direct impact on human life engineers have. Ethics and ethical dilemma can be taught to students in creative ways to make them more relatable. The authors have used expert lectures and debate presentations to provide students with an opportunity to explore the grey nature of the engineering ethical dilemmas in their Fundamentals of Engineering Design 101 courses. The lectures provided the students with the knowledge and ethical decision guidelines to help them analyze and make a decision on the problems. For the debate presentations, students in teams of two are assigned topics that contained fictional scenarios based on real-life examples and a binary question to debate on. Student teams need to research these scenarios and present them to the class in the form of debates. The aim is to help the students to explore the conflict, apply the knowledge presented during the lecture to make a decision and support their argument, and make a fact-based debate presentation. Students appreciated learning about these important topics during their first year and felt that they will benefit from this activity throughout their engineering career.

32094: Engineering the Future -- Communicating Across Borders Through Elevator Pitches

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Our first-year engineering students are goal oriented and not deterred by any levels of technicality. But when it comes to sharing their knowledge, they do face challenges in communicating concisely, logically, and persuasively. Communication is a skill that needs to be learned and practiced, and this skill will enhance the quality of their first-year engineering experience.

This need can be addressed by teaching our first-year engineering students to make elevator pitches. Through their pitches, our freshmen engineering students can get to introduce themselves, let their peers know who they are, what they do, and why its important to them. They will learn to give an overview of themselves in a concise manner and in doing so, they may create bonds with other students of diverse backgrounds which may spark interests in their personal and professional stories and help them discover and cherish somethings in common.

An elevator pitch is one of the simplest yet most powerful tools for our freshmen students to bond, socialize, and network. But the intangible and hidden benefits are far more overwhelming. This tool can enrich their learning experience by increasing their connectivity and inclusivity. Along with breaking communication barriers, they can immediately develop a sense of belonging towards their peers who may come from ethnically and culturally diverse backgrounds and who may share common interests, beliefs, and hobbies.

For a freshman, an elevator pitch may not only be a compelling tool to talk about oneself, but it may also help break the ice in many networking situations. They will get connected and engaged in personal, social, and professional networking situations. Effective and precise communication skills in turn will boost our first-year students' team performance, grit, leadership skills, and team building skills.

A variety of novel techniques can be implemented to teach and assess communication skills through the delivery of elevator pitches. Students can pitch with dorm mates, peers, and outsiders in their dorms, cafetarias, on elevators, corridors, etc. and be observed by peers, who can then provide feedback. Peer review can be in the form of a report or an executive summary, which is another innovative method of enhancing writing skills. They can face mock interviews or attend mock career networking events in an active learning environment in class, with peers enacting as hiring managers, company managers, researchers, and so on. By playing the greetings' game with the first person they meet in the classroom, by improvising around their well-crafted introduction, and by tailoring their pitches, they can make these interesting, succinct, and memorable. These assessment-based activities can be incorporated in the first-year engineering design, communication, writing, or career related curriculum.

Thus, the concept of connecting and engaging through elevator pitches could be an innovative yet fundamental pathway for us to build our future engineers into better team players and global communicators.

32030: GIFTS: Overcoming Student Resistance to Active Learning: First-Year Educator's Experiences of Transferring Research into Practice

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This GIFTS paper presents ideas for overcoming student resistance to active learning by leveraging recent STEM education research in the area. In this paper, active learning is described as a teaching methodology which involves student participation in the learning process during class time instead of being passive note-takers or listeners. Some of the examples of active learning include think-pair-share, just-in-time teaching, group discussions, and project-based learning. The benefits of such active learning techniques are widely noted in engineering and STEM education literature. However, the translation of active learning in engineering classrooms has been slow. Research has noted several faculty-reported barriers to the use of active learning such as faculty preparation time, concerns about the availability to come cover required syllabus, and negative student response or student resistance to active learning. The presented paper focuses on student resistance as a barrier to the use of active learning in engineering classrooms. Faculty attempting to use active learning often discontinue its use due to the fear of student resistance in the form of negative in-class response and/or negative course evaluations. To address student resistance as a barrier to instructional change and continued use of active learning, recent research has identified several strategies for mitigating student resistance in undergraduate classrooms. This paper uses these recent research findings in a real-classroom setting. The paper presents a reflective summary of a faculty's experience in using research-identified strategies to overcome student resistance in a first-year engineering course.

32058: GIFT: The Influence of Stakeholders in Ethical Decision Making

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Students in first-year engineering design courses recognize that the purpose of their design is to solve a problem or meet a need for a new product or process. Therefore, their end user is a major stakeholder for their design. In our design courses, we emphasize that the end user is not the only stakeholder, but that the views of everyone who could be impacted by the new product or process should be addressed by the design and its implementation or manufacture.

Stakeholder interests often extend beyond the technical domain and involve broader societal impacts. Conflicts in interests and motives among stakeholders make ill-structured and incompletely defined societal problems perplexing at best. Where are the solutions that used to be conveniently found in the back of a textbook? Instead, our students need to develop a problem solving process, based on the design model consisting of defining the problem, investigating its causes, conditions and constraints, brainstorming alternative solutions, and testing these solutions in view of problem specifications arising from causes, conditions and constraints in order to determine the optimal solution.

Stakeholder interests often become part of product or process specifications, therefore, a similar problem solving process can be applied to the resolution of an ethical dilemma in engineering. We had designed an ethics-based exercise to help our students to identify stakeholder interests and apply them to the resolution of an ill-structured problem taken from the engineering workplace, involving a hypothetical software design firmed called Occidental Engineering. Stakeholders from both inside and outside the company were used to define the problem in greater detail provide additional specifications for its resolution. Students worked in teams, in class, to represent certain stakeholders and recommend a solution based on that stakeholder's position, as they perceived it. Our latest version of this exercise combined stakeholder roles and interests with the application of four ethical frameworks for decision making: Deontology, Virtue Ethics, Consequentialism and Utilitarianism. How would each stakeholder recommend a solution under each of these four frameworks?

Deontology is based on rules, such as the Code of Ethics for Engineers by the National Society for Professional Engineers or the codes of ethics published by engineering professional organizations. Under Virtue Ethics, individuals act in ways that reflect on their character, by using commonly accepted historical or societal norms of moral virtue. By contrast, Consequentialism is often described as a case where ”the ends justify the means”, sometimes without regard for either rules or virtue. Finally, Utilitarianism is a framework for ”greatest good for the greatest number”, or a form of cost-benefit analysis.

This GIFT includes a matrix in which students can describe solutions to an ethical dilemma, as expressed by stakeholders under each of these four frameworks. Other frameworks can be used instead. This exercise can be given either in class or as a homework assignment. If used as a homework assignment, students can also share their results with the rest of the class after submitting their responses. Would a stakeholder's response change under any of these frameworks?

32080: GIFTS: Reimagining the Early Calculus Experience

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Early calculus courses are often barriers for student persistence in engineering. Several factors contribute to the difficulty of calculus courses, including poor math preparedness and, perhaps more importantly, low math self-efficacy. We previously conducted a systematic review that summarized numerous ways in which institutions and instructors are innovating calculus experiences, including adding engineering applications and using active pedagogies. We have used the insights from this literature review, as well as our own institutional-level observations, to re-imagine the calculus experience for a pilot group of civil engineering students at The Citadel. Our goal is to turn early calculus courses into mastery experiences that build self-efficacy and encourage students to remain in engineering.

We have created an extended calculus sequence that allows students to complete their Calculus I and II requirements over three semesters, rather than two, in a small-cohort structure with personal, academic, and professional structures intentionally designed to help students build self-efficacy. During the summer before their freshmen year, the cohort participated in a residence-based experience to help them adapt to college life and complete essential math requirements before the rigors of the academic year. As part of this program, students completed Calculus I with an embedded precalculus review. To encourage success, students worked with a peer leader, academic coach, and supplemental instruction leader. In addition, students participated in a parallel engineering applications seminar to connect math topics with future coursework and professional practice. The course indeed served as a mastery experience for students, as they all received grades of ”C” or higher. Furthermore, results from a follow-up focus group and previously-developed survey instrument support that students generally experienced gains in self-efficacy and a positive outlook heading in to their freshmen year. We wanted to sustain students’ math preparedness and success, while still providing them with flexibility to manage other areas of academic life during their freshmen year. Subsequently, we created a two-semester Calculus II course to allow students to continue to sharpen their math skills but at a more relaxed pace. Preliminary results suggest that students are performing well in their courses, as well as becoming involved in other campus activities and groups. We are interested in scaling up our extended sequence and believe that re-imagining the early calculus experience can provide GIFTS for other institutions as well.

Work in Progress Papers

32038: Work in Progress Paper: Advantages of Applied Engineering Programming in a Civil Engineering First-Year Course

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This Work in Progress Paper discusses the advantages of applied engineering programming in a civil engineering firstyear course. In civil engineering, there has been discussion as to what the most appropriate scientific programming content is for first-year students. In addition, how that content should be delivered, what programming language is most useful, and what prerequisite material should be required is of interest. Some civil engineering curricula require a traditional, mathematics-based theory in their scientific programming content. This often includes scientific programming topics ranging from root-finding methods, numerical differentiation, integration, solutions to ordinary differential equations, and matrix operations. Such topics may be delivered in a way that students can enroll in the course during their first year in engineering, while other delivery methods may require prerequisite material causing students to enroll during their second year. The application of traditional mathematics-based theory in a scientific programming course can refresh and sharpen the skills that students had been exposed to prior but may quickly become repetitive and lose the interest of the students. A scientific programming course can become very useful upon entering the engineering profession; however, with a programming course using only the mathematics-based theory, the connection to later courses of study and the engineering profession may not be as clear. If the programming content has a more direct relation to the engineering profession, students would be exposed to basic concepts of future courses and have an early understanding of these relevant engineering topics. While mathematics-based topics are important for the students to become familiar with, the questions that should be asked are ”How do these topics complement freshman and sophomore-level engineering content?”, ”How does exposure to these topics motivate or demotivate freshman and sophomore-level civil engineers to continue to pursue their degree?”, and ”What are appropriate prerequisites for this material?” This research provides a list of topics that are easily integrated into a scientific programming course for first-year students majoring in civil engineering that can be useful and stimulating, while not requiring rigorous prerequisite material that will delay enrollment into the course until the second year. Specifically, this research shows how topics from Statics and Mechanics of Materials can be organized and delivered to first-year civil engineering students such that they are able to write programs to solve problems from said topics, prior to being enrolled in the sophomore-level Statics and Mechanics of Materials courses. This research also provides an outline for how other engineering programs can develop their own unique scientific programming course content that can have a positive impact on students’ performance in later engineering courses.

32075: WIP: Using engineering discourse instruction to promote equitable and inclusive group work

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This work in progress paper describes a two-session instructional module on equitable engineering talk, which explicitly addressed the role of discourse in engineering practice as well as the importance of inclusive and equitable discourse in a first-year engineering course. In the module, students audio recorded themselves as they worked in small groups to plan an initial solution to an engineering design problem. After listening to their recorded discourse, they participated in scaffolded reflection about engineering group work interactions. The module provided students with the opportunity to assess and evaluate their own discussions for equity and inclusion as well as those of experienced engineers. Data were obtained in the form of student written work and post-intervention in-class video of student group interactions.

32090: Work In Progress: Engineering Success Bridge Program: Creating Sense of Belonging through Campus and Industry Supported Summer Bridge Program

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This work-in-progress paper will highlight the creation and expansion of the Mizzou Engineering Success Bridge Program (ESBP), a no-cost summer transition program for incoming freshmen at the University of Missouri-Columbia (MU) that has grown from a week-long to a month-long program that brings campus and industry professionals together to serve engineering’s most at-risked population.

The Engineering Success Bridge Program was organized by the First Year Engineering (FYE) Office, which serves to provide all new undergraduate students with the resources, opportunities and connections to smoothly transition to Mizzou Engineering, but also jumpstart their future careers. This retention initiative originated two years ago, with financial support from MU’s Provost Office, and has since evolved into a successful FYE Office consisting of a First Year Director, academic advisors and two

graduate students. Through FYE strategies, students experience more individualized advising and follow-up, an exploration of their majors, participation in student success programs, and a better sense of community within the College of Engineering and MU.

This paper will follow the success of the FYE Office's Engineering Success Bridge Program first two cohorts and how the office plans to expand to serve more students in June 2020. The bridge program that began as a one-week summer transition program in August 2018 was first created to serve the college's Pre-Engineering population, students who have not met the college's admission requirements based on ACT scores and math levels. Historically these students had significantly lower retention and graduation rates than students who met the college's admission requirements.

Following higher education's best retention practices on student's Sense of Belonging, Mizzou Engineering hosted 45 engineering freshmen in a one-week transition program before the start of their freshmen year in August 2018. This one-week program introduced students to resources and opportunities available at MU and promoted a sense of community in which students felt comfortable utilizing peer and faculty mentors for guidance, academic services, and student success strategies to smoothly transition to engineering. The FYE Office saw a 12% retention rate increase from participants compared to Pre-Engineering students who did not attend.

Continuing the success of the 2018 program, ESBP expanded to four weeks in July 2019 hosting forty incoming freshmen. The 2019 ESBP, provided at no-cost to students, featured many of the components offered in 2018 with an addition of an engineering design project, career exploration sessions, hands-on activities highlighting engineering departments, and community-building activities with current Engineering students. Along with these research-based initiative, ESBP also provided students with a Chemistry and Math mock class, a Student Success Seminar Course, 3-credit hours of Public Speaking and access to industry professionals through company site visits and presentations. In its first semester, the 2019 cohort experienced a 93% fall-to-spring retention rate within the College of Engineering.

This goal of this paper is to provide attendees with the framework to implement a similar bridge program at their institutions. Additionally, the paper will demonstrate how this research-based initiative has helped Mizzou Engineering reach its highest retention rates in recent years.

32067: WIP: Building Intuition in Mechanics with Haptic Feedback

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Haptic technology is quickly emerging as a powerful tool for enriching human interaction with complex environments. In particular, the additional sensory feedback provided by haptic technology has been shown to lead to a richer understanding of complex environments and enhance comprehensive learning for new skills. In the field of engineering, complex structural models are common practice in many courses. These concepts often require intuitive understanding of the relationships between the system and environment. However, the traditional classroom lacks the interactive experience that has been proven to increase learning and retention. Haptic environments can improve the learning rate and comprehensive understanding of engineering concepts in the classroom. The goal of this Work in Progress research project is to conduct a comparative experiment using the Haply robot to explore the effect of learning via an interactive tool versus traditional learning. In this Work in Progress, two groups of engineering students who have not taken engineering mechanics courses (statics, dynamics, mechanics of materials, or fluid mechanics) will undergo two different treatments to learn about concepts in mechanics that are known to be difficult for students to learn: moment and friction. This will be a quasi experimental study with the control group receiving a traditional worksheet with verbal explanations, print images, equations, and examples. The control group will work through a similar worksheet, but with the images and examples replaced by physical manipulation of the Haply virtual environment. Pre/post assessments that compare the control group and treatment group will be used to address two primary research questions: 1) is there a difference in students ability to accurately manipulate algorithms to solve moment and friction problems; and 2) is there a difference in students ability to answer conceptual questions about the system. To answer the first research question, items from the Concept Assessment Test for Statics (CATS) and one computational problem will be given to the students to answer and solve, and for the second research question, a series of open-ended questions will be drafted to isolate changes to the system based on changes to a single parameter. We hypothesize that the students who engaged with the interactive Haply virtual environment will develop a deeper understanding of how the system will behave under different conditions, and thus will be able to answer the open-ended questions with more accuracy than the control group. The concern, however, is that the intuitive sense may come at the expense of algorithmic understanding, and so this will be investigated as well. We intend to expand the scope of this project to a wider range of target audiences, including middle and high school students, to better understand the effects of haptic learning across age groups.

32028: Work In Progress: Assisting Academically Underprepared Engineering Students in Mathematics

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This work-in-progress paper focuses on educating academically underprepared engineering students in mathematics. The problem of student attrition and retention continues to be a critical issue facing undergraduate engineering education. While the literature notes several socio-cognitive factors contributing to student attrition in engineering, academic preparation in pre-college mathematics is widely noted as an important precursor to student progression in engineering. In addition, access to educational experiences that better prepare students in pre-college mathematics content is often tied to students' socioeconomic status and thus adversely affects students from underrepresented and underserved minorities. To better support academically underprepared students, a mathematics course with emphasis on applications for engineering was initiated at our institution. In this paper, we present preliminary analysis results identifying topics of difficulty and areas of error in students' mathematical problem-solving. The findings offer implications for first-year engineering education and directions for future research.

32114: Understanding First-Year Engineering Student Definitions of Engineering Disciplines

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This work-in-progress paper examines first-year engineering students' definitions of engineering disciplines. In this study, 158 second-semester first year engineering students from a public midwestern technical university were asked open ended questions about their definitions of various engineering disciplines. Qualitative analysis of results involved coding for emergent themes by two undergraduate researchers and one faculty member. After each of the three researchers independently coded the responses, meetings were held to discuss the coding, resolve coding differences, and modify the codebook as necessary. As codes evolved, the data was reanalyzed to ensure consistency in coding until convergence was reached among researchers. After all of the data was coded, an analysis identified themes within the data related to student understanding of the definitions of various engineering disciplines was compared with definitions provided by engineering departments within the university, as well as discipline-specific industry associations.

All first year engineering students complete a common first year at this university. The selection of an engineering major is a major focus of first year students. The results of these findings will be used to inform the various engineering departments internal university recruiting and advertising efforts. The common first year classes include engineering explorations to learn about the various disciplines. This reserach will also provide the first year program with an understanding of the effectiveness of its approach at introducing first-year students to the various engineering disciplines. Information about common misconceptions of disciplines or lack of understanding of disciplines will direct future efforts at exploring the engineering majors.

32033: Work In-Progress: Mental Health Initiatives and TAO at the University of Windsor

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This paper documents a work in progress at the University of Windsor to expose our first-year students to mental health supports available on campus. The University of Windsor prides itself on being a leader in providing wellness and mental health services to its students as part of the institution's comprehensive, multi-year Mental Health Strategy (http://www.uwindsor.ca/studentexperience/322/mental-health-strategy). As well, within the Faculty of Engineering, many new initiatives have been implemented to provide mental health services to our students, especially first-year students who are transitioning to university and, for some, to Canada. One such initiative is Therapy Assistance Online (TAO). TAO is an online library of interactive modules that helps students learn skills to handle challenges in their lives (http://www.uwindsor.ca/engineering/831/tao). TAO is available to all University of Windsor students; however, not all students use the service. In order to encourage Engineering students to use it, first-year students are introduced to TAO in their second-semester Technical Communications course. A course assignment asks students to complete four of the five modules within the Communication and Interpersonal Relationships TAO pathway. The five modules are: Managing Anger, Communication Strategies, Communication Styles, Problem Solving, and Relationships (this fifth module is available to students, but they are not required to complete it).

At the time of writing, this initiative had only been completed over the course of one academic year; the second academic year was in progress. This paper will discuss how the initiative was implemented, changes that were made as it was developed, and instructor recommendations for further development. It is anticipated that additional undergraduate engineering courses will incorporate TAO pathways into their course requirements. Specific pathways include ”Calming Your Worry” and ”Let Go and Be Well”, which address topics like anxiety and resilience, respectively. As well, this paper will discuss additional wellness and mental health initiatives that are being implemented to support our first-year Engineering students such as mental health counselling, drop-in counselling, weekly therapy dog drop-in sessions, international student support services, and the creation

of a new space within the Faculty of Engineering: the Engineering Student Support Services Centre in conjunction with the services currently offered at the WINONE office (First Year Engineering Office), making a home for incoming local and international students alike.

32085: Exploring Math Self-Efficacy Among First-Year Civil Engineering Majors

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Across the country, engineering retention rates are often low and highly correlated with calculus performance. The underlying cause of poor performance in college math courses may be more complicated than just lack of preparedness or ability. Rather, low math self-efficacy may be an important contributing factor to poor performance. Math self-efficacy refers to an individual's beliefs about understanding math concepts and solving related problems. Among college students generally, past math performance is thought to inform self-efficacy; however, future achievement is most dependent on how students perceive their past performances. Studies examining development and impacts of math self-efficacy for engineering students are somewhat sparse, although some authors report that feelings about math are an important component of general engineering self-efficacy.

The goal of our study is to explore how math self-efficacy develops among civil engineering students and how that self-efficacy might drive their will to succeed as engineering students. Specifically, we address the following questions: (1) To what extent, if any, does math self-efficacy evolve over students' first academic semester? (2) How does math self-efficacy vary based on students' high school and college math experiences? (3) To what extent might math self-efficacy be associated with persistence in engineering? We hope to provide insights for how self-efficacy building can be used to encourage retention of diverse engineering students.

31986: Increasing Student Understanding of Diversity/Inclusion Issues in a First-Year Engineering Classroom

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More attention is turning to increasing diversity and inclusion in engineering education as a means to recruit and retain first-year engineering students from underrepresented backgrounds in engineering, and more engineering educators are implementing novel pedagogical techniques to make engineering courses more diverse and inclusive. In this paper, we present initial results of a novel diversity/inclusion-based pedagogical approach to the first-year introduction to computing course at the University of Texas at Austin, implemented during the Fall 2019 semester. This pedagogical approach consisted of group active learning activities in class, diversity/inclusion-based programming assignments, and careful selection of a diverse teaching team. One section of the course, containing about 100 students, was used as the target population. To measure the effectiveness of the diversity/inclusion approach on sense of belonging, engineering identity, and student beliefs about diversity and inclusion, we designed a longitudinal panel study that compares student responses to a survey addressing these issues at three time points: at the beginning of the Fall 2019 semester, at the end of the Fall 2019 semester, and at the end of the Spring 2020 semester. A repeated-measures ANOVA was conducted on the results from one inventory on the survey to investigate whether students' perceived understanding of diversity and inclusion issues had changed during the course of the semester as a result of the class ($n = 36$). The ANOVA results show that at the end of the course, students perceived themselves to have a statistically significantly stronger understanding of certain specific diversity and inclusion issues that were discussed through the course content, whereas they perceived themselves to have no change or a statistically significantly weaker understanding of diversity and inclusion issues that were not discussed as part of the course content ($F[1, 4] = 0.13$, $p << 0.001$). This may imply that implementing diversity and inclusion-oriented curricula is one approach to highlighting the importance of diversity and inclusion in engineering to first-year students. Furthermore, we suggest that such curricula may have lasting effects on students as they become socialized into the engineering profession. In the future, we intend to examine interest in diversity and inclusion issues based on race and gender identity as well as the relationships between diversity/inclusion interest, sense of belonging, and engineering identity using our dataset. We reflect on possible avenues for further improvements to the course under study as well as implications for practice in general.

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