First-Year Engineering Experience Conference

14th Annual Conference

EXPANDING STUDENT SUCCES: MULTIFACETED APPROACHES FOR STUDENT SUCCESS IN TODAY'S "NEW NORMAL"

FIRST-YEAR FYEE ENGINEERING EXPERIENCE

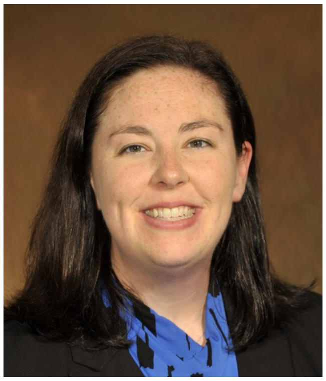
Knoxville, Tennessee

Zeanah Engineering Complex
University of Tennesee, Knoxville

July 30–August 1

THE UNIVERSITY OF TENNESSEE KNOXVILLE

Welcome from the General Chairs



Rachel Ellestad

Director, Engineering Fundamentals

The University of Tennessee, Knoxville

Conference Chair

Haritha Malladi

Assistant Professor, Civil and Environmental Engineering

Director, First-Year Engineering

University of Deleware

Co-Program Chair

Stephany Coffman-Wolph

Assistant Professor, Computer Science

Ohio Northern University

Co-Program Chair

Welcome to the 14th Annual First-Year Engineering Experience Conference hosted at the University of Tennessee in Knoxville. The conference has a long history of sharing of ideas developed by innovators in first-year engineering education from around the country and beyond.

FYEE presents first-year engineering educators with the opportunity to network with and learn from others in small group settings. Workshop and paper presenters will share their ideas and best practices so that all may benefit from their efforts. We hope attendees will fully engage in the conference to better the first-year engineering experiences at their home institutions.

First year engineering has a long history of innovation and excellence at the University of Tennessee in Knoxville. The Stoneking engage® Engineering Fundamentals Program began in 1997, with its first full class in 2001. The program has grown over the last 25 years to now serve over 1000 students per semester using active, hands on learning with a focus on engineering physics and computer programming.

The FYEE conference will take place in Zeanah Engineering Complex, starting with workshops and a meet & greet session on Sunday. Monday will feature works-in-progress and poster presentations followed by workshops and paper presentations. Keynote speakers will present at our breakfast session as well as dinner on Monday. The conference will conclude on Tuesday with additional paper presentations and discussions.

We hope the conference will be beneficial for all!

Conference Committee

The FYEE Conference is made possible by the dedication of many volunteers:

- **Location Chair:** Rachel Ellestad (*University of Tennessee, Knoxville*)
- **Program Co-Chair:** Haritha Malladi (*University of Delaware*)
- **Program Co-Chair:** Stephany Coffman-Wolph (*Ohio Northern University*)
- **Program Chair-Elect:** Haritha Malladi (*University of Delaware*)
- **Publication Chair:** Tracy Hammond (*Texas A&M University*)
- **Sponsorship Chair:** Kevin Calabro (*University of Maryland*
- **Treasurer:** Jes Kuczenski (*Santa Clara University*)

The FYEE Steering Committee:

- Sean Brophy (**Chair**) (*Purdue University*)
- Lee Rynearson (*Campbell University*)
- Kathryn Schulte Grahame (*Northeastern University*)
- Ashwith Chilvery (*Xavier University of Louisiana*)
- Scott Streiner (*Rowan University*)
- Stephany Coffman-Wolph (*Ohio Northern University*)
- Ashish Borgaonkar (*New Jersey Institute of Technology*)

FYEE Web Manager

- Ethan Danahy (*Tufts University*)

Welcome from the Dean

Dear FYEE Attendees,

Welcome to the Tickle College of Engineering at the University of Tennessee. We are honored to be hosting the 14th annual First-Year Engineering Experience (FYEE) Conference.

There's never been a better time to be on Rocky Top. For the 22-23 academic year, TCE has set records for undergraduate and graduate student enrollment, female and historically underrepresented student enrollment, research expenditures, patents filed and issued, and facilities, highlighted by the Zeanah Engineering Complex. And that's just the beginning.

For fall 2023, we are expecting over 1,000 incoming students to participate in one of two first-year student programs, the Jerry E. Stoneking *engage* Engineering Fundamentals (EF) program, which employs an innovative success-oriented educational approach that emphasizes problem solving through collaboration, or the Joseph C. and Judith E. Cook Grand Challenge Honors program, which offers a high level of intellectual challenges and broad educational experiences.

Much of this year's conference will be held in the Zeanah Engineering Complex, a 228,000 square-foot building, which was purposefully designed for engineering education from its very inception. With configurable counterspace that full integrates advanced teaching technologies, not a single detail was missed. Zeanah is also home to nearly all of the college's student services, the highly ranked Department of Nuclear Engineering, collaborative lab spaces, and the Min H. and Yu Fan Kao Innovation and Collaboration Studio.

The FYEE Conference provides faculty an opportunity to learn from one another by sharing experiences and best practices in first-year engineering education. Students from across the nation and the world will benefit from your participation in the conference publications, presentations, and workshops. I wish all of you an engaging and beneficial conference.

Best Regards and Go Vols,

Matthew M. Mench

Dean and Wayne T. Davis Dean's Chair

Tickle College of Engineering

FYEE 2023 Conference Spnsors

Platinum

THE UNIVERSITY OF TENNESSEE KNOXVILLE

ENGINEERING FUNDAMENTALS DIVISION

Gold

Cengage

Workshop

MathWorks®

eGrove Education, Inc.

Exhibitors

eGrove Education, Inc.

engineering 4 us all

NSF

Society Sponsors

ASEE

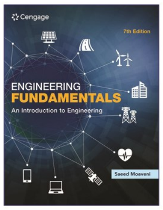
FIRST-YEAR PROGRAMS DIVISION

Cengage

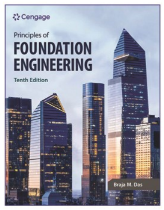
Keep Your Engineering Course Fresh With the Most Relevant and Up-to-Date Content From Cengage

Our catalog of Engineering titles spans the 4-year curriculum for all fields of study with comprehensive, engaging content. Many of our titles are available with the *WebAssign* online learning platform, which enables you to customize your course with online assignments, exams and resources.

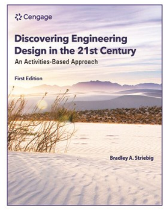
New Titles Available for the Fall Term



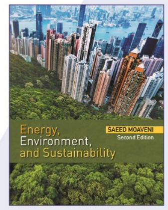
Engineering Fundamentals, 7e
Moaveni
©2024
978-0-357-68441-2



Principles of Foundation Engineering, 10e
Das
©2024
978-0-357-68465-8



Discovering Engineering Design in the 21st Century: An Activities-Based Approach, 1e
Striebig
©2024
978-0-357-68520-4



Energy, Environment, and Sustainability, 2e
Moaveni
©2023
978-0-357-67607-3

Visit **cengage.com/discipline-engineering**
to browse titles and preview content.

FYEE 2023 Conference at a Glance

***All times are Eastern Daylight Time (EDT)**

Sunday July 30, 2023	Event	Corresponding Author	Location
2:00PM - 8:00PM	Registration	Corresponding Author	ZEC 1st Floor
2:30PM - 4:00 PM	**S1A: Workshop I**		ZEC 377
	Workshop on Engineering First-Year Holistic Support to Succeed Model	Lisa Lampe	
	S1B: Workshop II		ZEC 277
	Interfacing MATLAB with Sphero Robots for an Introduction to Programming Class—Part 1	Joshua Fagan	
4:00PM - 4:15PM	Networking Break		ZEC 178
4:15PM - 5:45PM	**S2A: Workshop III**		ZEC 378
	Tips for Top Tier Team Teaching	Todd R Hamrick	
	S2B: Workshop IV		ZEC 377
	Building Bridges (but not with balsa wood) through Scalable Engineering Design Process Lessons	Betsy Chesnutt	
	S2C: Workshop V		ZEC 277
	Interfacing MATLAB with Sphero Robots for an Introduction to Programming Class—Part 2	Joshua Fagan	
6:00PM - 8:00PM	**Welcome Reception** *Please join us for heavy hor d'oeuvres, lawn games and a casual time to get to know others in the First Year Programs community.*		ZEC First Year Design Studio/ Outside Quad

Monday July 31, 2023	Event	Corresponding Author	Location
7:00AM - 12:00PM	Registration		ZEC 1st Floor
7:30AM—5PM	Exhibit Hall Open		First Year Design
7:30AM - 8:30AM	Breakfast		ZEC 178
8:00AM - 8:30AM	Welcome Rachel Ellestad *FYEE 2023 Local Chair* Dean Matthew Mench *Dean, Tickle College of Engineering*		
8:30AM - 9:00AM	**Keynote 1: Dr. Krystyne Savarese** *A Culture Where Students Thrive: Wellbeing at the University of Tennessee, Knoxville*		
9:00AM - 9:15AM	Transition Break		

FYEE 2023 Conference at a Glance (cont.)

Monday July 31, 2023	Event	Corresponding Author	Location
9:15AM - 10:30AM	**S3A: Work in Progress I** *It All Begins With a Solid Foundation*		ZEC 378
	Varying the Design Experience in First-Year Engineering	Kathleen A Harper	
	Integrating Computation within an Engineering Physics Course	Darren K Maczka	
	Engineering Education after ChatGPT	Howard L Richards	
	A 3D-printed speaker and audio system project for teaching interdisciplinary engineering design	Brian Scott Krongold	
	Opening the First-Year Design Project	Nathan M. Hicks	
	Introducing a research project to a First-year Mechanical Laboratory Course	Gloria Guohua Ma	
	How to Interview the Crowd: Enlisting Informal Student Feedback in a Formative Assessment Process	Natalie C.T. Van Tyne	
	Sustainability and Life Cycle Assessment in Engineering Curriculum	Lauren H. Logan	
	MATLAB WebTA, Enhancing the bigger picture through human factors.	Laura Albrant	
	S3B: Work in Progress II *How Do I Get Them? How Do I Keep Them?*		ZEC 377
	Impact of Peer Mentor Program on First Year Engineering Students Success	Kenneth Reid	
	A focus on well-being to increase non-calculus ready students' problem-solving self-efficacy	Erin McCave	
	Investigation of Recruitment Communication Channels and Student Awareness of an Engineering Bridge Program via Cross-Disciplinary Collaboration	Xinyu Zhang	
	Using an Elevator Pitch Competition to Introduce Engineering Students to Entrepreneurship	Lizzie Santiago	
	The First-Year Engineer's Learning Journey	Amber Kemppainen	
	Development of Career Preparation and Portfolio Modules in a First-Year Engineering Course	Victoria Bill	
	Developing a Virtual Peer-Facilitated Workshop Experience for First-Year Engineering Students - A Comparative Study of Online and Face-to-Face Engagement	Dan Burleson	
	Developing a First-Year Experience Professionalism Certificate for Engineering Students: Strategies and Structures for Enhancing Career Engagement	Dan Burleson	
	How Professional Networking Impacts Outcome Expectations and Choice Goals in a First-year Engineering Course	Evelyn Walters	

NOTE: For these sessions, we will start in separate rooms where authors will give a short pitch of their work in progress. After pitches are complete, the rooms will be combined for one larger digital poster session.

FYEE 2023 Conference at a Glance (cont.)

<table>
<tr><th>Monday
July 31, 2023</th><th>Event</th><th>Corresponding Author</th><th>Location</th></tr>
<tr><td>10:30AM - 10:45AM</td><td colspan="2">Networking Break
Intro to NSF RIEF Program
Matthew Verleger - NSF Program Director, ENG/EEC</td><td>ZEC First Year Design Studio</td></tr>
<tr><td rowspan="6">10:45AM - 12:15PM</td><td colspan="2">S4A: Workshop VI</td><td rowspan="2">ZEC 378</td></tr>
<tr><td>SPONSORED eGrove Education, Inc.: Spatial Visualization and Sketch Training in First Year Engineering to Increase Design, Teamwork, and Technical Communication Skills</td><td>Lelli Van Den Einde
Lizzy Cowan</td></tr>
<tr><td colspan="2">S4B: Workshop VII</td><td rowspan="2">ZEC 377</td></tr>
<tr><td>Democratizing and Demystifying Engineering for All: A workshop to help you bring e4usa to your campus</td><td>Kevin Calabro</td></tr>
<tr><td colspan="2">S4C: Workshop VIII</td><td rowspan="2">ZEC 277</td></tr>
<tr><td>Why on earth do I have to take a class in [fill-in-the-blank]?</td><td>Stephany Coffman-Wolph</td></tr>
<tr><td>12:15PM - 2:00PM</td><td colspan="2">Lunch
Focus on Exhibits</td><td rowspan="2">ZEC First Year Design</td></tr>
<tr><td>1:15PM– 2:00PM</td><td colspan="2">Tours of First Year Design Studio, Kao Innovation and Collaboration Studio and EF Active Learning Classrooms
TCE and EF Faculty and Staff</td></tr>
<tr><td rowspan="6">2:00PM - 3:30PM</td><td colspan="2">S5A: Workshop IX</td><td rowspan="2">ZEC 378</td></tr>
<tr><td>SPONSORED MathWorks: Meeting Students where they are: Accessible and Effective Learning with MATLAB and Simulink</td><td>Jon Loftin</td></tr>
<tr><td colspan="2">S5B: Workshop X</td><td rowspan="2">ZEC 377</td></tr>
<tr><td>Flipping Across the First Year Workshop</td><td>Rachel McCord Ellestad</td></tr>
<tr><td colspan="2">S5C: Workshop XI</td><td rowspan="2">ZEC 277</td></tr>
<tr><td>Making Patterns, Breaking Patterns - Applying ethnographic system mapping and analysis to support your group's culture</td><td>Courtney June Faber</td></tr>
<tr><td>3:30PM - 3:45PM</td><td colspan="2">Networking Break</td><td>First Year Design</td></tr>
</table>

FYEE 2023 Conference at a Glance (cont.)

Monday July 31, 2023	Event	Corresponding Author	Location
3:45PM - 5:00PM	**S6A: Full Paper** *Out with the Old, In with the New*		ZEC 378
	An Immersive Approach for First-Year Engineering Students	Alexander Campbell	
	Introducing Machine Learning to First Year Engineering Students	Joshua Eron Stone	
	Exploring the Impact of ChatGPT on a First-Year Engineering Design Course	Kevin Calabro	
	A multi-faceted Model to Enhance Engineering Student Success	Derin Ural	
	Implementation of Course Structure in STEM Courses for Student Motivation and Learning, and Lab Innovation	Muzammil Arshad	
	S6B: Full Paper *One Size Does Not Fit All*		ZEC 377
	Engendering Engineering Inclusion through an Interactive Theatre Sketch	Robin A.M. Hensel	
	Incorporating Academic Coaching in First-Year Engineering Program to Support Student Success and Persistence	Aysa Galbraith	
	Engineering Catalyst: An Alternate Supported Path to the Same Destination	Susan E. Walden	
	A Pilot Study: Undergraduate Teaching Assistants Fostering Engagement, Inclusion and Belonging in Engineering	Tameka Sharona Clarke Douglas	
	Engaging First-Year Engineering Students Through Team-Based Design and Peer Review: A Service-Learning Approach	Djedjiga Belfadel	
	S6C: Full Paper *Cannot Have Too Much Math!*		ZEC 277
	Where's the Math? A Case for Reconsidering Math in K-12 Engineering Activities	Todd France	
	Promoting First-Year Student Success through the Data-Driven Creation of a Preparatory Engineering Program and an Engineering Math Resource Center	Katherine A Grover	
	Fostering Success in Introductory Calculus through Peer-Led Team Learning (PLTL)	Karen D Alfrey	
	The Impact of Freehand Sketch Training on Engineering Students' Creativity, Communication Abilities, and Spatial Visualization Skills: A Controlled Trial	Nathan Delson	
5-6PM	Break *Attendees are welcome to either stay in ZEC or return to the Cumberland House during the break.* *Buses will start taking conference participants to the Foundry at 6pm and will leave from both ZEC and the Cumberland House. Buses will return participants to the Cumberland House at the end of dinner. If you are driving yourself, you can pick up a map at the information desk for the Foundry, where there is free parking.*		
6:30PM - 8:30PM	Dinner **Keynote 2: Dr. Lynne Parker** *Shaping the Future of Engineering Education in the Age of AI*		The Foundry, Knoxville

FYEE 2023 Conference at a Glance (cont.)

Tuesday August 1, 2023	Event	Corresponding Author	Location
7:00AM - 11:00AM	Registration		ZEC 178
7:30AM - 8:30AM	Breakfast		ZEC 178
7:30AM– 11:15AM	Exhibit Hall Open		First Year Design Studio
8:30AM– 8:45AM	FYEE 2023 Picture		ZEC Outside 1st Floor
8:45AM - 10:00AM	**S7: Special Session** First Year Programs Primer *Jack Bringardner*		ZEC 378
10:00AM - 10:15AM	Networking Break **Practicing Mindfulness in the Classroom** *Katheryn Schulte-Graham and Richard Whalen*		First Year Design Studio
10:15AM - 11:30AM	**S8: GIFTS** *Great Ideas for Teaching, or Talking with, Students!*		ZEC 378
	Understanding buoyancy with building a miniature concrete canoe	Helen Yoonhee Jung	
	Developing Data Literacy through the NAE Grand Challenges and MATLAB App Designer	Dan Burleson	
	Situational Learning of MATLAB Using Data Collection and Analysis Modules Based on Upper-Level Engineering Lab Experiments	Brian Patrick O'Connell	
	A Fantastically Creative AutoCAD Assessment	Angelina Jay	
	Team selection using team leaders as hiring managers	Todd R Hamrick	
	Meeting the students where they're at: a flipped model of office hours	Kimberlyn Gray	
	Showcasing Interconnectedness of Engineering Disciplines in an Introductory Engineering Class through a Climate Change Module	Haritha Malladi	
	Integration of a Problem-Solving Heuristic Across Teaching and Assessment	Baker A. Martin	
	Broadening Students' Self-Knowledge and Self-Development in an Introductory Engineering Design Course	Ashish D Borgaonkar	
	Lifelong Learning in Perspective – An Activity for Student Understanding of an Engineer's Need to Acquire and Apply New Knowledge	Lee Kemp Rynearson	
	Leadership, Engagement And Professionalism (LEAP) Peer Mentoring Program	Marsha Christine Kowal	
	Metacognition reflection notecard: A 5-minute daily class activity to drive self-efficacy, classroom engagement, and community	Alexandra Maley Landon	
11:30AM -	Closing Session		ZEC 178
12:00PM - 1:00PM	Lunch		ZEC 178
12:30PM - 1:30PM	First Year Administrators Community of Practice Session		ZEC 378

Map to Conference Hotel

FYEE 2023 Keynote Speakers

Morning Keynote

Dr. Krystyne Savarese
Assistant Vice Provost for Student Success
The University of Tennessee, Knoxville

A Culture Where Students Thrive: Wellbeing at the University of Tennessee, Knoxville

The University of Tennessee, Knoxville set a bold new vision to create a campus rooted in well-being where every student thrives. Through initiatives that lift a strengths-based, well-being centered experience for first-year students, both in and out of the classroom, UT is committed to holistic student success. This session will explore how the PERMA Model of Well-being and a strengths-based approach are being infused in FYS 101, extended orientation, Vol Success Teams, and in unique academic interventions such as our student success grants and Volunteer Experience Faculty Fellows.

Biography:

Krystyne Savarese serves as the assistant vice provost in the Division of Student Success. In this role, she leads the work of the Volunteer Experience initiative, a university-wide approach to promoting student well-being and career readiness in all aspects of a scholar's experience.

Krystyne has served in a variety of roles in her 20 years in higher education. She started her career at Ohio State University in residence life, eventually serving in a role coordinating annual reporting, strategic planning, and accreditation for the Division of Student Life. Later, she moved to the Office of Legal Affairs where she managed the university's policy portfolio. She also had the honor of serving as chair of the University Staff Advisory Committee. Most recently Krystyne served as the senior director of residence life at Rutgers University, New Brunswick, one of the largest residential programs in the country.

Originally from Southern California, Krystyne has a B.A. in English from the University of California, Irvine, and a Master of Arts in College Student Personnel from Bowling Green State University. She holds a Ph.D. in Higher Education and Student Affairs from The Ohio State University where her dissertation research focused on the organizational socialization experiences of new mid-level managers in student affairs.

FYEE 2023 Keynote Speakers

Evening Keynote

Dr. Lynne E. Parker

Associate Vice Chancellor
Director, AI Tennessee Initiative
University of Tennessee, Knoxville

Shaping the Future of Engineering Education in the Age of AI

As artificial intelligence (AI) becomes more pervasive, its impacts on engineering education are becoming increasingly apparent. Educators today face the imperative to not only educate future engineers about AI, but also understand how AI is transforming engineering education itself through customized and personalized learning approaches. By advancing efforts both in "educating for AI" as well as "AI for education", engineering educators can empower students to excel in the AI-driven engineering workforce. This talk will discuss recent trends, opportunities, and challenges in these areas, and provide suggestions for pathways forward in this era of AI.

Biography:

Dr. Lynne E. Parker is Associate Vice Chancellor at the University of Tennessee, Knoxville (UTK), and Director of the AI Tennessee Initiative, which is positioning the University and the state of Tennessee as a national and global leader in the data-intensive knowledge economy. Prior to this role, she led national AI policy efforts for four years (2018-2022) in the White House Office of Science and Technology Policy, serving as Deputy Chief Technology Officer of the United States, Founding Director of the National Artificial Intelligence Initiative Office, and Assistant Director for AI. She also served as co-chair of the Congressionally-directed National AI Research Resource Task Force, which aimed to democratize access to the computational and data infrastructure needed for AI research. She served for two years (2015-2016) at the National Science Foundation as Division Director for Information and Intelligent Systems. In these roles across three Administrations, she led the development of numerous landmark national AI policies bolstering research, governance, education and workforce training, international engagement, and the Federal use of AI.

Dr. Parker joined the UTK faculty in 2002 and is an expert on distributed and intelligent robot systems, human-robot interaction, and AI, having published extensively in these and related areas. She previously worked for several years as a Distinguished Research and Development Staff Member and Group Leader at Oak Ridge National Laboratory. She has received numerous awards for research, teaching, and service, and is a Fellow of AAAI (Association for the Advancement of Artificial Intelligence), AAAS (American Association for the Advancement of Science), and IEEE (Institute for Electrical and Electronic Engineers); and a Distinguished Member of ACM (Association for Computing Machinery). Dr. Parker earned a Ph.D. from the Massachusetts Institute of Technology.

Sunday July 30, 2023 2:30pm–4:00pm
Session S1 Workshops

S1A: Workshop I	
Workshop on Engineering First-Year Holistic Support to Succeed Model	Lisa Lampe

First year engineering students need an ecosystem of support to persevere through a multitude of barriers while pursuing their degree. Engineering programs should play a role in facilitating an environment where students can easily connect to faculty and staff to solve difficult and complex problems as engineers, including non-academic barriers. While our university has a variety of personal and resources available in both Academic and Student Affairs, students often have physical and knowledge barriers to accessing them. To remove the physical distance to resources, our unique embedded model offers an ecosystem of readily available supports specific to engineering students. Through this workshop we aim to 1) explain the embedded support to success model enabled by a collaboration of our Center for Diversity in Engineering, embedded Assistant Dean of Student Safety and Support, 2 embedded counselors from our Counseling and Psychological Services (CAPS) Office, an accessibility specialist from our Student Disability Access Center (SDAC), and Engineering Undergraduate Programs Office, 2) share important logistical and financial considerations in forming such a team approach, and 3) review our methods in researching the outcome of an embedded position. This workshop is geared toward decision makers in engineering who drive students' success, advising, retention, diversity, equity, inclusion, and justice efforts.

S1B: Workshop II	
Interfacing MATLAB with Sphero Robots for an Introduction to Programming Class **PART 1**	Joshua Fagan Amy Katherine Biegalski

This workshop is for engineering and technology educators who want to enhance their programming course with robotics. It will focus on interfacing MATLAB with wheeled robots to provide a fun and engaging introduction to programming, in the context of engineering concepts. Participants will learn how to implement the workshop leaders' open source toolbox with raspberry pi controlled Sphero RVR robots, allowing instructors and students to program highly customizable robots with MATLAB. Exploring mobile robotics and autonomous car technology can be enticing for students interested in engineering and technology, but there are limited options for affordable wheeled robots that can be readily programmed with MAT LAB, the computer language of choice for many engineering introductory programming classes. MATLAB offers a robust IDE, live help, an extensive amount of built-in toolboxes, and the ability to rapidly prototype and visualize data. The workshop leaders developed a toolbox that implements ROS as a bridge between Python running on a Sphero RVR's Raspberry Pi and MATLAB running on a student's computer. With this toolbox, the ROS and Python communications are hidden from the user/student, ensuring beginners in programming are not burdened by extraneous details and complications. This implementation of MATLAB controlled Sphero RVR's may be a good fit for other classrooms and institutions; the chassis is commercially available and relatively inexpensive, and the system is versatile and easily expandable for adding custom components and features. This workshop will show participants how their students can use MATLAB to control a raspberry-pi controlled Sphero RVR for developing programming skills. We'll share ideas for how students can gain practical experience with key programming concepts such as flow control, inputs and outputs, and data analysis and manipulation. The vehicular robots simulate some basic autonomous car technology and use of neural networks. Students can learn about data collection and analysis using sensors and actuators, such as ultrasonic sensors, infrared sensors, digital cameras, and motors. We'll show how students can practice programming algorithms that process data from these sensors and control the movements of the robot, such as obstacle avoidance, following algorithms, and lane following. Further explorations can offer hands-on application and connection of concepts learned in their other introductory engineering courses, including tracking positions as vectors and creating pos-vel-acc plots (calculus based physics), examining correlation matrices and confidence data (statistics), Fourier analysis of recorded sounds (signal processing), and early introductions to machine learning and trained networks with object, human, and speech recognition. Example project presentation and assessment activities will be discussed to demonstrate how the activities can develop teamwork, writ ten and oral technical communication, and design skills. The addition of robotics in programming classes adds a fun-factor that is excellent for struggling learners and enables highly motivated students to experiment with implementing MATLAB's powerful tools.

PART 1: The first part of the workshop provides an overview of the system architecture, instruction on classroom implementation, and visual demonstrations of capabilities.

Sunday July 30, 2023 4:15pm—5:45pm
Session S2: Workshops

S2A: Workshop III

Tips for Top Tier Team Teaching	Todd R Hamrick Atheer Almasri Carter Hulcher

Team teaching has great advantages for both students and faculty but can be challenging to implement. Team teaching is defined here as each instructor teaching a different section of the same course and coordinating on the material and overall course schedule. Some advantages are that instructors can divide the workload, generate and develop new ideas, build on one another's strengths, ensure consistency among different class sections, and effectively integrate new faculty member into the teaching team. Students see uniformity across sections, interesting and applicable projects, and assessments that are fair and consistent. Challenges can include lower levels of autonomy, communication problems, and a risk of students in different sections copying work. A Mid Atlantic University has a common first year program for all incoming freshmen in the engineering college. All of the primary courses in the program are team taught. After more than a decade of team teaching, the faculty in the college's Fundamentals of Engineering Program (FEP) have developed effective, efficient, and collaborative methods that make the most of team teaching. This workshop will be team taught by members of the FEP teaching team. Participants will gain valuable and practical methods for implementing and improving team taught courses.

S2B: Workshop IV

Building Bridges (but not with balsa wood) through Scalable Engineering Design Process Lessons	Betsy Chesnutt Laura Knight

The purpose of this workshop is to expose STEM and first-year engineering educators to a greater depth and breadth of understanding of the engineering design process (EDP) in order to strengthen their self-efficacy with teaching engineering and ability to motivate student interest in learning engineering principles, and to provide educators with lesson plans and supplies to implement these skills immediately.

The goals of this workshop are to provide K-12 STEM educators with high-quality engineering lesson plans that they can utilize immediately, and to improve the self-efficacy of participants with teaching engineering in K-12. Al- though engineering is becoming increasingly important in K-12 education, research has demonstrated that, similar to the general population, K-12 teachers typically have limited experience with engineering and, consequently, hold inaccurate perceptions of engineers and engineering work. The perceptions that teachers hold about engineering have also been shown to affect their self-efficacy with teaching engineering. Teacher self-efficacy influences teachers' willingness to engage with a particular topic, such as engineering, and also to influence the self-efficacy, motivation, and achievement of their students.

S2C: Workshop V

Interfacing MATLAB with Sphero Robots for an Introduction to Programming Class **PART 1**	Joshua Fagan Amy Katherine Biegalski

PART 2: The second part of the workshop gives participants experience interacting with the robots and programming them in some basic hands-on activities that allow participants a higher appreciation and retention of covered material.

Monday July 31, 2023 9:30am—10:45am
Session S3A: Work in Progress

S3A: Work in Progress I
It All Begins With a Solid Foundation

Varying the Design Experience in First-Year Engineering	Kathleen A Harper

The first-year engineering experience at X University is structured around a series of two-week modules that introduce students to cooperative engineering problem solving using a variety of tools and techniques. Most modules are built on a foundation of MATLAB coding and electronic device building. Each module is inspired by one of the engineering majors available on campus and culminates with a 75-minute design project. Each project lends itself to highlighting different aspects of the design process, as well as different ways in which prototypes might be shared. Here we share two examples of design projects from the course: a water filter from the environmental engineering module and a spy gadget from the materials science module. The water filter follows after students have learned about turbidity and how to measure it using a sensor, an Arduino microcontroller, and MATLAB. Students design, build, and test a few prototypes before creating their final prototype. The filters are evaluated in an in-class competition based on two criteria: the speed of the filter and its effectiveness in reducing the turbidity of the filtered water. The spy gadget design is more open-ended and comes after the students have worked with a piezoelectric film, Arduino, and oscilloscope to write MATLAB code for detecting knocks on the piezoelectric film. The students choose additional electrical components to incorporate with the Arduino and film to create their devices. The designs are shared in a format resembling a conference poster presentation during class. Stu- dents provide feedback to their classmates regarding the creativity, uniqueness, practicality, and other positive aspects of the designs. This paper compares and contrasts these two projects, both from the standpoint of the challenges themselves and the ways the students present their products. We share some of the sources that inspired the technical content and pedagogical approaches, as well as our observations and some student feedback. Finally, we describe a few variations on these projects we have developed, along with potential future variations.

Integrating Computation within an Engineering Physics Course	Darren K Maczka Erin McCave

There has been much interest in supporting the development of computational thinking skills in engineering students. Computational thinking (CT) supports both general problem-solving as well as computer programming. This work-in- progress paper describes efforts to develop a new two-course sequence that combines an introduction to engineering physics with computation and modeling. These courses were developed to support students who entered not calculus ready in their first semester. Retention rates for these students were significantly lower than calculus ready students, with 40% of these students never reaching their first engineering course. Evidence that integrated curricula lead to strengthened learning outcomes was a significant motivator in the development of this course sequence. We discuss literature support for such an integration as well as how existing work informed the design of the course. The course sequence has both active-learning lecture sections as well as lab activities. Integration of CT occurs in both. We hope that a successful integration of CT will help us answer this research question: Does CT implemented in the context of a physics course improve learners' problem-solving self-efficacy, programming self-efficacy, or both as compared to learners who experience similar content in separate courses? In conducting this work, we plan to collect pilot data from our population receiving the CT implementation that are enrolled in the two-course sequence and control students in the regular first physics course, both at the end of the fall and spring semesters. The data will be analyzed and the preliminary results shared for feedback on both our instrument and trends seen comparing the two populations. We expect to see that the students receiving the CT instruction will demonstrate that students in the new course sequence will have higher self-efficacy in both parameters.

Engineering Education after ChatGPT	Howard L Richards

The remarkable successes of ChatGPT have caused surprise, excitement, and alarm. Some students report being told by their instructors that soon coding will no longer be performed by humans, resulting in fewer job opportunities; it takes little imagination to conclude that many engineering jobs might also be at risk. Such fears are premature, but it is certain that coding and engineering in general will change. To prepare students for this new engineering landscape, engineering programs will need to place more emphasis on teaching students to monitor the human context, the big picture, and the ground truth.

Monday July 31, 2023 9:30am—10:45am
Session S3A: Work in Progress

S3A: Work in Progress I *It All Begins With a Solid Foundation*	
A 3D-printed speaker and audio system project for teaching interdisciplinary engineering design	Brian Scott Krongold Gavin Buskes

This work-in-progress paper details an innovative and newly-taught design project within the first-year course ENGR10006 Engineering Modelling and Design at the University of Melbourne. This course's goal is to develop students' under- standing of the modelling and design processes by taking them through the life cycle of a real-world engineering project, using a combination of lectures and integrated hands-on workshop sessions. Students work in teams of three and choose one of three possible projects at the start of semester. Our students have no declared major during their first year, and a majority need some experience to help determine their pathway going forward. The only course prerequisite is standard high school mathematics, and student backgrounds can range from little or no physics to those having previously studied mechanics and electricity and magnetism. With these issues in mind, we asked ourselves: how can first-year students learn core aspects of both electrical and mechanical engineering through a unique, fun and engaging design project? Our solution was the interdisciplinary "speaker project", which had as its focus the important physical principle of energy conversion from electrical to mechanical; namely, Faraday's Law resulting in speaker cone movement to generate acoustic waves. As speakers are common consumer products, students could readily relate what they were doing to concrete, real-world examples. On the mechanical engineering side, students designed and built a physical speaker (driver plus enclosure) comprised mainly of 3D-printed parts, magnets, fabric, wire, and laser-cut MDF for an enclosure. The cone, due to weight and surface issues, was pre-made using injection moulding of plastic. Students used CAD software (SolidWorks) to draw their design, 3D-print some parts, and laser cut an enclosure that could house their speaker. On the electrical engineering side, students designed circuits for an audio equalizer, stereo-to-mono mixing, crossover unit, and some additional analog filtering. Students then built and tested these circuits on breadboards. A small battery-powered amplifier module was provided to them to boost the audio power for their speaker. Students learned to measure their speakers' performance using a sound-isolation box, measurement microphone and software. Using frequency response plots of their constructed midrange driver and a provided tweeter, students chose a crossover frequency and designed the crossover circuit. Due to the varied student backgrounds, in-depth theory could not be taught, and alternative approaches that abstract away some details were instead employed. For example, only very basic circuit theory concepts (KVL, KCL, voltage division) were taught, while more advanced concepts, such as active and passive filters and op amps, were taught with a "functional depth". Students learned a systems-based approach, whereby they view filters and summers as basic sub-system blocks that can be designed and interconnected provided loading effects are properly minimized. The first offering was in the latter half of 2022, and along with some success, there were some underperforming groups and unexpected issues. Discussions at the final demonstration showed a majority of students grasped the core design concepts. Further outcomes and lessons learned in the development and teaching of this project will be discussed.

Opening the First-Year Design Project	Nathan M. Hicks

While evaluation of student performance in at least some non-technical courses for first-year engineers effectively use rubrics to help communicate expectations, prepare students, and provide feedback, many of the more technical courses often fail to provide similar levels of communication. For example, under more traditional approaches to grading physics exams, students often feel clueless about what they need to draw or not draw while answering a question, or how many points they could expect to lose for forgetting a single force in a sum of forces equation. Even when they might know how many points correspond to any given problem, different features of a problem might warrant different weights within the problems that can make these issues confusing for students. Understanding instructors' expectations is a critical element in a student's sense of trust, fairness, and safety, all of which can hinder or enhance a student's ability to learn. Our institution offers a variety of introductory engineering courses through a central program, including teaching physics 1 for engineers at three different levels. These three levels span a traditional course, an honors version, and a somewhat slowed-down and spread-out version for students with weaker mathematical backgrounds. One benefit of this structure is the opportunity to field test and collectively reflect upon multiple approaches to achieving various instructional goals. Over the past year, across our different courses, our program has experimented with a few different ways to evaluate assessments in technical coursework in a more structured and transparent way. This paper presents the different approaches that were used and provides the findings from a collaborative reflective discussion of the instructors regarding the perceived strengths and weaknesses of each technique for student learning through the lens of modern assessment theories.

Monday July 31, 2023 9:30am—10:45am
Session S3A: Work in Progress

S3A: Work in Progress I *It All Begins With a Solid Foundation*	
Introducing a research project to a First-year Mechanical Laboratory Course	Gloria Guohua Ma
In Fall 2022, our university introduced the first-year laboratory course for Mechanical Engineering students as part of the revamped first-year program. The course's primary objective is to equip students with fundamental technical skills and provide exposure to various laboratory concepts through hands-on experiments. The course covers a wide range of topics, including laboratory safety, experiment design, measurement techniques, design synthesis, Computer Aided Design (CAD), algorithmic thinking, simulation, and technical reporting. The main aim of the course is to enable students to gain practical experience in using modern engineering tools and techniques required for engineering practice. To achieve this goal, students are required to undertake a final research project. The instructor provides a list of technical articles, and students can choose a topic from the list or propose their own topic for approval by the instructor. Then, they must apply the tools and techniques they learned in the course to implement part of the study presented in the technical article. In this paper, the research project's implementation is presented in detail, highlighting the challenges faced and the feedback received from students. Additionally, recommendations are provided to improve the course in the future.	
How to Interview the Crowd: Enlisting Informal Student Feedback in a Formative Assessment Process	Natalie C.T. Van Tyne Benjamin Daniel Chambers Benjamin Goldschneider Michelle Soledad
This Work in Progress addresses the issue that many first-year engineering students want to be heard and to have their educational needs met but may be reluctant to share their thoughts directly with faculty, either during class sessions or between them. Faculty, for their part, want to facilitate learning environments that meet their students' needs, and to let students know that they are doing so on a regular basis. Soliciting student feedback during a semester or term can also facilitate formative assessment of student learning when the survey questions are written to solicit feedback about what went well during and between class sessions, and what could be improved. We developed and administered periodic Exit Surveys for student feedback using Google Forms. Participating instructors had autonomy regarding the frequency of administering these surveys. QR and URL links are provided for students to access each survey. Responses are anonymized, but students' email addresses are collected for the purpose of identifying the sources of feedback among multiple sections of the same course. Faculty can then reflect on how they viewed student progress within each section, and compare their impressions with what students are telling them. Students receive a summary of what went well during a particular week, as well as what could be improved, and faculty describe what they have done or will do to address the identified needs and further promote what students liked about the previous weeks' activities. Students' feedback is addressed after each class session or after all class sessions for the week, depending on faculty preferences and the frequency of survey administration. In addition to timely faculty response to student feedback, these data can be summarized over the course duration to reveal trends in students' extent of satisfaction with the course content and delivery methods, which will inform areas for reinforcement and improvement during the next iteration of the course. We will share typical responses that participating instructors received from students and how the instructors used this feedback to improve the course. Recent examples of feedback about what enhanced student learning were tech- nical instruction, design showcases, interactive in-class activities, and time for project teams to work together during class. Suggestions for improving the course included additional background information in course materials, examples of previous designs, and in-class discussions. Succeeding work will include a summative assessment of the impact of the process on the student learning experience.	
Sustainability and Life Cycle Assessment in Engineering Curriculum	Brady Harmon Madeline Rose Fisher Evan Jackson Budnik Lauren H. Logan
To educate students on sustainability and how to apply sustainability practices to engineering practices, an engineering life cycle assessment (LCA) module was developed and piloted within a first-year engineering course at Ohio Northern University. To determine the current LCA gaps in engineering education while designing a standalone module, a literature review of current practices in university sustainability and LCA curriculum was completed. Curriculum was analyzed on the basis of major/program, course integration (horizontal vs. vertical), and overall pedagogical techniques. The intended result of this module development is to improve engineering education as it relates to sustainability and the triple bottom line of people, planet, and profit. Initial module design (which incorporated undergraduate student research) and implementation will be shared, and feedback is welcome.	

S3A: Work in Progress I *It All Begins With a Solid Foundation*	
MATLAB WebTA: Enhancing the bigger picture through human factors.	Laura Albrant Laura E Brown Leo C. Ureel II Jon Stricklen Michelle E Jarvie-Eggart

Code critiquing software is often discussed with the specific audience of novice programmers within the computer science community. This makes sense as computer science is the field of study in which programming is most affiliated with. However, computer science is not the sole field to utilize programming languages. So, what happens when the target audience of a code critiquer shifts to a different field of study? This research seeks to answer this question from a human factors perspective. Our Work-In-Progress paper outlines the first steps taken. In previous research, a Java code critiquer was developed to identify antipatterns within students', or novice programmers', code and provide beneficial feedback on how to write better code on multiple levels. This system was coined WebTA. A pilot version of WebTA for the programming language MATLAB was developed. The MATLAB WebTA was then alpha tested in an introductory engineering course for three lab assignments with time for revision of the auto critiquer between each assignment. Optional feedback surveys were offered for students and instructors to fill out after each assignment. Additional in-person observations of the three lab blocks in which students used the WebTA system were conducted. The com- bination of this data works to provide an understanding of the common friction points between the students' learning and the good coding practices that the WebTA encourages. For example, one point of friction could be the terminology the WebTA utilizes for its feedback. WebTA was initially implemented for computer science students; therefore, use of the same terminology could be a major point of confusion for engineering students. A human factor mindset is applied in analyzing both this data and the overall system in order to tackle the problem set from multiple angles. The use of human factor principles supplies excellent methods to analyze any system with human-computer interactions and/or training process(s) as well as effective design approaches. Involving this approach directly in the middle of the development process provides a robust foundation for future, post-development analyses. The primary goal of implementing human factors' principles is to improve the usability of WebTA for students in all fields of study, starting with engineering. Viable improvements include, but are not limited to, the minimization/elimination of common, observed friction points and the formation of a more intuitive user interface.

Monday July 31, 2023 9:30am—10:45am
Session S3B: Work in Progress

S3B: Work in Progress II *How Do I Get Them? How Do I Keep Them?*	
Impact of Peer Mentor Program on First Year Engineering Students Success	Kenneth Reid
A small private school in the Midwest began an engineering peer mentoring program to foster community and support networks among first-year students in order to improve retention and student success. Engineering can be isolating in college, especially so in newer and smaller programs. Feelings of isolation are known to be detrimental to student success and mental health. To combat this impact on students, upperclassmen were paired with all first-year students based on common interests in order to meet outside of the classroom in social environments. Impact of this program was studied through academic vectors such as grade point average (GPA), major and university retention rates, and social vectors such as community engagement and qualitative surveys. These results are also compared with first year student attendance and participation in the peer mentoring events. This program ran in the 2022-2023 academic year, and impact was monitored each semester. Initial results are promising, as first-year student retention improved by over 10%, however, more analysis is needed to investigate all factors that may have contributed to this rise. Future work will continue to monitor these factors and look at ways to improve the program.	
A focus on well-being to increase non-calculus ready students' problem-solving self-efficacy	Erin McCave
At our University, students that were not calculus ready did not enter into an introductory engineering course when they started as first-year students. Due to this, student contact with engineering faculty was limited and we observed that only 60% of these students ever made it to their first engineering course. With an increased focus at the University level on student success and well-being, our first-year program created a two-course sequence that incorporated the first semester engineering course along with content related to student success and well-being to engage non-calculus ready students in their first year. The course meets five days a week with three 50-minute active learning sessions and two 75-minute lab sessions each week. As an instructional team, we have dedicated time to incorporate activities related to topics such as study skills, time management, well-being, and resources for mental health. For each of these topics we invite campus partners to talk about each topic and present the resources available to the students. Feedback from the students on incorporating these topics into the class has generally been positive. To better understand the integration of success and well-being into the course and its effects on students' problem-solving self-efficacy, our research team developed a mixed methods study utilizing quantitative surveys on problem-solving self-efficacy, stress management, and well-being. The research team will be conducting classroom observations and focus groups to better understand trends from the quantitative data. We are currently in our first round of data collection and plan to conduct a preliminary analysis of the quantitative survey results and classroom observations upon the completion of the Spring semester. From this analysis we will identify participants for focus groups.	
Investigation of Recruitment Communication Channels and Student Awareness of an Engineering Bridge Program via Cross-Disciplinary Collaboration	Xinyu Zhang Lynette Michaluk Clayton Scott Hammond Isabel Perez
The Academy of Engineering Success (AcES), a summer bridge program for incoming first-time freshmen (FTF) engineering students at West Virginia University (WVU), faced challenges in recruiting underserved students for years. To address this issue, research was conducted via a collaboration among faculty in engineering and business, with support from an undergraduate researcher and faculty in the Center for Excellence in STEM Education. A mixed methods study using surveys and interviews was designed to assess recruitment communication channels and student awareness of AcES and another university-level trip-based summer program to explore any misalignment and propose suggestions to improve future recruitment of diverse students. Results from 91 survey responses and 2 interviews are discussed. This paper also describes how cross-disciplinary non-tenure track faculty collaborated on engineering education research.	

S3B: Work in Progress II
How Do I Get Them? How Do I Keep Them?

Using an Elevator Pitch Competition to Introduce Engineering Students to Entrepreneurship	Lizzie Santiago

An elevator pitch is a brief description of a product or idea with the purpose of allowing the listener to understand the basics of the concept in a short period of time. An elevator pitch is aimed to create interest in a project, product, or idea. A good elevator pitch is brief yet persuasive, uses clear language, and emphasizes only the specifics of the idea or product. The purpose of this project is to introduce first semester engineering students to entrepreneurship using an elevator pitch competition. The elevator pitch competition was developed within the context of the first year engineering seminar. Six hundred students enrolled in a first year engineering program were asked to identify a problem and to brainstorm potential solutions to the problem. Students were split in groups of three per team. Each team was asked to devise one solution to the problem, and the proposed solution was presented using an elevator pitch format. This study summarizes the main process used to introduce students to entrepreneurship using an elevator pitch competition. A survey administered at the end of the semester was used to better understand students' views of entrepreneur- ship and the impact of the competition is students' interest in engineering. This project benefits those institutions searching for ways to engage students and to introduce them to entrepreneurship and innovation.

The First-Year Engineer's Learning Journey	Amber Kemppainen Mary Raber AJ Hamlin

The first-year in a student's college experience is one of significant learning and transition, not just in the classroom, but in life. Often it is the first time a student is living away from home, facing adult responsibilities and decisions, building new friendships and support systems and learning at a pace that requires a level of initiative, self-motivation, and organizational skill that is beyond what they experienced at the high school level. Low retention of engineering students beyond the first year is an issue that receives a great deal of attention as retaining university engineering students through graduation is a key factor in alleviating shortcomings of U.S. institutions to prepare sufficient scientists and engineers to compete in the global, high-technology fields (Friedman, 2005). Re- search has shown that most engineering students leave engineering due to deficits in one of the following four areas: academic and career advising, faculty, engineering structure and curriculum, and high school preparation (Haag et al., 2007). To gain insight into the student's learning and experiences in the first-year and how those might impact retention, we introduced a reflection assignment in the first semester common engineering course during Fall 2021. This reflection asks students to map out both their learning and their emotions at three points during the semester: after their second, third, and fourth learning unit in the course. While this assignment was intended to help students reflect on their own learning experiences, we also saw this as an opportunity to help instructors better understand the individual contexts in which students are trying to learn. We are utilizing both quantitative and qualitative approaches to analyze the complex interaction between student emotions and learning during the learning process. For the quantitative approach, we will adapt the Emotion Learning Model (ELM: Kort, Reilly, & Picard, 2001) aiming at transforming student mapping of their emotions and learning to the ELM quadrants and aggregating the results to demonstrate descriptive statistics at each checkpoint. ELM can effectively display the range of emotion states experienced during the learning process (both positive and negative aspects of the complex interaction between emotions and learning, including quadrant I: positive affect & constructive learning, quadrant II: negative affect & constructive learning, quadrant III: negative affect and un- learning, and quadrant IV: positive affect and un-learning). As for the qualitative approach, we are adapting the four-dimensional Mental Model Matrix (MMM, Borders, Klein, & Besuijen, 2019) to synthesize student written comments and represent the critical themes occurring during the learning process. MMM is an effective and holistic tool to assess a learner's self-reflection and self-explanation holistically and quantitatively through four dimensions, including positive and negative sides of a learning module and of a personal self-reflection (Tan & Yang, 2022). n this Work-in-Progress paper, our goal is to share the approach, responses, analysis and results to date, and how that might inform our understanding of the student's learning and emotional journey through their first semester engineering course.

S3B: Work in Progress II *How Do I Get Them? How Do I Keep Them?*	
Development of Career Preparation and Portfolio Modules in a First-Year Engineering Course	Victoria Bill

This is a work-in-progress innovative practice paper describing the addition of several career preparation and development assignments into a single semester first-year engineering design course. The class is taught at a large, private institution in the US Northeast region and includes weekly lecture, lab, and recitation. Students must complete a semester-long design project as well as project documentation and the enhanced career development assignments, which include a resume, cover letter, LinkedIn profile, and a digital portfolio. The cover letter and portfolio assignments are new for the 2022-2023 academic year and the design and implementation of these assignments as well as the learning outcomes and course planning will be detailed in the paper. These enhanced assignments are part of a long-term plan to embed professional skill development across the undergraduate engineering curriculum and experience at the school. They were made possible through approval of the school of engineering faculty to expand the course from 3 credits to 4 credits per semester. Development for these modules and support for student career preparation has been created in partnership with the school's new Assistant Dean of Student Life and Career Services, who now leads one lecture per semester introducing students to the various resources available on campus. The portfolio assignment was created through a partnership with the school's Design Lab, which focuses on project documentation, mentoring, and support within the school's makerspace. Throughout the semester, students are instructed on career preparation through introductory presentations within their recitation, and they are structured so that the students prepare to apply for an internship or job posting of their choosing. Implementation of the new modules for the 2022-2023 academic year will be described with preliminary student feedback.

Developing a Virtual Peer-Facilitated Workshop Experience for First-Year Engineering Students - A Comparative Study of Online and Face-to-Face Engagement	Dan Burleson

This work-in-progress focuses on the development of a virtual, open-access peer-facilitated workshop experience for first-year engineering students in a first-year, second semester computing course. The project aims to investigate if engagement and achievement of students differ between online (asynchronous) and face-to-face peer-facilitated work- shops. Peer-facilitated workshops are designed to support key gateway courses in science, math, and engineering, but accessibility can be limited for underrepresented, first-generation, and non-traditional students due to additional costs and scheduling constraints. Asynchronous videos provide flexibility, but often lack opportunities for engagement and community building. Leveraging undergraduate students as facilitators, we created an integrated MS TEAMS and STREAM framework with video modules, MATLAB© Grader problems, and online forums for communication. The Fall 2022 implementation focused on content development during the first eight weeks of the course, when student attrition is high. Over 20 hours of asynchronous peer-recorded support content and 10 associated MATLAB© Grader problems were developed, and 50% of students enrolled in the first-year course joined the MS TEAMS platform, with 20% engaging at least once through comments, questions, and MATLAB© Grader attempts. Qualitative responses were collected from participants in the virtual and in-person workshops, and normalized student achievements were collected for each group. While statistical comparison was inconclusive due to small sample size and response rate for the virtual workshop (n=5), key themes such as "support", "community", and "practice" emerged from qualitative responses, which are being used to inform a subsequent survey tool for understanding the student support experience broadly for all students in the class. The findings from the asynchronous participants have informed the development of a broader virtual course support system for Spring 2023, which integrates professional development, advising, undergraduate teaching assistant office hours, and peer-facilitated support material.

S3B: Work in Progress II *How Do I Get Them? How Do I Keep Them?*	
Developing a First-Year Experience Professionalism Certificate for Engineering Students: Strategies and Structures for Enhancing Career Engagement	Dan Burleson

This work-in-progress develops a First-Year Experience (FYE) Professionalism Certificate for engineering students at a large, Hispanic serving institution for students in a second-semester, first year engineering course. The certificate program aims to provide a strategy and structure for enhancing student engagement in career and professional development activities during their first year of engineering supporting both first-time-in-college (FTIC) freshman and transfer students. The transition from high school or community college to 4-year institution can be challenging, especially for engineering students who are navigating the complexities of a rigorous academic curriculum while also preparing for their future careers. Many first-year students struggle with finding opportunities to engage in career and professional development activities due to various barriers such as lack of awareness, confidence, and resume preparation skills. To address these challenges, the FYE Professionalism Certificate was originally designed in 2019 to provide external motivation and structure to students' engagement in career and professional development activities, including resume and peer review, career fair attendance, student organization meetings, and other workshops/information sessions. Based on qualitative feedback from students, one of the identified barriers to career fair attendance is the lack of a well-prepared resume. To address this, the certificate program in its most recent implementation in Spring 2023 includes specific resume support early in the semester, providing students with the skills and confidence to create a professional resume that will enhance their chances of success at career fairs. The FYE Professionalism Certificate is a co-curricular approach though students are incentivized with course extra credit. The program is evaluated through an end-of-semester quantitative tools that inform programmatic implementation. Qualitative data, such as student feedback and reflections, are collected to assess the impact of the program on students' career engagement and professional development. Quantitative data, such as attendance and participation rates, are also collected to measure the effectiveness of the program in improving student engagement. Data is currently being evaluated for the Spring 2023 implementation. Initial results indicated engagement of approximately 25% of students enrolled in the second semester first year engineering courses. Among these students, approximately 50% of students completed all requirements for the certificate. Further analysis of participant demographics and academic success is ongoing with qualitative information to be collected from students at the end of the semester (May 2023). The results will inform future implementation and program communication.

S3B: Work in Progress II *How Do I Get Them? How Do I Keep Them?*	
How Professional Networking Impacts Outcome Expectations and Choice Goals in a First-year Engineering Course	Evelyn Walters Cory Budischak Shawn Fagan

A plethora of studies exist which link the development of a professional identity to retention and persistence within undergraduate engineering. Factors such as student experiences and perceptions of their knowledge and skills as well as the culture of the university have all been linked to identity development. A study by Pierakos et al. (2009) com- pared first-year engineering persisters with those who transferred out and additionally found that persistence occurs when students have more knowledge and exposure to the field as well as contact with actual engineers. Generally, first-year engineering students have very limited interactions with the field and practitioners. Social cognitive career theory (SCCT) is a theoretical framework which may be used to understand the processes which influence how people form interests, make choices, and achieve various career outcomes (Lent et al., 2002). In SCCT, the interaction between social cognitive variables and other variables such as personal characteristics and social environment work together to explain career pathways (Lent et al., 2002). Outcome expectations are personal beliefs about what will happen if given actions are undertaken and may be acquired through learning experiences such as personal attainment or social persuasion (Lent et al., 2002). As students establish a set of beliefs about the consequences related to an engineering degree, they begin to develop goals directed towards these outcomes and formulate a plan to achieve their goals (Fagan, 2019). Using the SCCT model as a guiding theoretical framework, this study seeks to understand how a professional networking intervention in a first-year Introduction to Engineering course affects a student's engineering outcome expectations and their engineering choice goals. As part of a first-year engineering course, we are developing a module which introduces students to required soft skills, including professional networking. Students use the networking sites LinkedIn and Handshake to create profiles and connect with their peers. As a next step, they conduct an informational interview with an upper-level classmate to learn more about their involvement in cocurricular activities, required professional skills, and any internships or research experiences they have had. Lastly, students reach out to a practicing engineer and conduct a similar informational interview. Since this is a work-in-progress paper, we hope to share observations from faculty about our first impressions of the module and obtain feedback from the first-year engineering community about improvement in assessment or delivery/design of the module itself. In future work, we intend to conduct pre-and post-surveys to learn more about short-term student gains in recognizing the need for professional networking skills as well as outcome expectations and choice goals associated with building a professional network. We also plan to conduct an Interpretative Phenomenological Analysis exploring the student's lived experiences to gain an in-depth understanding of how engineering outcome expectations and engineering choice goals are influenced by the professional networking intervention.

Monday July 31, 2023 10:45am-12:15pm
Session S4: Workshops

S4A: Workshop VI	
SPONSORED: eGrove Education, Inc: Spatial Visualization and Sketch Training in First Year Engineering to Increase Design, Teamwork, and Technical Communication Skills	Lelli Van Den Einde Lizzy Cowan

Spatial visualization, thinking in 3D, is an essential skill for engineering students. Learning to freehand sketch orthographics and isometrics increases spatial skills and performance in many engineering subjects. Sketching skills also aid concept generation and sharing technical ideas with teammates. The Spatial Vis™ software makes it more engaging for students to learn and easier to teach technical sketching. Students sketch on a computer, tablet, or smartphone, and their sketches are graded automatically. If a student makes a mistake they receive a small hint and are encouraged to try again thereby gaining points for persistence.

This workshop will review the data on the benefits of freehand sketch training, which have been shown to be especially advantageous to women and other underrepresented minorities. Participants will then have an opportunity to use Spatial Vis™, and we will discuss best practices for implementation in the classroom.

All participants will receive a free account to use Spatial Vis™ and are encouraged to bring a laptop, tablet, or smartphone to the workshop.

S4B: Workshop VII	
Democratizing and Demystifying Engineering for All: A workshop to help you bring e4usa to your campus	Kevin Calabro Stacy S Klein-Gardner Medha Dalal Susan E Walden

In this workshop, participants will be introduced to the research-based Engineering for US All (e4usa) curriculum, will learn how the e4usa curriculum has been modified and offered as undergraduate coursework at universities around the country, and will understand the benefits of offering an e4usa course at their institution. Workshop participants will have time to explore ways to bring an engineering literacy course derived from the e4usa curriculum to their home institution. This workshop is designed for higher education administrators and faculty who offer or plan to begin offering first-year engineering programs. High school engineering educators and administrators may also find this workshop of interest as it relates to developing a network of institutions offering coursework that is closely aligned with the high school e4usa curriculum. Lastly, influencers and changemakers frustrated with the status quo and who desire more diverse, equitable, and inclusive engineering degree programs and workforces will find this session of interest.

S4C: Workshop VIII	
Why on earth do I have to take a class in [fill-in-the-blank]?	Stephany Coffman-Wolph

Anyone who has interacted with first-year students (or their parents) was asked the dreaded question – ”why do I have to take ___?” or heard ”I do not see how this will help me become a [fill in the blank] engineer”. For first-year engineering students, their introduction to engineering course and professors support making these connections. However, high school students, community college students, and pre-engineering university students (those who are required to take foundational courses before being admitted to an engineering program) may not have access to some- one who is able to clearly articulate how applications of early science and math courses connect to engineering careers. For many students interested in pursuing engineering, the ”why” of the course is important. When students fail to see the connection between the material they are learning and their career interest, they may lack motivation to learn the material, thus hindering their performance in future engineering curriculums, or they may choose not to pursue engineering altogether, thus contributing to the ”leaky pipeline” in STEM. Therefore, it is essential to support students understanding the connection between foundational coursework (basic math, science, and biology) and future engineering careers. We have developed a process that instructors may use to show students the connection and hopefully retain their interest in pursuing engineering.

Monday July 31, 2023 2:00pm - 3:30pm
Session S5: Workshops

S5A: Workshop IX	
SPONSORED MathWorks: Meeting Students where they are: Accessible and Effective Learning with MATLAB and Simulink	Jon Loftin

Over the past few years, there has been a remarkable and rapid transformation in the way teaching and learning take place, leading to significant advancements. The pandemic forced students and educators to incorporate different curriculum modalities. As a result, there have been great advancements in the ways we teach and learn. The students of today are very familiar with virtual content, and embracing this is a way for educators to meet students where they are. In this workshop, we will learn about innovative ways to meet our students where they are. We will:

- Walk through MATLAB Live Scripts for creating interactive documents.
  Learn how to implement and build apps that students can use to accelerate learning.
- Learn how to incorporate virtual labs into the curriculum.
- Introduce MATLAB Grader and learn how to incorporate it into your course.

These tools help increase student learning and the efficiency of teaching workflows. Upon completing the workshop, you will have the knowledge and confidence to leverage innovative teaching mechanisms that increase learning flexibility while increasing interactivity with curriculum materials, ultimately expanding student success.

S5B: Workshop X	
Flipping Across the First Year Workshop	Rachel McCord Ellestad Kevin Kit Erin McCave Andrew A. Puretskiy

The use of a flipped classroom pedagogy has gained significant momentum in engineering education over the past decade. More instructors are taking on the challenge of transitioning their courses to a flipped classroom pedagogy to allow for more active learning and support during class time. While there are many benefits to the use of flipped classrooms in engineering courses, there are many challenges associated to the implementation and sustainability of this approach. Additionally, first year educators may be hesitant to transition their courses to a flipped classroom model due to fears that students may not be ready for such a dramatic shift in classroom approach. The Engineering Fundamentals Program in the Tickle College of Engineering at the University of Tennessee Knoxville is a common, student success-based first year program that teaches engineering physics, introduction to computer programming, design, teamwork and communication to over 1000 students per semester. In Spring 2018, our unit began an initiative to flip all courses associated with our program. In previous years, one course had attempted flipping a portion of the content in the course to provide more time for active learning. While performance data showed an improvement due to the flip, student feedback was negative towards a mid-semester shift in learning approach due to increased demands for adapting to the new style. In Spring 2018, the EF team decided to commit to flipping the program in an effort to provide a more positive experience for students in the transition to a new classroom environment. In this workshop, members of our team will conduct an active workshop on how instructors can approach the process of flipping an entire course. We will also share lessons learned as we worked through flipping a sequence of courses. Attendees are encouraged to bring course documents and ideas to the workshop, as working time will be encouraged and feedback will be provided by facilitators.

Monday July 31, 2023 2:00pm - 3:30pm
Session S5: Workshops

S5C: Workshop XI	
Making Patterns, Breaking Patterns - Applying ethnographic system mapping and analysis to support your group's culture	Courtney June Faber Lorna Treffert

Systems thinking is an essential skill for engineers in an increasingly complex world. Engineers must be able to see beyond applied science and mathematics to the social, political, economic, ethical, environmental, and even interpersonal forces acting on any problem in order to arrive at optimal solutions. As we endeavor to "expand student success" by helping them develop these skills, it seems only natural that engineering educators use the same paradigm to evaluate their own group, classroom, and departmental cultures. A system, as defined by renowned environmental scientist and systems scholar Donella H. Meadows is, "A set of things: people, cells, molecules, or whatever – interconnected in such a way that they produce their own pattern of behavior over time". If we treat a group's culture as a complex system, it becomes simple and effective to use tools from systems thinking (system maps and causal loops) and ethnography (descriptive observations, language identification, and domain analysis) to identify helpful and harmful patterns in a group's function. In this workshop, we combine approaches from systems thinking and ethnography, namely Spradley's Developmental Research Sequence for participant observation, to guide participants through the development of a culture map. Participants will select a group or social situation they are a part of to construct their own culture maps. These maps could represent a team, a classroom, a student society, a department, or a number of other scenarios relevant to educators of first-year engineering students. To construct these maps, participants will take into account the functions, goals, values, languages, activities, actors, and their interactions which constitute their group culture. Then participants will use these culture maps as a tool to identify areas of strength, weakness, and risk within their groups. This workshop is applicable to any researcher or faculty member looking to reflect on and improve the culture of their team, classroom, department, or other chosen scenario.

Monday July 31, 2023 3:45pm—5:00pm
Session S6A: Full Paper I

<table>
<tr><th colspan="2">S6A: Full Paper
Out with the Old, In with the New</th></tr>
<tr><td>An Immersive Approach for First-Year Engineering Students</td><td>Alexander Campbell
John J Philips</td></tr>
<tr><td colspan="2">The concept of utilizing a multidisciplinary approach for first-year engineering students has been increasingly studied over recent years. However, many of these studies examine the use of general engineering concepts and subsequently provide a connection of how they apply to engineering design. As one example, a program may discuss how mathematics and physics fit within the context of an overarching engineering project. While it is imperative that first-year engineering students understand the relationship between these fields and their role within engineering, there are limited studies which examine immersing first-year engineering students into a teaching environment that is centered around the understanding of another closely related major. Many universities reserve cross-discipline collaboration for senior cap stone projects, but what if this cross-discipline collaboration occurred during students first year at the university? Will students have a better appreciation for other engineering disciplines or will students feel as though they have been misplaced? This paper will present an overview and assessment of immersing Architectural Engineering students into an architectural design studio that is instructed by both Architecture faculty members and a Structural Engineering faculty member. One question that will be addressed is if the Architectural Engineering students benefit from being introduced to architectural design concepts and how this understanding can be used to further their knowledge of the entwinement of these two different fields of study. Whether these students feel a sense of belonging in taking a class outside their major of choice will also be carefully explored. Although this paper specifically addresses the relationship between architecture and structural engineering, the con- cepts of this paper can be utilized for various other disciplines where close relationships between fields are essential for the success of a project. As a few examples, mechanical and electrical engineering, civil and environmental engineering, aerospace and mechanical engineering, and computer science and software engineering all share similar characteristics as the relationship between architecture and structural engineering. A literature search will be included in related research regarding immersing first-year engineering students into other core major classes that are outside of the major of choice. An understanding of how programs utilize senior cap stone projects where the idea of inserting students into multidisciplinary teams is often utilized will also be discussed. The paper's conclusions and recommendations will include results of student surveys given during the architectural design studio, along with information obtained through researching other programs and how they address integrating two or more departments.</td></tr>
<tr><td>Introducing Machine Learning to First Year Engineering Students</td><td>Joshua Eron Stone
Forrest Milner
Sophie Roberts-Weigert</td></tr>
<tr><td colspan="2">Machine learning has undoubtedly emerged as a crucial topic spanning all disciplines, particularly for those pursuing careers in technical fields. Students and instructors alike are eager to explore this innovative technology. With the increasing relevance of machine learning, it is important for students to be exposed early in their educational journey. Exploration of the topics in first year courses will help them grasp fundamental concepts more effectively and broaden their engineering horizons.
Introduction to Engineering Design (ENES100) is the University of Maryland's introductory engineering course that every engineering student is required to take in their first year in the engineering school. The course gives students a wide variety of foundational skills and knowledge useful throughout the rest of their engineering career, including 3D modeling, prototyping, manufacturing, troubleshooting, project management, coding, electronics, and teamwork.
ENES100 has piloted machine learning through the use of industry standard hardware: NVIDIA's Jetson Nano. The Jetson Nano is used in student activities, and sewn into the fabric of the existing course by integrating the Jetson in the semester-long Over Terrain Vehicle (OTV) collaborative project. The Jetson introduces students to how machine learning works and how they can fit their own models in Python. Machine learning course material was piloted with three sections with a total of 120 students, and five teams of eight went on to develop their own machine learning classification models using the Jetson's pre-trained image processing neural networks. Those five teams used a wireless camera to send training and testing images between their OTV and the Jetson Nano, which was loaded with their trained model. Students then used the model's feedback to perform actions on the OTV.
This paper discusses the implementation specifics, behind-the-scenes efforts, the outcomes, and student responses to the machine learning pilot program.</td></tr>
</table>

Monday July 31, 2023 3:45pm—5:00pm
Session S6A: Full Paper I

S6A: Full Paper *Out with the Old, In with the New*	
Exploring the Impact of ChatGPT on a First-Year Engineering Design Course	Kevin Calabro Joshua Cocker Catherine Marie Hamel

In this full paper we present findings from an exploratory study conducted to better understand the impact of ChatGPT on the teaching, assessment, learning, and development of design solutions within a first-year engineering design course (ENES100: Introduction to Engineering Design) at the University of Maryland. ChatGPT was launched by OpenAI in November 2022 and is one of the most popular generative artificial intelligence tools. Within this paper we seek to answer three research questions (RQs):

- **RQ1**: In what ways might ChatGPT impact the teaching and assessment of ENES100?
- **RQ2**: In what ways might ChatGPT impact learning within ENES100?
- **RQ3**: In what ways might ChatGPT be used to produce solutions to open-ended design challenges in ENES100?

Our findings from this qualitative study are intended to invite dialogue among first-year educators around this topic. With this aim in mind, our paper seeks to provide balanced and non-judgmental analyses of the potential impacts of this emerging technology by exploring potential use-cases, and describing benefits, hindrances, and potential risks of the existence of these technologies on the teaching, assessment, learning, and development of design solutions within ENES100.

A multi-faceted Model to Enhance Engineering Student Success	Derin Ural

Creating a supportive learning environment remains essential for engineering student success, especially as we have witnessed changing student engagement in the post-pandemic context. Engineering programs globally were challenged to adapt to changing learning environments and modalities. Institutions utilized various technological re- sources, mentoring, training and support for both engineering students and faculty to ensure continuity and improve effectiveness of teaching and learning. A case for enhancing engineering student engagement and success through a multi-faceted effort at an Engineering College will be presented in this paper. The approach first includes re-evaluating and redefining the role of the engineering students' academic advisor, faculty mentor and peer mentor. The second approach is to re-evaluate the engineering first year course offerings as well as their content. Third is to re-imagine teaching and learning spaces in engineering, and fourth is the comprehensive assessment of the impact of these new programs. The new first year engineering students have three champions ready to support them as they arrive to campus, with the goal of helping new students succeed during their first year. The College worked with each Engineering Department Chair, as they identified upper class students who were academically strong, and active in meaningful co-curricular activities with the mandate to engage with admitted students bridging the summer prior to their first years. A series of carefully timed scripted messages and activities, culminating in an Orientation in person meeting proved to give new engineering students a successful welcome to campus. The second approach required Engineering faculty to re-consider first year introductory courses offered for Engineering majors, as students were heavily taking science and math courses and disconnected from their engineering major course offerings. A series of new broad, general engineering courses were identified and developed. The first offerings took place the Fall semester following the pandemic closures. The current teaching and learning spaces in the College were renovated to accommodate these active, team-based and challenge-based learning courses. The new initiatives were carefully assessed and monitored. The National Survey for Student Engagement was ad- ministered each year for Engineering students following the new initiatives being launched. Results will be shared in the paper.

Monday July 31, 2023 3:45pm—5:00pm
Session S6A: Full Paper I

S6A: Full Paper *Out with the Old, In with the New*	
Implementation of Course Structure in STEM Courses for Student Motivation and Learning, and Lab Innovation	Muzammil Arshad
The present study is an extension of implementation of the course structure which was initially designed, developed and implemented at Texas A&M University for engineering courses. This study extends its implementation to other STEM courses to assess its applicability and effectiveness in science related courses. The course structure is employed at the Chemistry department at University of Texas Rio Grande Valley (UTRGV). The present study is an autoethnography of the implementation of the course structure and its effectiveness assessment. This study highlights the implementation of the course structure considering student motivation and learning since student motivation is an important research area for modern instructional design. Lab coursetips for motivation is incorporated by asking the students to make TikTok videos of labs and submitting them on Blackboard.	

S6B: Full Paper *One Size Does Not Fit All*	
Engendering Engineering Inclusion through an Interactive Theatre Sketch	Robin A.M. Hensel

Teaching students the necessary skills to work collaboratively, inclusively and productively in teams composed of diverse members continues to challenge engineering educators [1]. Many diversity-related educational interventions, typically, focus on preparing students from minority or marginalized populations to work within a majority-focused and sometimes unwelcoming culture [2]. Supported by NSF funding, a team of researchers investigated a different approach. They infused existing engineering and computer science curricula with small, but impactful, changes or additions intended to change the culture to one that respects and values diversity and helps engineering and computer science students develop inclusive professional identities. The project incorporated a holistic perspective of diversity ”that includes different life experiences, demographic characteristics, problem-solving approaches, and personalities,” and values ”the experience of populations historically underrepresented in engineering and computer science [2, p.1].” One intervention, the Interactive Theatre Sketch, adapted from Finelli and Kendall-Brown [3], uses observation and role-play to explore and demonstrate how to approach biases within peer group settings, behave inclusively, and create inclusive and productive environments within their field [2]. Students in a first-year ”Engineering Problem Solving 1” course at a large, R1 institution in the mid-Atlantic region were required to attend an Interactive Theatre Sketch ”performance” and reflect on the experience. The sketch, performed by student actors sitting at a table with an empty chair, depicts a dysfunctional lab team working on a report. Students are asked to picture themselves in the empty chair. After the sketch is completed, trained facilitators guide a discussion, provide insight, and guide the interactive component. The sketch is then replayed with audience volunteers taking the empty chair and intervening to try to solve the issue presented. Following the sketch, students are asked to answer reflection questions relating to their observations and experience. Before COVID, the sketch was performed live in an auditorium and students were asked to participate with the actors during part of the event. In 2020, the sketch was re-created for virtual implementation with students observing as webinar participants. The actors performed a related, but modified, sketch depicting a Zoom-based lab-group meeting. The ’empty chair’ exercise was replaced by a ”debriefing” of the characters, in role, in which they expressed their feelings caused by the actions of the other group members [2]. This paper describes the Interactive Theater Sketch activity, the challenges related to its implementation, in both in-person and virtual environments, and facilitator observations of student engagement, as well as recommendations for future implementations or possible adaptations for different educational environments.

Monday July 31, 2023 3:45pm—5:00pm
Session S6B: Full Paper II

S6B: Full Paper
One Size Does Not Fit All

Incorporating Academic Coaching in First-Year Engineering Program to Support Student Success and Persistence

Aysa Galbraith
Leslie Bartsch
Heath Aren Schluter-man
Gretchen Scroggin

The First-Year Engineering Program (FEP) was designed to deliver foundational knowledge of engineering studies, to provide proactive support for all new freshmen entering the College of Engineering and to help the College's efforts to increase retention and graduation rates. Since FEP was established in 2007, the 2nd year retention rates for College of Engineering increased from 61% to around 70%. For the last several years, the rate has been fluctuating around 71-72%. FEP continually explores new ways to support the freshmen engineering students and increase retention rates. Time management and study skills are key areas with which most new freshmen engineering students struggle. FEP added academic coaching to its services in 2018 to better equip our students to prepared for those academic struggles outside of learning course content. The academic coaching team started as one coach and continually grew; currently, there are two full-time academic coaches that are supported by two part-time academic coach graduate assistants. This paper focuses on the impacts of the addition of academic coaching components to our First-Year Engineering Program. Academic coaches provide individualized academic support to students in the College of Engineering to improve student persistence and degree completion. The coaches schedule one-on-one meetings with students to co-create a success plan that considers life experiences, academic goals, and long-term professional aspirations. The Academic Coaching team also offers in-class presentations, group coaching, and monthly skill-based success workshops for engineering students. Additionally, academic coaches also connect students to appropriate services on campus, such as mental health services, tutoring, career guidance, learning accommodations, and more. In this paper, we share the results of the feedback collected from students on group coaching sessions and in-class presentations given by the academic coaches. We will also examine the impact of an 8-week course offered in spring 2022 for students placed on probation after their first semester. This course was a combination of self-awareness and college learning topics, and was offered free of charge for students who made a passing grade in the course. Lastly, this semester, coaches are piloting an academic recovery program for students on probation with 51 active students. We will detail any results that will be available by the final paper submission date.

Engineering Catalyst: An Alternate Supported Path to the Same Destination

Susan E. Walden
Randa L Shehab
Brian M McSkimming
Jahnavi Dirisina
Javeed Kittur
Allison Quiroga
Jude Okolie
Casey Violette Haskins

Engineering Catalyst is a new program to support engineering and computer science students who enter the University of Oklahoma with a pre-calculus or college algebra math placement. With a strategic goal to increase B.S. engineering graduates by about 30% by 2029, the Engineering Pathways team at the University of Oklahoma (OU) designed and launched a new first-year engineering transition program in 2022. In early brainstorming in 2021, the name Engineering Catalyst was chosen to represent the vision of the program – providing students entering our college in pre-calculus or college algebra a supported path to their engineering or science degree. The program is an adaptation of national models for "gold/red shirt" programs and a first-year research program for mid-tier incoming students, guided by significant features of our local context. Here we describe the motivation and structure for this hybrid model first- year plus support program and an informal assessment of our first year.

Monday July 31, 2023 3:45pm—5:00pm
Session S6B: Full Paper II

<table>
<tr><th colspan="2">S6B: Full Paper
One Size Does Not Fit All</th></tr>
<tr><td>A Pilot Study: Undergraduate Teaching Assistants Fostering Engagement, Inclusion and Belonging in Engineering</td><td>Tameka Sharona Clarke Douglas</td></tr>
<tr><td colspan="2">The College of Engineering (COE) sought to capitalize on the underutilized and underdeveloped resource of undergraduate students as teaching assistants providing instructional support to our faculty and students within our first year engineering courses. Traditionally, within first year engineering courses, undergraduate teaching assistants (UTAs) are primarily used to support grading of assignments. However, the COE sought to extend the ways UTAs are utilized through design and development of a training and support pilot program that in effect prepared the UTAs to effectively support first year engineering instruction by fostering inclusion and promoting diversity within first year engineering courses. The training and support program was designed with specific UTA outcomes which included, more specifically, UTAs fostering a sense of belonging, fostering a growth mindset, recognising when a student needs referral and in a sensitive and respectful manner, referring students to and providing instructional support to students with disabilities and diverse learners. At the center of this program design was the intent that UTAs are effectively prepared to support instruction and appropriately trained with the knowledge, skills and attributes to practically and effectively promote and foster diverse and inclusive practices within these first year engineering courses. At the end of the training program, approximately one hundred UTAs responded to an online four point Likert scale pre-post reflective survey on the perceived gains of participating in the virtual training program and community check- in activities. Each question was developed in alignment with the predetermined UTA outcomes. This paper discusses the UTAs' perceived gains or value-added when asked to reflect on their abilities before and after participating in the training and support program. Analysis of the survey results indicated that UTAs reported a positive change or growth in their self reported abilities to foster inclusion, foster a growth mindset and refer and support students with a disability. More than eighty-six percent responded that they learned knowledge and necessary skills to support their faculty, in training. Before the training, seventy-one percent of the respondents indicated they did not believe they were able to foster a sense of belonging in the engineering classroom. After the training, eighty-three percent agreed that they were able to foster a sense of belonging in the classroom. Only twenty-five percent of the respondents believed they could foster a growth mindset: seventy-five percent of the respondents believed they were not able to. After the training, eighty-nine percent of the respondents believed they had the ability to foster a growth mindset. Twenty-three percent of the respondents believed they could make a referral and provide instructional support. After the training, seventy-one percent of the respondents believed they were able to make a referral in a sensitive way and provide sup- port for students with disabilities. More than ninety-five percent of UTAs stated they learned knowledge, skills, and abilities that will benefit beyond their time as an undergraduate student. This study presents a successful example of a training program for UTAs that was designed to provide the knowledge and skills needed to foster inclusion and support diversity within first year engineering classrooms.</td></tr>
</table>

Monday July 31, 2023 3:45pm—5:00pm
Session S6B: Full Paper II

S6B: Full Paper *One Size Does Not Fit All*	
Engaging First-Year Engineering Students Through Team-Based Design and Peer Review: A Service-Learning Approach	Djedjiga Belfadel Isaac Macwan

This Complete Evidence-based Practice paper outlines the benefits of incorporating a challenging team design term project informed by service-learning in a first-year engineering course for students majoring in electrical, biomedical, mechanical engineering, and students who have not declared a major. The course provides core engineering knowledge and competencies in a highly interactive course format. Topics include professional skills such as technical writing and presentation, guidelines for professional engineering practice, and career preparation. In this three credit-hour course, an engineering approach to problem solving is taught with an emphasis on teamwork, oral and written communication, creativity, coding, and computer-aided design tools. The instructional approach used in this course involves first-year engineering students as active participants in the learning process. Project based learning involves implementing projects with hands-on tasks, well-defined outcomes, multiple solutions to a given problem, and linking science and engineering concepts. The final term design project is redesigned to provide a service-learning experience. This experience is created to build confidence in the first-year students and to allow them to practice their communication skills in an environment in which they are also serving as role models and mentors. By forming design teams, students learn the systematic design process and design. This introductory design experience culminates with a peer review and presentation component, where students explain their design choices to their peers and visiting community youth via their poster presentations. This project forms a structured introduction to the implementation of principles of design and engineering methodologies, project management, and presentation skills. Teams are required to design a system that propels a single person (the ”operator”) across the length of the University’s swimming pool with a walking or running motion entirely above water. The project is open-ended in the sense that students are allowed to creatively design and fabricate a system that satisfies the requirements. This has encouraged pluralistic thinking allowing students to freely create any working design that meets the task specifications. The commonly encountered right or wrong philosophy did not apply to the project. They were also tasked with explaining their design choices to the visiting community youth via their poster presentations. The teams learned important lessons about the transition from conception to implementation. One of the most important outcomes of the course was learning to work in teams. At the end of the course, each team was assessed on quality of design and team efficacy. Students developed their professional socialization skills while preparing technical reports and PowerPoint as well as poster presentations. On the last day of the program, students also got to experience presenting their group projects in the form of team presentations.

Monday July 31, 2023 3:45pm—5:00pm
Session S6C: Full Paper III

S6C: Full Paper
Cannot Have Too Much Math!

Where's the Math? A Case for Reconsidering Math in K-12 Engineering Activities	Todd France

Prior evidence suggests that active, student-centered learning environments can positively influence students' perceptions of STEM career pathways, and that engineering activities can provide motivational contexts for learning math concepts. However, specific benefits to student proficiency in mathematics via engineering design activities are less well established, with some studies pointing to greater student improvement in mathematical practices than content comprehension. Previous studies also note that math standards can be effectively aligned with hands-on activities, but obstacles may include a lack of teacher confidence with engineering concepts and student aversion of math during engineering activities. This paper details an investigation of the prevalence of mathematics in middle school and high school engineering, particularly with regards to a study of thirty popular activities on the virtual library Teach Engineering. Results show that standards-based math content is clearly integrated into most of the reviewed activities, with math tasks comprising about one-third of the total activity time on average. Notably, the math tasks occur almost exclusively during (e.g., measuring) or after (e.g., plotting data) the hands-on phase of each activity; in other words, math was not used to inform design decisions or make predictions. The study suggests that more readily deployable engineering curricula that utilize math at the front-end of activities may be needed for better integration of all STEM disciplines and to more authentically demonstrate the utility of mathematics in the engineering field.

Promoting First-Year Student Success through the Data-Driven Creation of a Preparatory Engineering Program and an Engineering Math Resource Center	Katherine A Grover Kristina T Glaittli Christian R Bolander Thomas H Fronk

Prior to 2019, the College of Engineering lacked precise historical data regarding student success for first-time, full-time freshmen. To fill this knowledge gap, a dataset of multiple freshmen cohorts was gathered and analyzed. The analysis evaluated each student's outcome nine years after their initial enrollment semester. Student success, as measured by graduation in the College of Engineering, was then evaluated by freshmen admission standards: high school GPA and ACT/SAT scores. The results showed that degree completion for freshmen was very low for those admitted with scores at the lower end of the admission standards. Success was also examined by the students' starting math course. Results indicated that student degree completion increased by twenty percent for each increasing level of math preparation, e.g., Pre-calculus, Calculus I, Calculus II. Based on this study, admission standards were reviewed and adjusted to admit students who had a good probability of graduating as demonstrated by their prior performance. As a land grant institution, maintaining access to education is an important mission for the university. Therefore, a preparatory engineering program was created to help the students who do not meet the new standards. Students who fall below the requirements are admitted to the preparatory engineering program and are provided a pathway to prove they can be successful in engineering. Upon completion of the preparatory pathway, the students are able to move into the engineering major of their choice. In addition to program adjustments, the analysis provided the needed information to create and fund new student resources including an Engineering Math Resource Center (EMRC). The mission of the EMRC is to assist engineering students in connecting math concepts to engineering problems. During the 2022-2023 academic year, the center was developed and began providing new resources including individual tutoring, math refresher workshops, online re- sources, and weekly study sessions. Analysis of the data gathered by the center will be used to determine the efficacy of the EMRC and guide future changes and initiatives.

Monday July 31, 2023 3:45pm—5:00pm
Session S6C: Full Paper III

S6C: Full Paper *Cannot Have Too Much Math!*	
Fostering Success in Introductory Calculus through Peer-Led Team Learning (PLTL)	Karen D Alfrey Jeffrey Watt Christine Krull

The NSF-funded Urban STEM Collaboratory project provides scholarship support and interventions promoting academic success and retention to undergraduate students at three partner urban universities (Indiana University-Purdue University Indianapolis (IUPUI), University of Memphis, and University of Colorado Denver) majoring in engineering, math, and computer science and with demonstrated financial need. Some interventions are common across all three campuses, while others are unique to each school and draw on particular existing strengths. All campuses employ a cohort model providing community-building summer bridge activities prior to the start of the first semester and additional community-building opportunities throughout the semester. At IUPUI, Urban STEM students were recruited based on readiness for Calculus 1, among other factors, resulting in a mix of entering first-time freshmen directly admitted to Engineering or Science, and returning sophomores who needed additional mathematics before they were ready for Calculus 1 and other freshman courses that depend on it (and thus admissible to their programs of interest). Drawing on the Peer Led Team Learning (PLTL) model that has long been successfully implemented in IUPUI's introductory Chemistry classes, each entering Urban STEM cohort at IUPUI was placed in a special Calculus 1 recitation section that implemented PLTL. The PLTL model differs from traditional recitation sections in that it is led by undergraduate Peer Leaders who have recently been successful in the class and who are trained to guide students through solving problems on their own rather than simply working demonstration problems in front of the class. In Chemistry it has been shown to decrease DFW rates and decrease equity gaps for underrepresented students. Both cohorts of Urban STEM students at IUPUI showed lower rates of D, F, and Withdraw grades in Calculus 1 compared to the class as a whole. Differences in the first year were stark: Cohort 1 (n=25, Fall 2019) had no grades of D, F, or W in Calculus 1, compared with an overall course DFW rate of 27.6%. Cohort 2 (n=20, Fall 2020) showed a smaller DFW reduction compared to the class as a whole, with a cohort DFW rate of 15.0% in Calculus 1 compared to an overall course DFW rate of 23.2%. Of note, however, no students in Cohort 2 failed the course, compared to 12.6% of students overall failing the course. While there are many factors at play in the success of these cohorts, including scholarship support, other opportunities for community-building outside of PLTL activities, and changes in course delivery and grading in response to the Covid pandemic beginning in Spring 2020, these results suggest PLTL is a powerful tool supporting student success in introductory calculus. This paper will describe the implementation of PLTL in these special recitation sections, the training provided to mentors, challenges presented by the Covid pandemic, and deeper analysis of results by demographic.

The Impact of Freehand Sketch Training on Engineering Students' Creativity, Communication Abilities, and Spatial Visualization Skills: A Controlled Trial	Nathan Delson Huihui Qi

Freehand sketching has been identified as beneficial for engineering creativity and for sharing design concepts among teammates. However, to the authors' knowledge, little research has been conducted to quantify the benefits of sketching, and how much training in technical sketching is required to achieve these benefits. In this study, student experience is compared in two sections of a freshmen hands-on design course in mechanical engineering. In one section, freehand sketching was taught in a traditional manner with students completing five orthographic and isometric sketches on paper in a homework assignment within a single week of the course. In another section, students were taught technical sketching using software where students sketch on computers or mobile devices and the sketches are automatically graded with personalized real-time feedback and hints provided to the students. The sketching software allowed students to work independently and over 100 sketches were assigned to the students over a four week period. In both sections, the sketching interventions were implemented in the first four weeks of the class. For the rest of the term, students worked on a team robot design project which included concept generation, CAD, 3D printing, and project management. Throughout the class, students completed weekly reflections and were asked about their confidence in sketching, CAD, and hands-on design. They were also asked about how well they could explain their design concepts to their teammates, and what methods they used to communicate; orally, written, or with sketches. The students also completed pre- and post-testing to measure spatial visualization ability using the PSVT:R test. The analysis will focus on whether the additional amount of sketching using the software had an impact on student performance and experience. The data considered will be students' self reported confidence in their ability to sketch and communicate their design ideas. Also, data from teammate peer review surveys will be used to quantify if there was an impact on the ability to communicate between teammates. The outcome of this study will help inform instructors of how much sketching is beneficial in an introduction design course.

Tuesday August 1, 2023 8:45am—10:00am
Session S7: Special Session

S7: Special Session

First Year Programs Primer

Jack Bringardner

This special session would be of interest to the entire First-Year Engineering Experience and First-Year Programs Division community. The purpose of this session is to engage the first-year engineering education community interactively in a discussion on developing a primer. After soliciting input and ideas from the FYEE 2023 conference, a repository of resources will be created. The session will be divided into three 15-minuite discussion sessions facilitated by two moderators. During each discussion session the participants will work in groups at their table to generate as many ideas as possible and write them down on an easel pad. 10 minutes will be used to brainstorm ideas and 5 minutes will be used to record the main ideas from each table. The results of this will be documented in the final 5 minutes for future the generation of the primer.

Starting Point for Break Out Discussions

The current FPD Call for Papers will be used as a starting point for topics[1]

Topic	Call for Papers Themes
Research	Advances in engineering education research as it applies to the first-year experience;
Innovation	Innovative approaches to first-year engineering education;
Assessment	Pedagogical strategies for first-year learning objectives, ABET accreditation requirements, assessment;
Curriculum	Design, reform, evaluation, and classification of first-year engineering curriculum;
Experiential	Integrated experiential learning curricula & global/societal problems including service, research, and entrepreneurship for the first year;
Projects	Project-based, activity-based, and hands-on learning in the first year;
Design	Teaching and practicing the engineering design process in the first year;
Problem-Based	Creative, open-ended problem-solving courses and/or related teaching activities in first-year engineering programs;
Teamwork	Insights into teaming, group work, and team/individual assessment among first-year students;
Diversity	Inclusivity and diversity in the first-year engineering experience;
Retention	Retention and student success/motivation strategies for first-year students;
K-12 Transition	Programs that support the transition from K-12 to first-year engineering;
Recruitment	Programs, policies, or frameworks linking high school/two-year/transfer prep/junior college institutions and first-year programs;
Student Outcomes	Advising, student services, learning communities, orientation, tutoring, and other co-curricular first-year engineering student development programs;
Classroom Strategies	Professional development, technical communication, integration with math & sciences, major selection, peer-led team learning, and other models for first-year engineering;
Learning Technology	Instructional use of learning technologies, online tools, computational methods, and computer software in first-year engineering programs;
Space	Makerspaces, labs, equipment, materials to support learning in the first-year engineering experience

S8: GIFTS *Great Ideas for Teaching, or Talking with, Students!*	
Understanding buoyancy with building a miniature concrete canoe	Helen Yoonhee Jung Jakob E Yovanovich
The first-year engineering students will build a "Miniature" version of a concrete canoe, smaller than 2 feet long. The students will gain hands-on practical experience in mix designs, concrete mixing, mold design, testing, and project management challenges. The project idea comes from the American Society of Civil Engineers (ASCE) Concrete Canoe Competition, providing civil engineering students with a unique opportunity to gain hands-on practical experience. This project not only teaches the students the topic of buoyancy, testing, and mixing the concrete but also provides a chance to be plugged in with the ASCE chapter at the university. The project must be done in a team of 4 (recommended) with a team-selected communication officer and a technical advisor with expertise in concrete mixing, typically a civil engineering professor. They will begin with understanding the equations and relationships of the variables involved in buoyancy. Then the students either design the canoe using CAD or find a mold that is easy to calculate the volume of the canoe. Using household items as mold is strongly recommended for better project time management. A few recommended options for mixing are cement, fiberglass, cement glue, and foam. The lab guidelines must be followed per university policy, and personal protective equipment must be worn at all times.	
Developing Data Literacy through the NAE Grand Challenges and MATLAB App Designer	Dan Burleson
A semester long project in a second semester, first year engineering course was developed to provide students an open- ended, collaborative opportunity. Using the 14 National Academy of Engineers Grand Challenges, students initially investigate and find quantitative information (data) related to a grand challenge. Students are provided peer mentors (undergraduate teaching assistants) and asynchronous learning modules to support narrowing the topic, identifying the challenge and information they want to present, and find data. The goal for each project is to develop MATLAB App that that allows the user to interact with the data and learn about the grand challenge. With regular weekly checkpoints, students are asked to develop each component, receive and address feedback, and reflect individually on their work. Since MATLAB App involves various components, each group member has ownership of a specific component on the interface with the group goal of making sure they integrate. Since MATLAB is taught as part of this second semester, first year courses, the program language and interface are a natural extension of the knowledge they are using regularly in class. Finally, students communicate their project in the form of a final poster. As part of an introduction to the UH Grand Challenge Scholars Program, the top groups from each section are selected to present their project at a Grand Challenge Summit as part of a Student Poster Session. As part of the final reflection, use Likert scale to rate their own learning in various objectives indicating a strong student experience and development in key areas such as data literacy, engineering context, and problem solving.	
A Fantastically Creative AutoCAD Assessment	Angelina Jay
This GIFTS paper presents the first iteration of an end-of-module AutoCAD assessment that promotes students' creativity by encouraging them to make connections to the non-engineering parts of their lives. In addition to creativity being a core engineering competency, normalizing non-technical interests and passions can assist in retaining a truly diverse engineering student body. For this assessment, students are tasked with drawing a themed fantasy map, like you might find on the inside cover of a novel, in AutoCAD. The theme for this fantasy land is entirely open and up to them. They are given a set of required features (borders, mountain ranges, rivers, etc.), a set of formatting requirements and layers on which to draw those features, and a few example/inspiration images. Themes students chose in this iteration varied from Tolkien novels and Poke'mon to students' countries of origin, Taylor Swift, and even the setting of a fantasy short story that one student had personally written in high school. This assignment provides a platform where Taylor Swift Land can be equally as successful, technically correct, and valuable as any Robot Land or New York City, with the intent of helping students with less of a technical background feel a greater sense of ease in the engineering classroom.	
Leadership, Engagement And Professionalism (LEAP) Peer Mentoring Program	Marsha Christine Kowal
We developed a semester-long peer mentoring program within Honors Engineering that matches freshman women with a same-major, female mentor in their junior year. Now in its second year, our program aims to improve retention and student success within Honors Engineering by fostering an engineering identity and building community. The LEAP program has a layered leadership approach where two student directors (themselves a mentor/mentee pair) co-organize the program under the guidance of faculty advisors. Mentors and mentees meet weekly as a cohort for structured professional development workshops that are relevant to both early and late-career students. Workshop topics were selected from student focus groups and representative topics include time management, LinkedIn, resumes, negotiation, career fairs, interviewing, and alumna panels. Each mentor/mentee pair also meets one-on-one three times a semester for unstructured mentoring. LEAP hosts social events where both current and past LEAP students are invited to encourage networking and community building across cohorts. We believe that mentoring is one approach to cost-effective professional development; therefore, we plan to expand our program to all first-year students in the Honors Engineering Program.	

Tuesday August 1, 2023 10:15am—11:30am
Session S7: Special Session

<table>
<tr><th colspan="2">S8: GIFTS
Great Ideas for Teaching, or Talking with, Students!</th></tr>
<tr><td>Situational Learning of MATLAB Using Data Collection and Analysis Modules Based on Upper-Level Engineering Lab Experiments</td><td>Brian Patrick O'Connell</td></tr>
<tr><td colspan="2">All College of Engineering students at Northeastern University participates in the first-year engineering courses in mixed discipline cohorts. Since these courses service students of all majors, the curriculum includes a range of engineering tools they will need in the following years. One of those tools is MATLAB due to its use in many upper-level lab courses across all disciplines. Historically, the curriculum for MATLAB has focused on introductory programming skills and MATLAB syntax taught through simple examples such as geometry calculators, games, and visualization of provided data sets. In those future labs, MATLAB will interface with external data collection hardware or other data sources, collect and organize the data, perform analysis, and present the data and results to support their conclusions. From a programming experience standpoint, a script to play a game of Tic-Tac-Toe and a script to assist with a complex experiment to answer a research question differ significantly in the algorithms used and vary fundamentally in logic development.
A grant produced a new situational learning curriculum to bridge that gap between the student's initial experience with MATLAB and how they will use it in future courses and professionally. A series of MATLAB modules inspired by typical lab experiments provide students with hands-on experience in data collection, organization, analysis, and visualization. In addition, the modules lead students to apply their MATLAB knowledge to real-world problems and develop algorithmic thinking skills relevant to their future use of the tool.
The initial implementation of the curriculum took place in a Fall 2022 Honors-level first-year engineering course. The data-collection aspect of the modules was well received, and with detailed guidance, they successfully analyzed large datasets and visualized the results. However, students struggled when the assignments became more open-ended, allowing them much more freedom in what research questions they might address and how they would do so. Even if given a list of possible questions, many students became stagnant and could no longer understand "What they were supposed to do" in that context.
Overall, the curriculum provided a beneficial situational learning experience for the students, with multiple means of engaging with and learning the material. The type of algorithmic thinking they experienced was much closer to their future use of the design tool. They not only engaged with MATLAB but engaged with experimental practices that they will utilize alongside MATLAB in the future. While there were some challenges with the open-ended assignments, the initial implementation suggests that this instructional approach could improve student learning outcomes in engineering education.</td></tr>
<tr><td>Meeting the students where they're at: a flipped model of office hours</td><td>Kimberlyn Gray
John T Hird</td></tr>
<tr><td colspan="2">First-year students are often reluctant to visit office hours or seek out tutoring. Many first-year students will spend hours on an assignment without making progress when a quick answer from a professor would help them move forward. Because of this, the authors have experimented with holding office hours in student friendly locations at high traffic hours. The chosen location is a student common space with comfortable seating, areas with both large and small tables, private study rooms, computers, and a tutoring area. This allows us to make more efficient use of otherwise underutilized office hours, as well as allowing us to promote tutoring opportunities nearby. The goals of holding "pub- lic" office hours are to encourage students to approach professors with questions and to have regular study sessions during the office hours, even if they do not anticipate having questions. In this paper, we discuss the strategies we have used over several years. The authors are from different departments and often share joint office hours. The office hours are promoted in both authors' classes. This year, we expanded public office hour times to include a wider variety of times of day and a greater number of days per week. We discuss strategies we used to attract students and the type of students who regularly utilized these times. Both authors regu- larly work with students from outside their own classes and refer these students to one-on-one tutoring. We discuss successes and failures of the strategy and what we plan to do differently in the future.</td></tr>
<tr><td>Team selection using team leaders as hiring managers</td><td>Todd R Hamrick</td></tr>
<tr><td colspan="2">Selection of project team members can be challenging. One way to ensure team harmony and effectiveness is to select team leaders who will select their own members based on member applications in a way that more closely replicates job applications. This method has been utilized in two courses with good success at a major mid-Atlantic University. First, team leaders volunteer to fill that role with the incentive that they get to select their own team members and direct the team's efforts. All other members complete an abbreviated application that illustrates their skill sets and work ethic that will make them effective team members. Team leaders select their team members based on the applications and skill sets that they will need for the project. Members can be "fired" if they fail to perform or can leave for other teams if they are unhappy with their first team. This method creates ownership and accountability in the teams, and better team participation has been observed.</td></tr>
</table>

Tuesday August 1, 2023 10:15am—11:30am
Session S7: Special Session

S8: GIFTS

Great Ideas for Teaching, or Talking with, Students!

Showcasing Interconnectedness of Engineering Disciplines in an Introductory Engineering Class through a Climate Change Module	Haritha Malladi

Introductory engineering courses taken by first-year undergraduate engineering students often include an overview of the different engineering disciplines. The learning objective is to help students understand the unique expertise of each major engineering field, and how they all use fundamental science principles and the basic engineering design framework. It is equally important for the students to recognize the similarities across the disciplines and real-world examples of work being done to tackle important global and societal challenges. At the author’s institution, Introduction to Engineering is a 2-credit required course taken by all first-semester undergraduate students in the College of Engineering (COE). Most students in the course have declared an engineering major (12 different majors) but there are some students who are admitted to the College of Engineering without a major—they need to declare their major before the end of their first semester. The course also has a small number of students from other Colleges who may be considering switching to an engineering major. Showcasing the different engineering disciplines in this class is particularly important for the students who haven’t yet declared an engineering major. Typically, engineering department overviews are provided to the students in the form of weekly lectures from guest speakers from each COE department. While the weekly overviews provided information on the expertise of that discipline, there was a need for students to have the opportunity to reflect on the interconnectedness of engineering disciplines. Sustainability and resilience are important goals in engineering. The theme of sustainability is an integral part of the National Academy of Engineering’s 14 Grand Challenges for Engineering in the 21st Century. Consideration of environmental factors in engineering design is a part of the student outcomes required by Accreditation Board for Engineering and Technology (ABET) for all engineering programs. Student feedback surveys have shown the author that students across all disciplines are interested in the topic of sustainability. Given that students across disciplines are interested in sustainability, the author recognized an opportunity to engage students with the important topic of climate change. In Fall 2022, a climate change module was created to showcase how different engineering disciplines are contributing toward resilience, mitigation, and adaptation techniques. The module included a lecture on the basics of climate change—introducing the concepts of ”Anthropocene”, greenhouse gases, and the Keeling curve. Students looked at the proposed plan for achieving net zero emissions described ”Speed & Scale by John Doerr (2021) and identified the engineering disciplines involved in each of the plan’s objectives. A list of articles featuring news on climate change-related work from all major disciplines was compiled for the students to highlight recent real-world applications. At the end of the module, each student created a concept map to link the fields of engineering, net zero objectives, and the information they gleaned from reading the news articles. Informal feedback from students on the climate change module has been positive. The author intends to continue developing this module and measure learning outcomes in future semesters.

Metacognition reflection notecard: A 5-minute daily class activity to drive self-efficacy, classroom engagement, and community	Alexandra Maley Landon

At the end of every freshman engineering class, I hand out a notecard and ask students to write their responses to three simple but powerful questions:

1. What's the most important concept you learned today that you want to remember?
2. Is anything unclear to you after today's class? Are there any outstanding questions still on your mind?
3. What is one song you'd like to be added to our class playlist? Include your name if you want credit for your song choice.

I review these notecards at the end of every class and use the responses to Question 1 to understand which lessons resonated with students. I use the answers to Question 2 to populate a shared Running Questions & Answers document (created using Google Docs). I add the student-generated questions and my answers to this document, which the entire class has access to. This helps to clarify confusion quickly and to demonstrate to nervous students that they aren't the only ones with questions. Finally, I use the answers to Question 3 to build our class's shared Spotify playlist and to provide incentive for the students to complete the reflection. Before each class starts and during our breaks, I play a randomly-selected song from the playlist. There are significant benefits to this simple practice. Many students shared that they have implemented personal metacognition reflections at the end of all their classes. Students take more control of their own learning as they become better at understanding where they need clarification on a topic and where they just need more practice. The openness to questions and shared playlist fosters a strong and inclusive classroom culture, as students have something to talk about with music at the beginning of every class. The 5-minute notecard can be implemented in any level course without taking significant time away from instruction in order to help students’ self efficacy, create engaged classrooms, and build a supportive engineering community.

S8: GIFTS *Great Ideas for Teaching, or Talking with, Students!*	
Broadening Students' Self-Knowledge and Self-Development in an Introductory Engineering Design Course	Ashish D Borgaonkar
Introducing students to experiential learning opportunities that stimulate self-reflection, self-awareness, and personal growth into a Fundamentals of Engineering Design course is an excellent strategy to widen students' self-knowledge and self-development. Self-knowledge and self-development are lifelong processes, and college is the perfect season in students' lives to help them further develop this fundamental information. First-year students are introduced to a variety of opportunities to engage in experiential learning such as: academic clubs and organizations, internships and co-op, as well as research. This is coordinated in a dedicated module within an introductory Engineering Design course. Through collaborative exercises, students identify things they like and desire to learn more about, skills they perform well and want to develop further, and qualities about their personality that make them distinctive. At the conclusion of the module, students will start to consider how their self-knowledge and self-development could be further enhanced through engagement in one or more experiential learning opportunities. This module also helps students self-reflect on their strengths and weaknesses, and their personal and professional goals. This can help them become more effective engineers and better equipped to navigate their path to degree completion.	
Lifelong Learning in Perspective – An Activity for Student Understanding of an Engineer's Need to Acquire and Apply New Knowledge	Lee Kemp Rynearson
This Great Ideas for Teaching, and Talking with, Students (GIFTS) paper outlines an activity to bring students to the realization (consistent with ABET criterion 7) that engineers will need to acquire and apply new knowledge throughout their careers. At the author's institution this activity is delivered in a first-year seminar, but it could be useful anywhere a similar effect is desired. In the activity, students are asked to respond to the prompt "How important is what you know at the end of engineering school for your career?" Students hold up 1-10 fingers to represent 10-100% influence over career and opportunities, but clickers or any other live response method could be used. Students typically respond with average values of 50-70%, saying that most career options and opportunities are dictated by knowledge and skills possessed at the time of graduation. The students are then asked to respond to the question 'What year do you plan to retire?" After establishing that their retirement date is some distance into the future, the class and instructor discusses the state of technology an equivalent distance back in time, and the changes that have occurred in technology since that date. Slides and supporting images are shown that illustrate some of these changes. After this discussion, students again respond to the prompt "How important is what you know at the end of engineering school for your career?", before pivoting the discussion to the importance for engineers of the ability to learn new information as needed, and methods for doing so. After the class students write and peer-review reflections on this topic. The presentation of this activity may be useful to FYEE attendees as motivating students to learn how to learn is frequently an important topic in first-year seminars and other first-years coursework, or first-year academic support environments. This activity is short but highly effective in putting the need to be able to learn new skills into perspective for Engineering students as the scope of technological change across the working lifetime of an engineer becomes clear. A shortened version of the activity will be delivered during the presentation of the paper and all activity materials, which are licensed with Creative Commons, will be made available to conference participants.	
Integration of a Problem-Solving Heuristic Across Teaching and Assessment	Baker A. Martin Courtney June Faber Betsy Chesnutt Erin McCave
Supporting students' development of problem-solving skills is a common goal within first-year engineering. It is important that students develop the ability to solve complex problems that require multiple steps because these types of problems will be common within later core engineering courses (e.g., thermodynamics, statics, dynamics, fluids). Research has shown that students struggle to break complex problems down and often get stuck identifying the first step to take. Furthermore, many students will consider a problem complete after getting a numeric answer and do not consider the reasonableness of the value they calculated. There are many processes and heuristics that have been developed to support problem solving. As instructors, we have focused on teaching our students PROCESS, which was developed by Grigg and Benson (2014, 2015). This approach breaks problem solving into 7-steps that start with problem definition and ends with evaluation of the solution. For this GIFT, we will share how we have integrated PROCESS into our instruction and assessment within our first-year engineering courses. We will share our observations (both positive and negative) from using PROCESS over the last year in three different courses.	

FIRST-YEAR
FYEE
ENGINEERING EXPERIENCE

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE