NORTHEASTERN • UNIVERSITY • 1898

BOSTON, MASSACHUSETTS

15TH ANNUAL

FYEE 2024

Northeastern University
College of Engineering
First-Year Engineering

THE "WHOLE STUDENT": HELPING FIRST-YEAR ENGINEERING STUDENTS SUCCEED ACROSS MULTIPLE DIMENSIONS

First-Year Engineering Experience

JULY 28 - 30, 2024

WELCOME
FROM THE GENERAL CHAIRS

RICHARD WHALEN
Director, FIrst Year Engineering Program
Northeastern University
Conference Chair

HARITHA MALLADI
Director, FIrst Year Engineering
University of Deleware
Program Chair

Welcome to the 15th annual First-year Engineering Experience Conference (FYEE), hosted by Northeastern University! We are thrilled to gather this year in the historic city of Boston to celebrate and explore the innovative strides made by First-year Engineering programs from around the country and beyond. As a metropolis with over 60 Colleges and Universities within a 30-mile radius, we can think of no better place to be to host the leaders in First-year Engineering Education.

FYEE has traditionally offered first-year engineering educators the chance to engage in intimate networking and collaborative learning in small group settings. Presenters of workshops, panels and papers will actively share their innovative ideas and best practices, aiming to inspire and benefit all participants. We encourage attendees to immerse themselves fully in the conference proceedings, enhancing their ability to enrich the first-year engineering experiences at their respective institutions.

The First-year Engineering Program at Northeastern University supports over 1000 students annually across campuses in Boston, London and Oakland, and offers a hands-on, projects-based learning experience of integrated design that leverages a state-of-the-art maker space to provide our students with an immersive experience into the College of Engineering community. The conference will take place this year at the Interdisciplinary Science and Engineering Complex (ISEC) which was designed to bring researchers from diverse disciplines together to solve global problems. We see this building as an appropriate site as it is our expectation to bring together colleagues from diverse institutions to share best practices and experiences for the opportunity to improve your home programs. The conference will begin on Sunday with a series of workshops and a meet and greet social. 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 at dinner on Monday night. The conference will conclude on Tuesday with additional paper presentations and discussions.

We look forward to the productive conversations and anticipate the conference will prove beneficial for all participants.

CONFERENCE COMMITTEE

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

FYEE 2024 Management
- Location Chair: Richard Whalen (Northeastern University)
- Program Chair: Haritha Malladi (University of Delaware)
- Program Chair-Elect: Kathryn Schulte Grahame (Northeastern University)
- Publication Chair: Constantine Mukasa (Northeastern University)
- Sponsorship Chair: Kevin Calabro (University of Maryland
- Treasurer: Jes Kuczenski (Santa Clara University)
- Website: Ethan Danahy (Tufts University)

The FYEE Steering Committee:
- Stephany Coffman-Wolph (Chair) (Ohio Northern University)
- Sean Brophy (Chair) (Purdue University)
- Lee Rynearson (Campbell University)
- Ashish Borgaonkar (New Jersey Institute of Technology)
- Andrew Bartolini (University of Notre Dame)
- Angelina Jay (Northeastern University)

WELCOME
FROM DEAN GREGORY ABOWD

Dear Colleagues,

Welcome to Northeastern University and the ASEE's 2024 First-year Engineering Experience Conference! The theme this year is "The 'Whole Student': Helping First-Year Engineering Students Succeed Across Multiple Dimensions." I hope you are ready to share and expand your knowledge, as well as discuss a wide range of topics with the goal to continually improve the first-year engineering experience nationwide, and for all students.

Our keynote speaker, Dr. Ernst Vanbergeijk, most recently led the Threshold program at Lesley University—a postsecondary program for young adults with diverse learning, developmental, and intellectual disabilities. He will discuss navigating neurodiversity in engineering with his talk, while providing examples of neurodiversity in engineering, describing what it is, and sharing best practices to improve outcomes. This is an important topic and one close to my heart.

Northeastern's College of Engineering is a top-ranked engineering school in Boston with a global network of campuses across the U.S., and in London, and Canada. We are known for our commitment to first-year engineering with dedicated teaching faculty, student support services, and an experiential curriculum. Experiential education is the heart of a Northeastern education, including our signature cooperative education program, and innovative research to address global challenges.

While here, I hope you take the time to enjoy our beautiful campus and city. I'd like to point out our two newest buildings, the Interdisciplinary Science and Engineering Complex, created to spur discovery through interdisciplinary collaboration, and the EXP building, designed to further science, engineering, teaching, and creating. On a more social note, across Huntington Avenue is the Museum of Fine Arts—the 20th largest art museum in the world.

Once again, welcome, and I wish you an informative and engaging conference.

Sincerely,

Gregory D. Abowd, D.Phil.
Dean of the College of Engineering
Northeastern University

SPONSORS

DIAMOND

Northeastern University
College of Engineering
First-Year Engineering

PLATINUM

ENGINEERING UNLEASHED
POWERED BY KEEN

EMIFY
Entrepreneurial Mindset in the First Year

GOLD

MathWorks®

QUANSER
INNOVATE · EDUCATE

BRONZE

eGrove Education, Inc.

SPONSORS

WORKSHOP

AUTODESK

Feedback Loop

onshape™

EXHIBITORS

ACUITY INSIGHTS

engineering 4 us all

onshape™

SOCIETY

FIRST-YEAR PROGRAMS DIVISION

PROGRAM

SUNDAY, JULY 28, 2024

SUNDAY JULY 28 2024	EVENT	CORRESPONDING AUTHOR	LOCATION
12:00 - 6:30 PM	Registration		ISEC Atrium
2:00 - 3:30 PM	**Workshop I**		
	Sponsored Workshop by EMIFY		ISEC 136
	Entrepreneurial Mindset in the First-Year: Socializing a Body of Knowledge	Kaitlin Mallouk Blake Hylton Krista Kecskemety Jack Bringardner	
			ISEC 138
	Engineering First Year Advising Best Practices	Lisa Lampe Esther Tian	
			ISEC 140
	Making the Invisible Visible (in First Year Engineering)	Nicole Batrouny Daria Kotys-Schwartz Micah Lande	
3:30 - 3:45 PM	Break		
3:45 - 5:15 PM	**Workshop II**		
	Post-Pandemic Pedagogical Pivots: Mental Health, AI, and Zoom Zombification in Engineering Education	Susan Freeman Rich Whalen Kathryn Schulte-Grahame Jennifer Love Angelina Jay	ISEC 136
	Social Identity- Back to Basics	Samantha Kennedy	ISEC 138
	Leveraging Different Scales of Course Feedback for Enhanced Student Learning and Growth	Benjamin Goldschneider Shaylin Williams Esther Tian	ISEC 140
5:15 - 5:30 PM	Networking Break		
5:30 - 6:30 PM	**Panel I**		
	Rethinking First-Year Engineering: Management, Collaboration, and Curriculum Alignment	Cory Budischak Haritha Malladi Brian O'Connell	ISEC 102 Auditorium
6:30 - 8:00 PM	**Welcome Reception Sponsored by EMIFY** Please join us for Hors d'oeuvres and drinks to get to know others in the First-Year community		ISEC Atrium

PROGRAM

MONDAY, JULY 29, 2024

MONDAY JULY 29 2024	EVENT	AUTHORS/ PRESENTERS	LOCATION
7:30 - 12:30 PM	Registration		ISEC Atrium
7:30 - 8:30 AM	**Breakfast Sponsored by Engineering Unleashed**		ISEC Atrium
8:00 - 8:30 AM	**Welcome** **Richard Whalen** FYEE 2024 Conference Chair, Northeastern University **Sue Freeman** Associate Dean of Undergraduate Education, Northeastern University		ISEC Atrium
8:30 - 9:00 AM	**Keynote 1: What do we teach next? Helping students learn for the age of AI** **Michael Sweet**, Director, Center for Advanced Teaching and Learning through Research, Northeastern University		ISEC Atrium
9:00 - 9:15 AM	Transition Break		
9:15 - 10:00 AM	**Work in Progress (WIP) Presentations** WIP paper presentations start in separate rooms, where authors give a short 5-minute pitch of their WIP. Then, we will have a combined poster session for all WIP papers.		
9:15 - 10:00 AM	**WIP I: Enhancing First-Year Engineering Education and Practical Skills**		ISEC 136
9:15 - 10:00 AM	Activity Centric Online Teaching and Learning with MATLAB	Lynn Albers	ISEC 136
9:15 - 10:00 AM	Micro-Credentialing for the First Year: Creating a Digital Badge for Engineering Information Literacy	Paul McMonigle	ISEC 136
9:15 - 10:00 AM	Online Modules to Develop Upper-classmen Mentors for a First-Year Biomedical Engineering Course	Gyeongtae Sun Moon	ISEC 136
9:15 - 10:00 AM	Survey Validation to Enable Investigating Community Cultural Wealth in Engineering Students' First Year Experiences (FYE)	Adetoun Yeaman	ISEC 136
9:15 - 10:00 AM	Increasing Maker Space Participation through First-Year Engineering	Kurt Rhoads	ISEC 136
9:15 - 10:00 AM	Pilot of Block Model Delivery of First-Year Engineering	Jeffrey Harris	ISEC 136
9:15 - 10:00 AM	Hands-on Activities to Improve Student Engagement and Learning in an Introductory Programming Course	Carter Hulcher	ISEC 136
9:15 - 10:00 AM	Energy Sustainability for First-Year Engineering Students- Exploring Renewable Energy Production through Hands-on Activities	Mohammad Heshmati	ISEC 136

PROGRAM

MONDAY, JULY 29, 2024

MONDAY JULY 28 2024	EVENT	AUTHORS/ PRESENTERS	LOCATION
9:15 - 10:00 AM	**Work in Progress II: Promoting Inclusivity, Mentorship, and Feedback**		ISEC 138
	Get Them to Tell You What Works: Exit Surveys for Formative Feedback	Michelle Soledad	
	Integrating DEIBJ and Inclusive Design Concepts in an Introductory Engineering Course Using Stand-alone Modules	Ashish Borgaonkar	
	Cultivating Relationships with Clients in the Community: Enhancing the First-Year Student Experience	Rebecca Krylow	
	Fostering the Development of Engineering Identity in First-Year Women Engineering Students Through First-Year Seminars	Angelika Tamura	
	Piloting a Human-Centered-Design Software Innovation Course for First-Year Engineering & Business Students	James Toney	
	How the STEPS Program Enhances the First-Year Experience for Engineering Students	Cory Budischak	
	Surprises in Student Stress and Academic Support SURVEY	Edward Gatzke	
10:00 - 10:30 AM	**Work in Progress Poster Session** **Common poster presentation session for all WIP papers.**	All WIP presenters	ISEC Atrium
10:30 - 10:45 AM	Transition Break		
10:45 - 12:15 PM	**Workshop III**		
	Sponsored Workshop by Onshape **CAD Analytics for Responsive Teaching and Education Research**	McKenzie Brunelle, Matt Shields	ISEC 136
	Problem Framing Canvases for Client-Centered Service Learning Design Projects	Todd France Blake Hylton Abigail Clark	ISEC 138
	Fostering Student Identities as Sustainability Changemakers: Entrepreneurial Mindsets and Tools for Change	Caitrin Lynch Joanne Pratt	ISEC 140
12:15 - 2:00 PM	**Group Photo ISEC Stairs** **Lunch** **Focus on Exhibits** **Tour of EXP Makerspace**		ISEC Atrium

PROGRAM

MONDAY, JULY 29, 2024

<table>
<tr><th>MONDAY
JULY 28 2024</th><th>EVENT</th><th>AUTHORS/
PRESENTERS</th><th>LOCATION</th></tr>
<tr><td rowspan="4">2:00 - 3:30 PM</td><td colspan="3">Workshop IV</td></tr>
<tr><td>Sponsored Workshop by AutoDesk
Autodesk AI: Today’s tools and tomorrow’s vision for design & manufacturing</td><td>Gaby Waldman-Fried</td><td>ISEC 136</td></tr>
<tr><td>Milestones-Based Structured Active Learning Approach to Improve Student Performance in Engineering Courses</td><td>Ashish Borgaonkar
Jaskirat Sodhi
Lucie Tchouassi</td><td>ISEC 138</td></tr>
<tr><td>Sponsored Workshop by MathWorks & Quansar
Bridging Theory and Practice: An Interactive Workshop on Control Theory using a Robotic Arm</td><td>Neha Sardesai
Noah Roberts
Arian Panah
Zinan Cen</td><td>ISEC 140</td></tr>
<tr><td>3:30 - 3:45 PM</td><td colspan="3">Transition Break</td></tr>
<tr><td rowspan="12">3:45 - 5:00 PM</td><td colspan="3">Full Paper Presentations
Full papers will be presented as 12-minute podium talks with time for Q&A.</td></tr>
<tr><td colspan="2">Full Papers I: Sense of Belonging and Self-Efficacy</td><td rowspan="6">ISEC 136</td></tr>
<tr><td>Enhancing Sense of Belonging in First-Year Engineering Students through Integrated Project-Based Learning and Communication Skills Development</td><td>Song Wang</td></tr>
<tr><td>Sense of Belonging in a First-Year Engineering Program: Analyzing Differences Across Design Project Courses</td><td>Heather Schwab</td></tr>
<tr><td>Continued exploration of the relevance of self-efficacy, self-determination and agency in describing the first-year African engineering student's experience</td><td>Heather Beem</td></tr>
<tr><td>Building on the First-Year Engineering programming experience: Understanding the motivation and self-efficacy of students in a follow-on programming course</td><td>Joseph Lyon</td></tr>
<tr><td>Examining first-year students' nascent disciplinary identities and epistemological orientations</td><td>Juval Racelis</td></tr>
<tr><td colspan="2">Full Papers II: Teaching Methods and Assessment Approaches</td><td rowspan="4">ISEC 138</td></tr>
<tr><td>Implementing Exam Wrappers in a First-Year Engineering Course</td><td>Andrew Bartolini</td></tr>
<tr><td>Future-Ready Students: Survey Analysis Utilizing Natural Language Processing</td><td>Toluwani Olukanni</td></tr>
<tr><td>Tinkering and Making to Engage Students in a First-Year Introduction to Mechanical Engineering Course</td><td>Micah Lande</td></tr>
</table>

PROGRAM

MONDAY, JULY 29, 2024

MONDAY JULY 28 2024	EVENT	AUTHORS/ PRESENTERS	LOCATION
3:45 - 5:00 PM	One Tool to Support Attendance, Engagement, Metacognition, and Exam Preparation	Kathleen Harper	ISEC 138
	A Generative AI Approach to Better Teamwork in First-Year Engineering	Ethan Danahy	
	Full Papers III: Wellness and Student Success		ISEC 140
	Impacts of a Wellness-Focused First-Year Course on Student Retention and Academic Success	Matthew Cavalli	
	Impact of Math Placement on Persistence and Time to Graduation In Engineering	David Gray	
	Self-Regulated Learning in First Year Engineering: Opportunities for Practical Implementation	Mohammed Kihal	
	Students' Self-Reported Self-Regulated Learning Skills Across a First-Year Engineering Program	Cassondra Wallwey	
5:00 - 5:15 PM	Transition Break		
5:15 - 6:15 PM	**Panel II**		ISEC 102 Auditorium
	Unlocking the Power of Entrepreneurial Mindset (EM) in the First-Year Experience	Blake Hylton Jack Bringardner Kaitlin Mallouk Krista Kecskemety	
6:15 - 7:00 PM	**Keynote 2: Reception & Networking** Sponsored by Northeastern University College of Engineering		ISEC Atrium
7:00 - 7:30 PM	**Dean Gregory Abowd Welcome** **Keynote 2: Navigating Neurodiversity in Engineering** **Ernst Vanbergeijk, Ph.D., M.S.W,** Senior Director of Local Educational Agencies, Elwyn President and Founder Ernst Equitable Education Services		ISEC 102 Auditorium
7:30 - 9:00 PM	**Keynote 2: Dinner** Sponsored by Northeastern University College of Engineering		ISEC Atrium

PROGRAM

TUESDAY, JULY 30, 2024

TUESDAY JULY 30 2024	EVENT	AUTHORS/ PRESENTERS	LOCATION
7:30 - 12:30 PM	Registration		ISEC Atrium
7:30 - 8:30 AM	**Breakfast**		ISEC Atrium
8:30 - 8:45 AM	Transition Break		
8:45 - 10:45 AM	**Great Ideas for Teaching (GIFTs) or Talking With Students!** GIFTS presenters will present their ideas in a lightning-talk format with 3-minutes per persentation with time for Q&A. Online resouces will also be shared with attendees.		
	A Hands-on Activity for Improving the Students' Understanding of Centroids in a Freshmen Engineering Mechanics Course	Roshina Babu	ISEC 102 Auditorium
	Concrete Is My Jam!	Christopher Frishcosy	
	Expanding Laboratory Experiences in Circuits and Networks	Mark Cambron	
	Matching 2D Engineering Drawings and 3D Objects	Danielle Barker	
	Tools to Help Students Prototype and Test Autonomous Robot Navigation Algorithms	Giang-Nam Facchetti	
	Three Methods to use Podcasts as Effective Learning Tools	Haritha Malladi	
	An example implementation of web-based, in-class polling as an active learning and formative assessment tool	Paul Anderson	
	Integrating MATLAB Grader into an Engineering Computing Course	Andrew Bartolini	
	Helping Students to Advise Themselves Using a Graded Curricular Map in the First Year	Melissa Kenny	
	Team Safety Brief: A tool to promote and enhance teamwork	Mirna Mattjik	
	Trial by Fire: GIFTS for Stress-Testing Student Project Management Tools	David Gray	
	Q&A		
	Marching LEGO Ducks towards Critical Ideation	Brian O'Connell	
	Crushing Cardboard: A Technical Design Challenge for First-Year Students	Melissa Kenny	
	Designing and Making an Olympic Cauldron: A First-Year Mechanical Engineering Design Challenge	Micah Lande	
	A Multi-Disciplinary First-Year Design Project with Systems Integration, Standard Requirements, Creativity, and Impact	Shazib Vijlee	

PROGRAM

TUESDAY, JULY 30, 2024

TUESDAY JULY 30 2024	EVENT	AUTHORS/ PRESENTERS	LOCATION
8:45 - 10:45 AM	**Great Ideas for Teaching (GIFTs) or Talking With Students! continued**		
	Getting Aloft in Engineering	Mary Bowden	ISEC 102 Auditorium
	Awards & Recognition to Shape Values & Drive Behavior	Lee Rynearson	
	Career Guidance 101	Katherine Pettrey	
	"What's Your Superpower?": Connecting Entrepreneurial Mindset, DEI, and Character	Krista Kecskemety	
	Implementing High Impact Practices to Support Transition from High School to First-Year Engineering Courses	Gretchen Scroggin	
	Developing a Community of Learners with Incoming Engineering Students that Initially Were Not Calculus Ready	Leah Rineck	
	First Year Foundations Learning Community	Edward Bednarz	
	Q&A		
10:45 - 11:00AM	Transition Break		
11:00 - 12:00PM	**Full Paper Presentations** Full papers will be presented as 12-minute podium talks with time for Q&A.		
	Full Papers IV: Curriculum and Course Design		ISEC 136
	Comprehensive Analysis and Assessment of An Introduction to Engineering and Computing Course	Longfei Zhou	
	Nurturing Interdisciplinary Engagement: A Case Study of Resourcing and Recruiting Strategies in an Early Academic Career Interdisciplinary Project-Based Learning Course	David Gray	
	Assessing transformative learning outcomes of a First-Year Engineering Program using TROPOS	Sukeerti Shandliya	
	Future-Ready Students: Providing Opportunities for Remote Collaboration on an Engineering Design Project	David Feinauer	
	Full Papers V: Professional Development and Skill Building		ISEC 138
	Applying Vertically-integrated Project as a Sustainable Pathway for First-year Student Professional Development	Rui Li	
	The Professional and Technical skills that engineering students find most important for success in their major	Atheer Almasri	

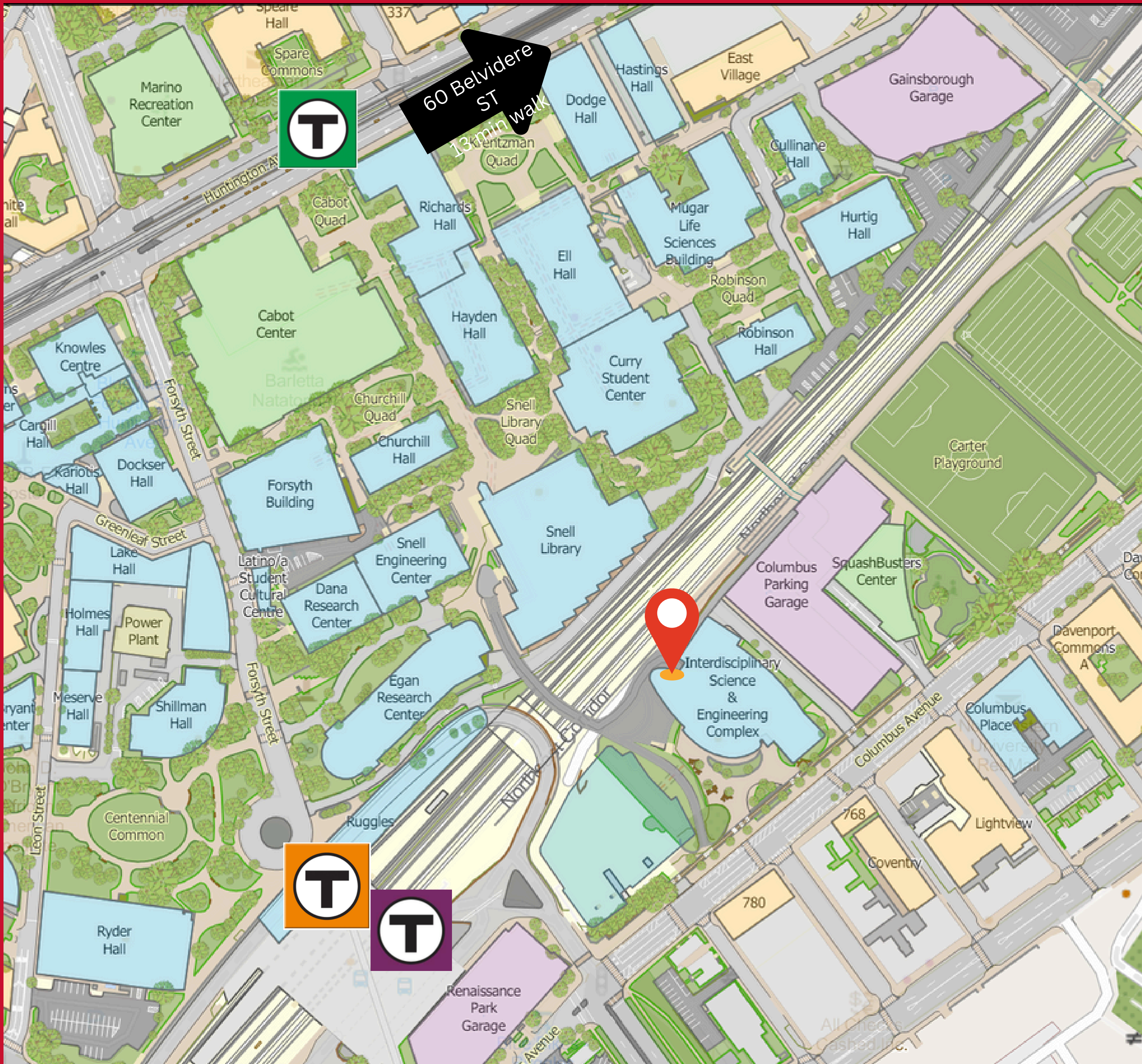
PROGRAM

TUESDAY, JULY 30, 2024

TUESDAY JULY 30 2024	EVENT	AUTHORS/ PRESENTERS	LOCATION
11:00 - 12:00PM	**Full Papers V: Professional Development and Skill Building**		
	Gender and First-Generation Status Impacts on the Perceived Importance of Technical and Non-Technical Skills for Upper-Level Undergraduate Engineering and Computer Science Courses	Carter Hulcher	ISEC 138
	A new procedural laboratory to demonstrate tool utilization for first-year engineering students	Raymond Brooks	
	Full Papers VI: Tools for Learning and Engagement		ISEC 140
	Exploring Instructors Insight' to a MATLAB Code Critiquer	Laura Albrant	
	A Cloud-Based Approach to Introducing Machine Learning in Project-Based Learning Environments	Joshua Stone	
	Integration of Digital Tools and Technologies in First-Year Engineering Courses	Kapil Gangwar	
	Supporting Students' Educational Robotics Experiences through Generative AI Chatbots	Ethan Danahy	
12:00 - 12:15PM	Transition Break		
12:15 - 12:45PM	Rapporteurs Presentations, Awards Closing Remarks		ISEC 102 Auditorium
12:45 - 1:30PM	Boxed lunches		ISEC Atrium
1:30 - 2:30PM	First-Year Administrators Community of Practice		ISEC 136

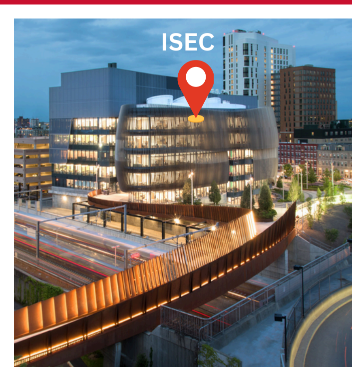
Northeastern University

CAMPUS MAP



Location: ISEC Building, Northeastern University
Address: 805 Columbus Ave, Boston, MA, 02120

The Interdisciplinary Science & Engineering Complex (ISEC) Building is located on Columbus Avenue on the East side of Campus. It is easily accessible from Columbus Ave or the pedestrian bridge which connects the east and west sides of campus.



Pedestrian Bridge

FYEE 2024 KEYNOTE SPEAKER

Dr. Michael Sweet

Director, Center for Advancing Teaching and Learning through Research (CATLR)

Bio: Michael Sweet leads a team that seeks to inspire, equip, and connect educators of all kinds across Northeastern University's 14 campuses as Director of NU's Center for Advancing Teaching and Learning through Research (CATLR).

Michael has led educational development efforts since 1995 at the University of Oregon, Portland Community College, and the University of Texas Austin—he has been at Northeastern University since 2013. With a Ph.D. in educational psychology, his professional and scholarly focus has remained on student learning processes in groups, especially Team-Based Learning.

Dr. Sweet publishes and presents nationally and internationally on team-based learning and critical thinking and served as the 2009-2010 President and 2014-2016 Executive Editor of Publications for the international Team-Based Learning Collaborative. The online resources he developed to support team-based learning and critical thinking instruction and have achieved international adoption.

Abstract: *What do we teach next? Helping students learn for the age of AI.* The seismic shifts that generative AI will bring to our society—and higher education specifically—have only begun. From the outset, Northeastern University has leaned into the reality that AI is here to stay and that we should be encouraging our faculty and students to learn about and use it. Where will the changes driven by AI take us? No one can say for sure. What we can do is stay discussion with one another about what we want to students to learn as they (1) engage with AI around our content, (2) analyze what it produces, and (3) communicate what they have learned. In this keynote discussion, we will share lessons, insights, and questions as we confront together the challenges that AI presents to us all.

FYEE 2024 KEYNOTE SPEAKER

Ernst Vanbergeijk, Ph.D., M.S.W

Senior Director of Local Educational Agencies
President and Founder Ernst Equitable Education Services

Bio: Dr. VanBergeijk has 35 years' experience in the special education and social service fields. As a social worker, he has conducted special education evaluations, designed individualized education programs, crafted behavioral treatment plans, and provided counseling, advocacy, and crisis intervention for students. He also has developed and implemented parent training curricula. Dr. VanBergeijk has conducted NIH funded research on the impact Asperger Syndrome has on family functioning while working as a research associate at the Yale Child Study Center in the Autism Clinic. His current research and practice interests are in the area of transitioning higher functioning individuals on the autism spectrum to postsecondary educational settings, independent living, and the world of work. For over a decade he served as the Associate Dean and Executive Director of New York Institute of Technology Vocational Independence Program. Following his tenure at NYIT, Dr. VanBergeijk was a Professor and Director of Lesley University Threshold Program which is the nation's oldest comprehensive transition program for students with a variety of disabilities. Dr. VanBergeijk is also a field editor for the Encyclopedia of Autism and a peer reviewer for the Journal of Autism and Developmental Disorders among other publications. Currently, he is Senior Director of Local Educational Agencies for Elwyn the nations oldest and largest social services agency, and the founder and president of Ernst Equitable Education Solutions, a consulting firm which specializes in helping individuals, families, and organizations to maximize the independence and employability of individuals with Intellectual and Developmental Disabilities (ID/DD). He holds a Doctor of Philosophy in social work from Columbia University, and a Master of Social Work and bachelor's degree in psychology from the University of Michigan.

Abstract: As educators in the postsecondary environment, we often are faced with students with invisible disabilities. Some are undiagnosed. Others suffer from "short bus fatigue" and refuse to identify as a person with a disability. Consequently, they do not register with the office of disabilities and do not receive reasonable accommodations under the Americans with Disabilities Act (ADA). We witness their struggles firsthand, and frequently see these students spiral into a crisis at their first semester's midterms and finals. The focus of this talk is what is neurodiversity? What can we do as educators to address the deficits these students possess? What can we alter in the classroom and in cooperative learning to embrace universal design concepts thereby creating equal access for all students. A neurodiversity mindset celebrates the strengths these students bring to the classroom and the world of work. Topics covered will include types of invisible disabilities in the classroom, commonalities across these disabilities, the medical model of disability versus a neurodiversity model, prevalence of the most common disorders, outcomes for this population, examples of neurodivergent thinkers, and creating opportunities for growth using empirically based interventions in and out of the classroom for all students.

SUNDAY, JULY 28, 2024. 2:00 PM – 3:30PM

Workshop I	
Sponsored Workshop by EMIFY **Entrepreneurial Mindset in the First-Year: Socializing a Body of Knowledge**	Kaitlin Mallouk Blake Hylton Krista Kecskemety Jack Bringardner
Few components of the engineering curriculum have as much opportunity to impact engineering students as first-year engineering programs. These programs typically serve all engineering students, and act as students' introduction to engineering culture while setting the foundation for skills, mindsets, and habits that students need throughout their engineering education. Integrating Entrepreneurial Mindset into first-year programs is a clear mechanism for developing entrepreneurially-minded engineering graduates. To realize this impact, first-year engineering educators must understand and embrace the connection between traditional first-year engineering curriculum and EM.The EM in the First-Year (EMIFY) team has been working to 1) Build consensus about the impact EM can have in first-year engineering program and 2) Develop and provide resources to faculty who teach in the first-year. In this workshop, we will share a framework of EM in first-year engineering that was co-developed by representatives from 19 diverse institutions and engage attendees in identifying opportunities in their own first year programs to support students' development of an entrepreneurial mindset. In this workshop, we will introduce the EMIFY Body of Knowledge and tools for sharing activities and classroom content via EngineeringUnleashed.com - a forum for sharing practical pedagogical ideas for incorporating the entrepreneurial mindset in engineering education. Over the course of the workshop, participants will develop an EngineeringUnleashed.com card to share a project, activity or other content from their first-year engineering course or program.	
Engineering First Year Advising Best Practices	Lisa Lampe Esther Tian
The purpose of this workshop is to disseminate best practices in First Year Advising and create a community of interested change agents. This two-hour session will empower administrators, first year instructors, Diversity, Equity and Inclusion staff, and advisors with information and practices to affect improvements to academic advising and to collect data to examine improvements on their campus. The format will include a presentation followed by multiple activities to engage participants in thoughtful reflection and planning to take ideas back to their campus. The presentation will include advising standards, re-sources, and recommendations. We do not expect any extra expenses and do not plan on charging for tickets for this session. Learning goals: Attendees will be able to name 2 best practices within Academic Advising that are feasible to imple-ment in their program. We will review National Academic Advising (NACADA) definitions of academic advising, advising val-ues, and resources. We will also cover some terminology and most cited literature on Advising Structures, and how academic advising should be seen as teaching [1]. We will also review the Academic Advising Handbook to help participants understand Student Learning Outcomes (SLOs) and recommended assessment practices [2].	
Design Signatures in the Wild: Making the Invisible Visible (in First Year Engineering)	Nicole Batrouny Daria Kotys-Schwartz Micah Lande
In addition to learning about and experiencing the engineering design process, a learning outcome of most first year engineering programs is to develop students' awareness of the design process itself. This can be difficult since engi-neering students, especially novices, often focus on the design deliverables as tasks rather than artifacts of an ongoing process. This workshop engages with the question: How might we help students become better able to intentionally engage in a design process, as part of an effort to help them become reflective practitioners [1] of design? One answer to this question revolves around the idea of "Design Signatures" [2], both a concept and a tool for representing and reflecting on a design process. The group of design educators leading this workshop have experience using Design Signatures to teach undergraduate engineering students across a diverse set of institutions about design processes, from first-year students to graduate students. We have used Design Signatures in a variety of ways ranging from short, in-class activities to longer ef-forts where seniors track their capstone projects. We have collected signatures using paper-and-pencil bubble sheets, Google forms, spreadsheets, and a newly-developed Design Signatures app. In each implementation students have had great "aha" moments about the design process and themselves as designers..The intent of this workshop is to teach participants how to build self-awareness for their students and themselves through self-tracked design timelines (Design Signatures). With these Design Signatures visible in front of them, students and faculty can better reflect on an otherwise invisible design process. Over the course of this 90 minute workshop, participants will explore the idea of Design Signatures from different perspectives. First, we will put on our "researcher hats" to trace the development of this idea through a long history of design education research. Next, participants will put on their "designer hats" to experience what it's like to track the design process using tools developed by the presenters. Finally, participants will put on their "design educator" hats to think about how the concept of Design Signatures and the associated tools and strategies could be implemented in their own first year context.	

SUNDAY, JULY 28, 2024. 3:45 PM – 5:15 PM

Workshop II		
Post-Pandemic Pedagogical Pivots: Mental Health, AI, and Zoom Zombification in Engineering Education		Susan Freeman Rich Whalen Kathryn Schulte-Grahame Jennifer Love Angelina Jay
We survived teaching during a pandemic and all the challenges that it brought. We pivoted so many times, we were dizzy. When we got back into our classrooms, we embraced some great things that the pandemic brought, new technologies, new platforms, some new approaches. So, what is going on? We are facing students and faculty with increasing mental health challenges. We realize that in many ways we need our approaches, classrooms, and words to be more inclusive. There is an increasing encroachment of generative AI and suddenly the internet seems less friendly. How students learn or try to acquire information and knowledge may not equip them to be good engineers. Students seem to prefer a more passive style of learning, from recordings or on Zoom, but are they engaged and retaining this knowledge. Does any of this resonate with you? So, what to do? - What changed? - How to be an inclusive teacher? - What am I missing about student's identities? - What about my neurodiverse students? - Are my students using AI or ChatGPT? - What do I change to deal with generative AI? Our first-year students were 9th graders in Spring 2020. These are post-pandemic students, they seem different –how do I engage them? - They are not coming to class, not interested in things, what do I do? Is it me? - What tools should we be using? - Courses and conferences – ISTP, Neurodiverse conference, ASEE workshops - Books – new ones. We need to learn about using AI: - Change courses - more projects? New ideas and approaches? - What about the students? - Have they changed? - How do we reach them? - What works for them? What doesn't? There are a lot of questions. This workshop aims to bring information from faculty that have participated in the Inclusive STEM Teaching Project, and other resources about changes being made in first year classes. There is also data on student use of AI and trying out new approaches, what is working and what is not. This workshop will discuss connecting with students in different ways. Are there ways to assess students' mental health? Discussing new models and methods of teaching and assessing student learning that help move us in a new direction. One part of this workshop will present some lessons learned on Inclusive design for teaching and inclusive teaching practices. Then participants will spend time working on what practical things they can adopt or adapt for their classrooms. The next section will be on approaches for adapting to generative AI. What are recommended practices? Looking at ways to adapt our teaching to embrace and work around the problems of things like ChatGPT. What can be adaptations for classroom practice? Another section approaches the fact that the mental health of our students is a concern. There are tests for assessing student mental health, for example from the University of Miami - Mental health screening. Just giving them resources may not be enough, what more can, or should we be doing? What do the experts that teach courses on Well-being say? Lastly, how do we engage this Zoom group? Project-based courses bring in much active learning. Are there more active learning approaches we need to use? Refreshing and refurbishing our active and engaged learning toolboxes, what works now? What has always worked. Are they unmotivated? The MUSIC model for motivation may provide some insights MUSIC model. This will be an interactive workshop. One outcome is that participants will discover that some parts of what they are doing is on target for student learning already. In all areas of exploration, the workshop is intended to provide participants with practical approaches, food for thought, and reassurance that we are all on a new path towards teaching and learning.		
Social Identity- Back to Basics		Samantha Kennedy
First year students arrive at our schools with vastly different levels of exposure to – and fluency in – the core concepts of diversity, equity, and inclusion education. When the Curriculum Committee for our First Year Experience course began developing a lesson to ground our STEM students in these concepts, we faced a big question. How can we meet each member of a diverse student body where they are while also fostering their growth? As a predominantly white institution, we wanted to challenge our students to reflect on their own identities and how that ties them to other students in the college. We designed a lesson that focused on individuals' social identities and how those identities affect their comfort levels in different scenarios, then used guided reflection to connect this mindset to other course lessons. This allowed our students to then tackle more complex topics such as implicit bias, structural racism, and how to be social justice accomplices – while also creating space for marginalized students to explore these issues in new ways. As this lesson has evolved over the past few years, we have been especially focused on preparing our instructors to guide this work in ways that does not require BIPOC students to take on additional work in educating their peers. This initiative required collegiate buy-in, educating 40+ instructors, and ultimately implementing these activities for 1600+ first year STEM students each fall. By taking it "back to basics", we create an opportunity for attendees to play with the building blocks themselves and discuss their own experiences in the classroom. I will demonstrate two classroom activities that will challenge participants to reflect on their own identities and how to grow beyond their comfort zones.		

WORKSHOPS

SUNDAY, JULY 28, 2024. 3:45 PM – 5:15 PM

Workshop II		
Leveraging Different Scales of Course Feedback for Enhanced Student Learning and Growth		Benjamin Goldschneider Shaylin Williams Esther Tian

This workshop explores how various modes and methods of feedback support facets of student development and, when used in concert, support holistic growth. This workshop will support first-year instructors, administrators, career development staff, and academic advisors in shaping the way they collect, process, and apply student feedback in pursuit of helping their students grow. This 90-minute session will be comprised of four interwoven explorations of distinct kinds of feedback implemented in a large public Mid-Atlantic university's First Year Engineering (FYE) program, followed by a conversation under-lining how they work in tandem with one another. The mini sessions will vary in presentation, but will all provide background information alongside examples of how the feedback was collected and applied to support student devel-opment. The mini sessions will be sequential, and all workshop participants will go through them together.Attendees will be able to identify and explain how four provided kinds of feedback–a full-year pre- and post-survey, career reflection assignments, module reflection assignments, and exit surveys–support different aspects of students' growth. Furthermore, attendees will be able to extrapolate from the provided feedback methods to design their own means to effectively target and support specific facets of students' development.

Panel I (5:30 PM - 6:30 PM)	
Rethinking First-Year Engineering: Management, Collaboration, and Curriculum Alignment	Cory Budischak Haritha Malladi Brian O'Connell

Many conversations focus on the pedagogy and learning objectives of first-year engineering courses, but just as important is how these courses are managed. This this panel discussion, we would like to discuss and generate a conversation in the community around the main question: What would the ideal management structure for a first-year engineering program look like? Things to consider are:
1) How should the first year be systematically improved and what feedback mechanisms should be employed? What stakeholders should be consulted (math/science/engineering faculty, academic advisors, student life/housing, etc.)?
2) Should the courses be run by a certain department or some other administrative structure? If other, what should it look like?
3) Should students be strategically enrolled in sections somehow (i.e. by math course, living learning community, other ways?)?
4) How should instructors be chosen for these courses? Should instructors be hired to teach in the first year specifically? What other responsibilities, if any, should these faculty have for the first-year experience?

MONDAY, JULY 29, 2024. 9:15 AM – 10:00AM

Work in Progress I: Enhancing First-Year Engineering Education and Practical Skills	
Activity Centric Online Teaching and Learning with MATLAB	Lynn Albers
The first-year engineering program at this university consists of a computer programming for engineers course, and a two-semester sequence of engineering design. Before the fall of 2018, the computer programming for engineers course covered algorithms, logic, flowcharting and programming of solutions to engineering problems through the MATLAB environment. A redesign of the course began in the Fall of 2018 to add Excel and math instruction. This new, activity centric model has been created for both first-year engineering students at the university and high school seniors. The course continues to evolve into an entirely activity-centric course building Excel, math, and programming skills through purely active learning. The author recently teamed with MathWorks® to begin the process of converting the lectures to MATLAB livescripts and the homeworks to MATLAB grader. This work-in-progress paper documents the collaboration, development, im-plementation, and lessons learned during this process. The resources were piloted during the Fall 2023 semester in two sections of the course with 21 and 23 students respectively, modified, and are currently being piloted with 30 students in the Spring 2024 semester. Students provide feedback by completing minute papers at the end of each lecture. They will complete three surveys at the end of the semester. Data will be incorporated into the draft paper.	
Micro-Credentialing for the First Year: Creating a Digital Badge for Engineering Information Literacy	Paul McMonigle Denise Amanda Wetzel Sara Kern
This Works-in-Progress Paper focuses on a micro-credentialing project through the creation of a digital badge for first year engineering students to teach basic research and information literacy skills. At the authors' university, all engineering students are required to take a first-year design course. Historically, engineering librarians approach in-formation literacy skill introductions through in-class instructional sessions, affectionately termed, "one-shots." The authors teach an average of 40 sections each semester, making it difficult to reach every class with the current libraries staffing model. This leaves some students at a disadvantage, lacking foundational research skills in their first year and requiring librarians to cover this basic material in some upper-level courses, in lieu of more advanced topics. This paper shares progress on a micro-credentialing project underway to asynchronously teach engineering first year students basic research and information literacy skills. With the assistance of their College of Engineering's education center and office of digital learning, the authors received a grant to develop an asynchronous digital badge designed to both replace the previous in-class instruction and complement regular engineering coursework. This badge allows all students in all first-year design courses to receive the same instruction. The authors share lessons learned while creating and designing of a digital badge in course management software. They also look toward future testing and implementation during the 2024-2025 academic year.	
Online Modules to Develop Upper-classmen Mentors for a First-Year Biomedical Engineering Course	Gyeongtae Sun Moon Eileen Haase Gyeongtae Sun Moon Meera R. Bhat
First-year biomedical engineering (BME) students take the introductory course, Biomedical Engineering and Design (BMED), and are mentored by lab managers who are enrolled in The Effective Teaching and Management of En-gineering Teams (ETMET) course. These lab managers are integral to the success of first-year students, as BMED is a team-based, flipped, active-learning course. Upperclassmen lab managers provide crucial support and guidance to first-year students to enhance their engineering experience. The lab managers are the first-year students' first-line resource on how to obtain and analyze data, present information in written reports and oral presentations, and divide group projects into manageable tasks to meet deadlines. Thus, the topics of conflict management, design of assess-ments, ethics, group development, peer review, public speaking, and technical communication are essential for lab managers to be successful mentors. We created seven three-to-five-minute videos to teach ETMET students about each of the previously mentioned top-ics throughout the semester and plan to test their efficacy next fall. We will first administer a baseline quiz at the beginning of the semester and then an end-of-semester quiz to assess the lab managers' understanding of the topics presented. We will follow up with a post-semester survey with two to three questions for each module. Students will rank their confidence using a Likert scale of 1-5, with 1 representing "Strongly Disagree" and 5 representing "Strongly Agree." Differences between pre- and post-modules will be assessed with Wilcoxon paired t-tests. Based on the data analysis and survey results, we can assess if these modules aided ETMET students in being better mentors to students in BMED and provided the necessary skills to navigate their engineering education as members of future engineering teams. Moreover, we will obtain feedback from the first-year students at the end of the semester to gauge the lab man-ager's effectiveness. This feedback will serve as a valuable indicator for identifying areas of improvement to enhance first-year experience in the future.	

MONDAY, JULY 29, 2024. 9:15 AM – 10:00AM

Survey Validation to Enable Investigating Community Cultural Wealth in Engineering Students' First Year Experiences (FYE)	Adetoun Yeaman Xiaojing Yuan Gisella Lamas-Samanamud Heather Beem Janie M Moore Randi Sims

Teamwork is an integral part of engineering and engineering identity. It is essential for engineering students going through their first year experience (FYE) to be exposed to teamwork as well as learn and practice skills of highly effective collaboration. Aspects of teamwork, including the social and navigational capital each team member brings, as informed by the assets-based theory of community cultural wealth, have the potential to affect interpersonal aspects of students' learning experiences and the forming of their engineering identity. Studies show that students with strong engineering identities tend to persist and graduate with engineering degrees in a timely manner. Social capital deals with support provided by various networks of relationships while navigational capital relates to one's ability to maneu-ver through social and professional situations. Both forms of capital provide support for students beyond the typical academic achievements normally emphasized in university settings. The purpose of this study is to investigate the social and navigational capital of first year engineering students from the lens of the entrepreneurial mindset (EM). Particularly, this paper focuses on two research questions: RQ1: To what extent does student social capital relate to the three EM components of curiosity, connection, and value creation? RQ2: To what extent does student navigational capital relate to the three EM components of curiosity, connection, and value creation? EM has been shown in the literature to have a solid direct connection with student success. We hypothesize that it has potential to catalyze engineering identity formation through the FYE. This study utilizes a concurrent triangula-tion mixed-methods approach with a quantitative priority. Data will be collected via a mixed closed and open-ended questionnaire deployed across five academic institutions with approximately 250 respondents (50 per institution). Comparison between institutions will reveal deeper understanding of the commonalities between the engineering ed-ucation practices in different institutions, their students' distinct learning experiences, and progress toward timely graduation with an engineering degree. The findings from the study will also provide insights into the connections between cultural wealth and student embod-iment of an entrepreneurial mindset in forming engineering identity. Broad impacts from this study include informing engineering education researchers and practitioners on types of interventions needed to catalyze engineering identity formation in various unique institutional contexts. The insights gained from the study will also support the design and development of such interventions beyond students' FYE in their engineering curriculum and promote their timely graduation with Bachelor's degrees.

Increasing Maker Space Participation through First-Year Engineering	Kurt Rhoads Kathleen A Harper Michael William Butler

We added an additional component to a design module in the First-Year Engineering course at X university with the goals of increasing student participation, expanding the options for student innovation, and increasing the opportuni-ties to utilize the campus maker space. The previous design module asked students to design and manufacture "whegs", or wheel-legs that are attached to remote controlled cars and act like wheels on flat ground but have spokes for climbing obstacles. In teams of four, students worked over six weeks to find a biological inspiration for their designs, test prototypes, sketch their designs in SolidWorks, 3D print, and make modifications. During the last week of class, students competed to traverse an obstacle course using their final whegs. While students rated this module as their favorite, there was often unequal participation among group members because most of the design work can be completed by one or two individuals. Working in close collaboration with our maker space staff, we changed the module by asking students to add an "adventurer" component that collects rings along the obstacle course. The adventurer attaches to the car chassis, above the whegs, and can be made from cardboard, plywood, or acrylic. Students cannot 3D print the adventurer, and instead must use an additional manufacturing method available at the First-Year Engineering Lab or maker space, such as laser cutting, traditional woodworking, or milling. Adding the adventurer component increased individual participation on teams, increased the number of manufac-turing techniques used by students, and added an exciting challenge during the obstacle course. In the future, we will analyze maker space utilization data to determine which resources were most used by students and whether this activity increased student maker space utilization outside of the First-Year Engineering course.

Pilot of Block Model Delivery of First-Year Engineering	Jeffrey Harris

York University's Lassonde School of Engineering, in collaboration with the Faculty of Science, is piloting a transfor-mative block model for delivering first-year engineering curricula. Inspired by the "VU Block" at Victoria University in Melbourne, Australia, this innovative approach aims to enhance student success and retention. The block model was first piloted during the first semester in fall 2023. Students who opted-in experienced a modular structure, blended course delivery, and active learning strategies. The modular structure consisted of one course that spanned the entire term and four courses taught sequentially in intensive 3.5-week blocks. The modular approach allowed students to concentrate on two subjects at a time, reducing the cognitive load and deadline management challenges. This structure also mitigates the stress of overlapping midterms and end-of-term assignment surges. All courses were taught using a blended delivery model that combined asynchronous online learning with in-person in-struction, balancing connectedness with flexibility. This format allowed for a student timetable with three days per week on campus, accommodating students' work and family commitments while reducing time spent commuting. In fall 2023, the block model pilot was offered in parallel with traditional program delivery, allowing for analysis of the block model's effectiveness. Initial data show that the block model has promise: student success rates (i.e. the percentage of students earning C+ or higher) were higher in the block model than in the traditional delivery model, and failure rates were lower. Discussions in student focus groups and faculty reflections were mostly positive, with some opportunities for improvement identified. Plans are in place to track the performance of students as they matriculate into their second-semester and sophomore year. This pilot will be repeated in fall 2024, allowing for more data collection and analysis. The outcomes of this pi-lot will inform an ongoing first-year engineering curriculum redesign at York University. This initiative represents a significant step towards a more focused, supportive, and flexible engineering education.

MONDAY, JULY 29, 2024. 9:15 AM – 10:00AM

Hands-on Activities to Improve Student Engagement and Learning in an Introductory Programming Course	Carter Hulcher Todd R Hamrick Lizzie Santiago Michael Keith Brewster
Computer programming has become an in-demand skill, even for those positions that are not directly involved in Computer Science. In general, students enter introductory programming courses from a variety of backgrounds and programming experience levels. Their backgrounds and prior experiences can influence how they perceive program-ming activities in the classroom. This paper summarizes the preliminary results of a mixed-method approach in which a survey is administered to students enrolled in an introductory engineering programming course at a public, 4-year university in the Mid-Atlantic region of the United States. Prior to these activities being developed, the course was taught with students completing programming work with no hands-on component. The pre- and post- surveys collected students' opinions on questions related to confidence, interest, knowledge, and understanding of programming concepts and applications before and after experiencing three different hands-on activities in the programming course. These hands-on activities also require students to program in a new language. This research aims to investigate the following questions: (1) how do hands-on activities influence students' inter-est in computer programming, (2) do hands-on activities influence students' understanding of specifically targeted programming concepts, (3) how does a students' prior knowledge and demographic influence their understanding, interest, and confidence in programming before and after experiencing hands-on applications of programming, and (4) does a students' interest, confidence, and understanding in translating code into a different programming language change after experiencing these hands-on programming activities? All hands-on activities have been developed and include a home security system, an object sorter based on color, and an obstacle avoiding robot. Information is cur-rently being collected and will continue in future semesters. These hands-on activities could be used by institutions to improve student engagement and learning in computer programming courses.	
Energy Sustainability for First-Year Engineering Students- Exploring Renewable Energy Production through Hands-on Activities	Mohammad Heshmati Bill B Elmore
Project-based, experiential learning (PBL) facilitates learning through hands-on projects, and when appropriately planned, it fosters the development of collaboration, communication, safety awareness, and critical thinking skills, as well. At Mississippi State University, the Introduction to Chemical and Petroleum Engineering and the Analysis courses are delivered in the fall and spring semesters of the first academic year, respectively. These courses are examples of, a) addition of hands-on projects (Introduction to Chemical and Petroleum Engineering) and, b) transformation of a completely lecture-based offering to a mostly PBL-based experience over the span of several years (the Analysis course). This transformation is closely following the guidelines and criteria established by the Accreditation Board for Engineering and Technology (ABET) and High-Quality Problem-Based Learning Organization (HQPBL). According to HQPBL, a successful PBL experience must include these characteristics: "Intellectual Challenges and Accomplishments", "Authenticity", "Public Product", "Collaboration", "Project Management", and "Reflection". In this manuscript, our primary focus lies on "Authenticity", emphasizing the significance of projects that generate tangible benefits for individuals and communities beyond the educational environments of classroom and school. While fossil fuels have historically played a pivotal role in technological advancement and enhancing human livelihoods, their irresponsible use poses drawbacks. To address these challenges, alongside stricter regulations, alternative energy sources have emerged. These sources include wind, solar, geothermal, nuclear, CO_2 conversion to fuel, hydropower, ocean energy, bioenergy, and others. These developments offer potential solutions to mitigate the environmental impact of fossil fuels on climate change and global warming. However, the new energy sources, although deemed clean and sustainable, have their own sets of drawbacks which are to be considered for realistic planning and investment purposes. Energy has immediate real-life impact on people and communities outside school; therefore, it clearly meets HQPBL's "authenticity" criteria. At Mississippi State University, for the two courses that are mentioned above, we designed hands-on experiential projects that are focused on energy production, and more specifically, sustainable energy pro-duction (wind, solar, and geothermal energy projects). In addition, we have designed an experimental module for ambient CO_2 capture. Our objective is to fulfill all necessary ABET and HQPBL criteria, while acquainting students with the benefits and drawbacks of various energy sources. Each energy production project requires students to refine their designs and conduct efficiency analysis for comparative purposes. We are continuously expanding our collection of projects directly tied to energy production and aim to develop a comprehensive portfolio in the near future.	

MONDAY, JULY 29, 2024. 9:15 AM – 10:00AM

Work in Progress II: Promoting Inclusivity, Mentorship, and Feedback

Get Them to Tell You What Works: Exit Surveys for Formative Feedback	Michelle Soledad Natalie C.T. Van Tyne Benjamin Daniel Chambers

First-year engineering students find it valuable to share their perspectives on what will make their learning experiences fruitful by having their voices heard about what works for them. Faculty would like to know more about students' needs by receiving feedback and responding accordingly. This two-way exchange facilitates student input into course planning, both in real time and retrospectively. However, this can be challenging to accomplish, particularly with relatively large class sizes. The answer to addressing all students' needs lies in the practice of formative assessment. Implementing a formative feedback process has also been documented to increase student motivation and engagement by providing empowerment and caring according to Jones' MUSIC model. Exit Surveys have been shown as easily accessible opportunities for students to reflect upon their learning process and share these reflections with their instructor. Our surveys are administered periodically, either after every class, at the end of the week, or at key touch points and milestones in the course. These surveys contain prompts about what was covered in class, the learning strategies that students use to master college-level course material, students' perspectives about their learning experiences in the course at that point of the semester, and suggestions for how their learning experiences can be supported further. We also include a sprinkling of topics intended to engage students as real people in addition to being students, such as, ”What's new? or ”What's exciting? or ”What's bothering you?” as part of a single prompt. In addition to providing feedback about student learning in real time, certain prompts in the exit surveys promote reflection for metacognition, particularly when students are prompted to reflect upon and evaluate their own learning processes and strategies.Some surveys are assigned for participation credit to encourage greater participation and feedback. Instructors present a summary of the results after the end of each survey period and are careful to note students' suggestions for course improvement that either have been or will be implemented in real time or during the next term. By giving them a voice in how the course is conducted, instructors impart empowerment, and demonstrate caring because instructors not only seek areas for course improvement, but care about students' well-being and success. For example, we often ask students to identify how difficult a particular unit was for them, or its most important ele-ments, to reinforce their learning. Specific suggestions for how to improve the course have included feasible changes to grading scales, more hands-on activities during class, and more class time to discuss ideas and issues with their design teams. All these suggestions have been easy to implement in real time, leading to greater student engagement and continuous course improvement resulting from implementing formative feedback and assessment.

Integrating DEIBJ and Inclusive Design Concepts in an Introductory Engineering Course Using Stand-alone Modules	Ashish Borgaonkar Lucie Tchouassi Jaskirat Sodhi

This work-in-progress paper explores implementing a stand-alone, multi-week module focused on Diversity-Equity-Inclusion-Belonging-Justice (DEIBJ) Inclusive Design (ID) considerations in engineering practice. DEIBJ are key elements of any society. The engineering practice with an immediate and direct impact on society needs to embrace DEIBJ elements in the form of general consideration as well as inclusive design practices in all aspects - from concep-tualization to design to implementation. Although, most engineering colleges and higher education institutions offer courses in engineering ethics and lately on sustainability and sustainable practices, there is a lack of consistent adop-tion of DEIBJ-focused courses. The authors feel that it is important to embed these concepts in multiple engineering and general education courses across the four-year degree curriculum. Still, it is even more important to start with an introduction to engineering or engineering design course. 100-level engineering courses are often students' first real exposure to engineering, engineering design, and the engineering profession. Integrating DEIBJ and ID concepts in such courses will make them part of students' natural thought processes and will have a profound and lasting impact on their engineering careers. This WIP paper will present a dedicated DEIBJ and ID module that the authors plan to implement in an interdisciplinary engineering design introductory course. The module will be designed to run over 3-4 weeks where students will get exposed to DEIBJ and ID concepts through their background as well as case studies for successful implementation in prominent engineering projects. The module will also engage students in discussions and activities that rely on active learning-based practices. Students will form groups to critically analyze an engineering project or product and present their findings to the entire class in short group presentations. The authors are looking to present this idea to get feedback to further improve the implementation aspect as well as to form a plan to assess learning outcomes and the effectiveness of the module.

Cultivating Relationships with Clients in the Community: Enhancing the First-Year Student Experience	Rebecca Krylow

Although there may be an interest in developing partnerships with community-based clients, the ”how” can feel ob-scure, cumbersome, and a bit overwhelming. ”How would we identify the gains for the client? For our students?”; ”We are a small staff and don't have the time to set up meetings to explain our course”; or ”First-year engineering students don't have the skills yet to build something useful for a client” are a few examples of concerns that faculty and administration might have. Moreover, it may be assumed that community partners would be uninterested in working with first-year engineering students. In contrast, our team has found the community to be very interested in partnering with our first-year engineering design course to bring authentic projects to our first-year students. At Duke University, Introduction to Engineering Design and Communication (EGR 101) hosts approximately 70 client-based projects each fall semester. To meet this need, our team approaches identifying clients and the subsequent communication as a year-round process. With this approach, we identify projects from a wide range of partners such as: Chapel Hill Public Library; Duke Cancer Center; Garmin; Durham Public Schools; and the North Carolina Zoo. Tips, tricks, and lessons learned from building client relationships in the Durham, NC and Duke University com-munities will be shared. Data from three years of a focused effort to build a wide-ranging client database will be shared. For example, >70% of clients who responded to our survey said they would like to return as clients the following fall semester. And >90% of clients were satisfied with the frequency of communication with their as-signed student team(s). The value of audience-centered speaking will be detailed, and examples of multiples modes of communication (emails, surveys, recruitment flyers, etc.) will also be referenced. This presentation will share how the infusion of client-based projects into EGR 101 has enhanced the student experience, the needs for the clients, and the learning outcomes for the course.

MONDAY, JULY 29, 2024. 9:15 AM – 10:00AM

Fostering the Development of Engineering Identity in First-Year Women Engineering Students Through First-Year Seminars	Angelika Tamura Tiffany Marie Chan Xianglong Wang
Despite strides in gender equity efforts, women continue to exit engineering majors at a higher rate than men, per-petuating gender disparities in the field. To address this issue, we developed a first-year seminar on Gender and Engineering Identity with a focus on women either in engineering majors or intending to work in engineering in the future. The choice of developing this course as a first-year seminar is based on research findings that the mentorship is more effective if provided early. This seminar aims to educate students on gender-related challenges in engineering while improving their self-efficacy and cultivating their engineering identity. The seminar will expose students to the complexities of gender inequity and chilly climates for women in both in-dustry and academia, mainly through discussion around four industrial and academic reports, as well as two case studies in a flipped format. Interactive lunches and panels with other students, staff, and faculty members will provide opportunities for students to engage in open dialogue and gain diverse perspectives from those familiar with the current state of the field. Weekly student reflections culminating in a final paper will facilitate deeper engagement with the material and help students to gauge their development throughout the course. At the beginning and end of the course, eligible and participating students will complete validated surveys in per-sistence, self-efficacy, engineering identity, and knowledge of gender equity to assess changes in their confidence levels and self-efficacy regarding navigating challenging situations in the field, understanding of principles in gender equity, and confidence in pursuing engineering as a career. Additionally, supplementary interviews will be conducted to delve deeper into the nuanced impacts of the course on students and to help shape the next version of the first-year seminar. We expect to report some preliminary results before the final paper deadline.	
Piloting a Human-Centered-Design Software Innovation Course for First-Year Engineering & Business Students	James Toney James Edward Toney Kristina Kennedy Julie Rose Cupka Roger Allen Bailey
Our University launched a Software Innovation track within our existing Integrated Business and Engineering Honors Program in 2023. In the Spring 2024 term, we delivered the initial offering of our Fundamentals of Engineering II course for the Software Innovation cohort made up of engineering and business students. The course helps students develop an understanding of the engineering design process within an entrepreneurial context by introducing human-centered design. Using an existing Entrepreneurial Mindset Learning (EML) curriculum as a starting point, the course presents basic concepts of business model generation and conceptual design within a software context. In teams of 4, students engage in a semester-long project in which they choose a problem to solve grounded in research, identify unmet market needs, generate and select design concepts, and create a software prototype. Value creation, business model generation, and price models are emphasized. To foster an interdisciplinary approach, each team consists of a mix of business and engineering majors from various disciplines. All business majors in the program are pursuing an engineering minor, and vice versa. The technical side of the course focuses primarily on high-level design. Teams produce user interface prototypes with a no-code design tool such as Figma and use Unified Modeling Language (UML) diagrams to represent the object-oriented structure and behavior of their application. In the final weeks of the course, students experience a lim-ited version of agile development, in which they create and prioritize a feature backlog and execute a 2-week ”sprint”, implementing and verifying the core functionality of their project in the programming language and platform of their choice. Frequent oral and written communication are emphasized; the largest contributor to the course grade is the quality of the final report. The course culminates in a pitch competition, in which students present their business models and conceptual designs to industry representatives. Since this is a pilot, the teaching team, which consists of faculty and teaching assistants from the College of Busi-ness and the College of Engineering, is focused on continuous improvement. An end-of-course survey will be used to gauge the impact of the course on students’ attitudes and understanding of the software development and business model generation process, through direct and indirect assessments. This feedback will be used to enhance subsequent iterations of the course. Data will be analyzed across demographic categories to ensure equity and inclusion with respect to underrepresented groups.	

WIPS

MONDAY, JULY 29, 2024. 9:15 AM – 10:00AM

How the STEPS Program Enhances the First-Year Experience for Engineering Students	Cory Budischak Shawn Fagan,
The Sustainable Energy and Power Scholars (STEPS) program, funded by the National Science Foundation (NSF) through the S-STEM program, offers scholarships alongside comprehensive curricular and co-curricular support to low-income, high-achieving students. The STEPS program, which admitted its first cohort of scholars in the Fall of 2023., has been designed to provide participants with cohort building activities, exposure to the sustainable energy in-dustry and engineering career professions, and multi-tiered mentoring. Guided by the Social Cognitive Career Theory (SCCT), the program's activities are designed to positively influence the scholars' self-efficacy and outcome expecta-tions in engineering while also fostering a sense of belonging within the engineering program. The research questions include: (1) How might academic and career choice take shape for low-income, high achieving students in the STEPS program? (2) What roles do learning experiences, coupled with robust support programs, play in a low-income, high achieving student's choice behavior and persistence? (3) How do low-income, high achieving students in the STEPS program overcome social and cultural barriers in engineering? This paper will discuss the details of the comprehensive curricular and co-curricular support provided to the schol-ars and present the initial findings and insights from participants' interviews and surveys. The support provided encompasses layered mentorship, participation in industry events, employing scholars in educational workshops and recruitment events, and proactive academic advising. While it's not uncommon for cohort building to prove challeng-ing for some S-STEM programs, the STEPS program has found success with the following strategies: (1) utilizing block scheduling for first-year engineering courses, which includes a 3-credit introductory engineering course and a 1-credit engineering first-year seminar course, to foster cohort building, (2) implementing regularly scheduled group and individual mentor meetings throughout the semester, (3) using targeted academic advising campaigns as a proactive outreach approach, and (4) employing scholars to participate in and develop renewable energy engineering activities for recruitment and educational workshops. To date, based on anecdotal evidence, the initial outcomes of these activi-ties appear positive. The comprehensive collection and analysis of survey and interview data are currently underway, promising more definitive insights in the near future. The preliminary results and observations from this year's ac-tivities will be presented at the conference. The paper will focus on strategies and results relevant to the first-year engineering education community, emphasizing insights gained on effectively supporting students' transition from high school to college.	
Surprises in Student Stress and Academic Support SURVEY	Edward Gatzke Robert Petrulis Rawle D. Sookwah
Engineering and Computing students were surveyed on a variety of topics related to academic progression. Some notable findings include: 1. Students were generally not worried about living away from home or family issues. 2. Students were most concerned about grades and finances. 3. Students most often attended lectures and prepared for class but felt these were least effective of the academic activities. 4. Students rarely sought help from TAs, office hours, or tutoring but felt these could be of medium to high value. 5. Students rarely did extra readings but ranked it most effective overall. These findings have been use to update a summer pre-freshmen early move-in experience targeting first-generation engineering and computing students. Experiences and lessons learned from the summer program will also be described.	

MONDAY, JULY 29, 2024. 10:45 PM – 12:15 PM

Workshop III

Sponsored Workshop by Onshape
CAD Analytics for Responsive Teaching and Education Research

McKenzie Brunelle
Matt Shields

This hands-on workshop will introduce attendees to the features of cloud-native CAD that allow educators and students to collaborate and learn in new ways, and how those same features enable companies to use agile methodologies when developing products.
Whether you've used Onshape for years or you have never touched CAD, this session will provide opportunities to learn, collaborate, and share. Following a brief introduction, participants will be provided with starter models and given the opportunity to complete small design challenges with the support of the facilitators. We will then show the types of data generated throughout the workshop and demonstrate how it might be used by educators for responsive teaching or understanding student learning.
The workshop will conclude with demonstrations of how Onshape's cloud-native architecture is changing the CAD industry and how you can prepare your students for the future of product development.

Problem Framing Canvases for Client-Centered Service Learning Design Projects

Todd France
Blake Hylton
Abigail Clark

Authentic design experiences have long been viewed as a critical element in engaging students and exposing them to the realities of engineering and design. Authentic design experiences that leverage a real-world client are particularly sought after. However, these experiences present logistical challenges and are resource intensive to implement, espe-cially at scale. This becomes particularly true in the first-year engineering space, where both scale and student design maturity can present barriers to providing clients with meaningful results. A series of problem framing design canvases have been developed over several years to help guide novice design-ers through opportunity recognition and problem framing processes. This work has been funded by the National Science Foundation, the Kern Family Foundation, and internal institutional support. Facilitators will present the service-oriented, client-based design project supported by the canvases while providing attendees the opportunity to experience using the canvases as they begin to design or redesign a project for their own course or program. The presented example project is completed in a multidisciplinary course by roughly 200 first-year engineering students. The workshop will detail how the project is structured, how clients are identified and engaged, and how the canvases enable students to critically assess their decisions as they move through initial stages of their project.

Fostering Student Identities as Sustainability Changemakers: Entrepreneurial Mindsets and Tools for Change

Caitrin Lynch
Joanne Pratt

This workshop introduces participants to tools used in Products & Markets (P&M), a required entrepreneur-ship class for first-year students at Olin College of Engineering. The course, which has run for 10 years, introduces students to an entrepreneurial mindset. We have recently oriented the class around the United Nations Sustainable Development Goals, in order to foster the creation among our students of Identities as "Sustainability Changemakers. Olin's Strategic Plan (2022-2027) orients the college around sustainability. The implementation framework (referred to as the "college as a living lab" for "human and planetary health") is an initiative that connects the college's cur-riculum, operations, and community to create innovative education and research models that create engaging learning experiences while addressing real-world sustainability challenges. This workshop aims to guide participants through student experiences that support the transformation of identities of students and faculty alike as we grapple with the role of engineers in shaping a more sustainable society. The delivery of the workshop is divided into three parts: Ideation, Experimentation, and Reflection. In the first part (30 minutes), we conduct an ideation activity in which participants generate ideas on sticky notes (one idea per note). We invite participants to respond to the following prompts: Create a "bug" list (things that bother you). What are roses (positives or opportunities) and thorns (annoyances, areas for improvement) related to a particular topic (e.g., your kitchen, traveling to this event, your office, teaching a first-year course)? What are you curious/passionate about? Participants ideate individually for several minutes, share in pairs or small groups, then select one idea to explore further as a group. Participants are asked to develop a value proposition for this idea using a fill-in-the-blank "ad-lib" value proposition template (see the Strategyzer tools https://www.strategyzer.com/library), then share it with a larger group. In the second part (45 minutes), we put participants through a full test/learn cycle in order to explore the assump-tions embedded in their value proposition. Participants write Test Cards that outline an experiment that they will run to test a hypothesis about their customers or about product/market fit. They create a low-fidelity representation of their product and engage with "customers" to conduct their test. After engaging potential customers, participants fill out a Learning Card that indicates whether the evidence they collected supports their hypothesis. Finally, they update their value proposition to reflect their learning. In the third part (15 minutes), we focus on how the course tools can be applied to one's own professional devel-opment. Participants complete an ad-lib template that is similar to the value proposition ad-lib they created for their product. This Personal Value Proposition encourages participants to think about how they could apply the tools to explore an area of potential personal learning, growth, exploration, or discovery.

WORKSHOPS

MONDAY, JULY 29, 2024. 2:00 PM – 3:30 PM

Workshop IV	
Sponsored Workshop by AutoDesk **Autodesk AI: Today's tools and tomorrow's vision for design & manufacturing**	Gaby Waldman-Frie
This presentation will give an overview of Autodesk AI, Autodesk's history in the AI space, and what we are working on around generative AI in design and manufacturing. We will end with how to get started today taking advantage of Autodesk AI in your classrooms.	
Milestones-Based Structured Active Learning Approach to Improve Student Performance in Engineering Courses	Ashish Borgaonkar Jaskirat Sodhi Lucie Tchouassi
This workshop will present a milestones-based approach to enhance key learning modules in engineering courses to improve student engagement, participation, and performance. This idea will provide a guided-inquiry-based structured approach to delivering key learning modules and the assignments, projects, or other deliverables linked to them. The basic idea is to redesign the delivery aspect of learning modules to allow for one or more in-class activities where students can review, discuss, and work on getting started and completing at least some portion of the major linked deliverable for the topic. Through the activity, students will be encouraged to reach a meaningful milestone toward completing the full assignment or project. This approach guarantees that all in attendance have at least started working on the deliverable and have a clear idea and understanding of what needs to be done. Instructors and support staff are available to answer any questions or to provide further clarification. The authors have piloted this approach in a multidisciplinary first-year engineering design course and have observed a significant increase in student participation, engagement, and performance. This approach does require some advanced planning and redesigning of lesson plans but also provides an added structure to the course. This workshop will be an engaging session of two parts. In the first half, presenters will go over the basic idea and a couple of examples of how some modules were updated based on this approach and the second half will invite participants to work in groups to identify some of their modules and to design a milestone-based activity around them. All participants will walk away with ideas and action plans based on this approach for immediate implementation in their courses. This session will be beneficial for those interested in Excellence in Teaching, Active Learning, Student Engagement, and Broadening Participation in Engineering and Engineering Technology.	
Sponsored Workshop by MathWorks & Quansar **Bridging Theory and Practice: An Interactive Workshop on Control Theory using a Robotic Arm**	Neha Sardesa Noah Roberts Arian Panah Zinan Cen
This workshop is designed to enrich the educational journey of first-year engineering faculty members by providing a comprehensive, hands-on experience that bridges the gap between theoretical control concepts and their practical applications. The primary objective is to demonstrate the relevance of control theory in modern engineering through the use of a robotic arm for task planning. Robotic arms, crucial in industries such as manufacturing and healthcare, for precision tasks like assembling electronic components and performing minimally invasive surgeries, demonstrate the importance of advanced control systems. Participants will be introduced to key theoretical equations and control concepts, laying a foundational understanding essential for the progression from theory to practice. The workshop includes an exercise that guides attendees through the process of translating control theory into a tangible simulation using Simulink. This step is crucial for visualizing and tweaking control strategies in a controlled environment before applying them to real-world scenarios. The culmination of the workshop is an exercise focused on the actual implementation of these simulations on a Quanser robotic arm, providing a hands-on experience that solidi- fies the learned concepts. By the end of the workshop, participants will have gained valuable insights into the seamless integration of theoretical knowledge and practical application, empowering them to incorporate these methodologies into their teaching and research endeavors.	

FULL PAPERS

MONDAY, JULY 29, 2024. 3:45 PM – 5:00 PM

Full Papers I: Sense of Belonging and Self-Efficacy	
Enhancing Sense of Belonging in First-Year Engineering Students through Integrated Project-Based Learning and Communication Skills Development	Song Wang Enrico Obst Beth Richards
Fostering a strong sense of belonging among first-year college students is paramount for engagement, academic suc-cess, and improved retention rates. This project focuses on enriching the sense of belonging for first-year engineering students at the University of Hartford by emphasizing project-based learning and communication skills development. The initiative was implemented within the first-year ES143 Engineering and Design class, where students actively par-ticipated in hands-on projects exploring diverse engineering disciplines and their practical applications. Throughout the semester, students engaged in weekly tasks involving technical reports, presentation slides, posters, and oral pre-sentations. Surveys assessing sense of belonging and technical writing were conducted at the beginning and end of the semester. The assessments of weekly assignments demonstrate the project's efficacy in enhancing students' academic achievement. The sense of belonging survey results, while not showing statistically significant changes, still reflect a practically meaningful impact on certain aspects of student's social belonging and self-awareness. These findings also underscore the complex challenges faced by first year engineering students.	
Sense of Belonging in a First-Year Engineering Program: Analyzing Differences Across Design Project Courses	Heather Schwab Peyton OReilly Laine Rumreich Krista M Kecskemety
This research paper investigates the differences in sense of belonging with respect to gender and intended major within a first-year engineering program. Research was conducted through survey responses from students at a large midwestern university at two points in the first-year engineering program. The first data point was collected at the end of autumn semester and the second at the end of spring semester. Students of all engineering majors must take two semesters of first-year engineering courses focusing on problem solving, computational tools, and design. This study is a follow-up to a previous study of analyzing the differences of sense of belonging between course themes (the second semester design course allows students to select between 2 different themes). The prior study found slight differences in sense of belonging between course themes, but demographic information was not collected. This study will examine the overall sense of belonging within the courses and the college of engineering while adding in the ad-ditional factors of gender identity and intended major and looking at the longitudinal changes throughout the first year. The data analysis examines how the environment of similar intended majors and gender identity could affect sense of belonging. This baseline information can be used to promote inclusion and diversity in these courses in the future. Additionally, we want to examine if the sense of belonging within the first-year engineering courses differs from the sense of belonging within the college of engineering which again can be used to identify areas of improvement with respect to inclusive teaching and academic systems.	
Continued exploration of the relevance of self-efficacy, self-determination and agency in describing the first-year African engineering student's experience	Heather Beem Charity Obaa Afi Ampomah
A first-year engineering student experiences various transformations as they engage in their first project-based course in the university. This can be particularly pronounced for students on the African continent, who may have largely experienced theoretical instruction prior to entering a university which emphasizes a project-based approach. The target group here is first year engineering students at Ashesi University in Ghana. This paper builds on previous work with this target group in ascertaining which constructs are most relevant in de-scribing their experiences in a project-based course. First-year students (N=49) in the 2023 offering of an Introduction to Engineering course were administered pre- and post-surveys. Drawing from validated scales in literature, these sur-veys asked students to report self-perceptions of their agency, self-determination, and self-efficacy on a Likert scale. They were also asked open-ended questions to enable them to articulate their project experience in their own words. Paired t-tests and Hedge's g tests were conducted on the Likert scale responses to determine statistical significance and effect sizes to any changes reported. Qualitative analysis was done on the open-ended questions in terms of cat-egorizing the dominant emotions and conducting thematic analysis to map their responses to the three constructs in view. These analyses were done for Cohorts A and B of the course separately, as Cohort B had taken an introductory design course prior to their official start to the university curriculum, and hence came in with a different exposure level. The results showed statistically significant increases with small to large effect size for both agency ($p=4.59E-02$, $g=0.2$) and self-efficacy levels ($p=3.96E-03$, $g=1.7$) in aggregate. Self-determination started high and remained high at the end. The majority of students from cohort A (50%) and cohort B (78%) had positive remarks to say about their project, while a few had negative and neutral remarks. The difference between cohorts suggests that the prior exposure they had coming into the course did influence their success in it. Thematic analysis revealed a trend of students starting with low self-efficacy, exhibiting self-determination and agency to persist through challenges, and ending on a level of high self-efficacy. These results posit that these three constructs may indeed be relevant constructs in describing the target students' experiences, albeit with a time dimension in view. Although self-efficacy and agency have been seen to increase amongst students engaged in project-based learning in contexts outside of Ghana, an exact comparison for the trend seen here for self-determination has not yet been found. Future work can probe further into this potentially unique dimension of African first-year students. Generally, this line of inquiry can result in informed curricular design to better serve engineering students in contexts where they may have had minimal prior exposure to project-based approaches.	

MONDAY, JULY 29, 2024. 3:45 PM – 5:00 PM

Full Papers I: Sense of Belonging and Self-Efficacy	
Building on the First-Year Engineering programming experience: Understanding the motivation and self-efficacy of students in a follow-on programming course	Joseph Lyon Mayari I. Serrano
This full paper overviews the educational design of a follow-on programming course designed for students exiting their first-year engineering sequence of courses. As computation and computational thinking are becoming critical skills for engineers of all disciplines, the aim of engineering educators should be to build on programming skills students are learning early in their engineering undergraduate curriculum. However, currently, there may be some problems with the approach that many undergraduate institutions are taking to teaching programming skills. Programming is often left in the abstract, doesn't get reinforced, and can feel isolating for students. The goal of this course design is to contextualize programming in new and unique ways for students to better understand its application and use using a community-based approach that would engage and motivate. The course teaches students concepts around numerical computation that are key to engineering problem solving such as simple numerical techniques for integration to complex methods such as finite element analysis. The course leverages principles from a communities of practice perspective to (1) help motivate and engage students to learn to program and practice computational thinking and (2) illuminate the importance of programming to various fields across engineering. Data was collected in the form of a validated survey based on the motivation literature, as well as a self-efficacy survey around computer programming. The results of the study are twofold: (1) an overview of how the curriculum was structured and implemented within this setting to be adapted and used in new and other contexts and (2) the survey results that indicate that follow-on courses can be a valuable tool in contributing to student motiva-tion and self-efficacy in learning computer programming and computational thinking. The paper concludes by giving recommendations for teaching and learning in first-year engineering classes based on the results.	
Examining first-year students' nascent disciplinary identities and epistemological orientations	Juval Racelis
Research on retention and persistence has shown the role that belonging and disciplinary connectedness can play in student self-efficacy and academic success. This has contributed to STEM curriculum innovations and first-year programming that has sought to foster disciplinary identity through engagement in undergraduate research and co-op programs. Such innovation and research are especially important for students from marginalized backgrounds who are often underrepresented in certain STEM fields. While much research has investigated pedagogical innovations and curricular programming to address these issues, few studies have explored the nascent disciplinary orientations that first-year students bring with them as they transi-tion from high school to their first year in college. This is particularly relevant for students who enter their first year with a declared STEM or design major. Exploring these conceptualizations of curriculum at a key point of transition can help elucidate ways to further foster students' disciplinary identity, thereby contributing to persistence and self-efficacy. In this paper, I analyze qualitative interviews of first-year engineering and design students to examine how students orient toward what it means to be an engineering student. Findings from this study reveal that many students who choose to be engineering or design majors bring with them STEM-oriented identities that are rooted in high school learning practices that focus on hands-on learning. This learning orientation suggests that students' nascent disci-plinary identities are epistemologically oriented toward certain ways of knowing. These findings have implications for student self-efficacy and persistence in engineering-related coursework such as the hard sciences and technical writing where connections to their discipline may not always be immediately apparent.	
Full Papers II: Teaching Methods and Assessment Approaches	
Implementing Exam Wrappers in a First-Year Engineering Course	Andrew Bartolini
This full paper examines the implementation of exam wrappers into a first-year engineering computing course. The study is currently being conducted at a medium-sized, private, Midwestern, residential university in the Spring 2024 semester. Exam wrappers allow students to reflect on how prepared they were for course exams and how effective their preparation was for the exams. Previous studies have shown that exam wrappers were generally successful in assisting students, particularly underprepared first-semester STEM students, in increasing their metacognitive skill sets [1, 2]. In the spring semester engineering computing course at the aforementioned university, a portion of the students completed an exam wrapper after each of the exams. Sample questions included: - Approximately how much time do you spend each week studying XXXX material using non-required activities? Examples of activities that fit this description include re-watching the videos, creating/using flash cards, reviewing solutions, trying new problems, and trying practice problems. - When did you start specifically preparing for the XXXX exam associated with this wrapper? - How much total time did you spend specifically preparing for the XXXX exam associated with this wrapper? - What tools and strategies did you use as part of your studying specifically for the XXXX exam associated with this wrapper? - How prepared did you feel coming into the XXXX exam associated with this wrapper? - How stressed did you feel coming into the XXXX exam associated with this wrapper? - How confident did you feel about your performance on the XXXX exam associated with this wrapper immediately after completing the exam? - Did you have a strategy for how to take the XXXX exam before starting (i.e., starting on problems you felt more comfortable with or starting on the free response problem(s) first - Did you perform as well as you wanted to on the XXXX exam associated with this wrapper? - Did you perform as well as you expected to on the XXXX exam associated with this wrapper? Results of this full paper will include responses from the students on their perceived preparation for each exam and how they felt they performed on each exam. In addition, a comparison will be made on the results of those students who completed an exam wrapper compared to those who did not complete a wrapper.	

MONDAY, JULY 29, 2024. 3:45 PM – 5:00 PM

Full Papers II: Teaching Methods and Assessment Approaches	
Future-Ready Students: Survey Analysis Utilizing Natural Language Processing	Toluwani Olukanni Majd Khalaf Michael Cross David M. Feinauer Ali Al Bataineh
First-year Electrical and Computer Engineering students from two institutions engaged in a collaborative project to develop a smart home device using sensors and actuators learned in their introductory courses. They reflected on the project, and their feedback was analyzed using unsupervised and Natural Language Processing techniques like K-means clustering and Latent Dirichlet Allocation. Key methods included data preprocessing and cleaning. AI tools like TF-IDF vectorization and ChatGPT helped identify key themes such as ”PROJECT,” ”PARTNER,” ”WORK,” and ”LEARNED.” This study highlights NLP’s role in enhancing educational strategies and understanding student experiences.	
Tinkering and Making to Engage Students in a First-Year Introduction to Mechanical Engineering Course	Micah Lande
This is a full paper that introduces a tinkering- and maker-based approach to engaging first-year students in an intro-duction to mechanical engineering course. Engineering students should get right into building and making. Much of what they will learn across the undergradu-ate engineering curriculum is about building (learning CAD tools, manufacturing processes) as well as analyzing built things or the characteristics/behaviors of physical phenomena (many of their engineering sciences courses). In teaching an introductory engineering course to our first-year students, there is both the need to address the ar-ray of (broad) topics across engineering and get students excited about their major. By introducing a collaborative making project very early in the course, the hope is to get students excited, introduce them to working collaboratively and creatively to solve problems, and make some implicit link making connections and spurring curiosity. The general approach to using tinkering and making as pedagogy is to 1) introduce a topic with a simple hands-on activity that can be done in the classroom in 30 minutes, 2) send the remainder of the class period discussing and debriefing, 3) follow up with specific technical content related to activity, 4) bridge to a more in-depth design challenge. This is also to encourage tinkering and making/thinking through materials with a number of considerations: what is success in this challenge, how to work through a creative design process, and how to balance a number of systems considerations (materials, time, role/jobs of people during the short demonstration window). With a making- and design-based approach the ambition is to make it more fun and worthwhile for students as well as help the instructor enjoy teaching the course/coach students through the design process, making skills, and applying those learning to solve problems that they care about. By tinkering, it is meant to start by showing students the basics (of some area of engineering fundamentals, of making) and expect them to then take that knowledge and skills further through exploration by imagining and building a physical solution, in an interactive and reflective way. Project based and design challenges are pedagogical approaches that can really engage and excite students. For a 1st year introduction to engineering course, we aim to bring making through hands-on design projects/challenges throughout the semester in small chunks (2-3 weeks). In our paper we will provide additional areas with associated introductory activities and design challenges: mechanics of structures, material and manufacturing, and fluids engineering. There is a cluster of learning goals that are overarching these sets of activities: applying a creative problem-solving design process, design under constraints (materials, time, tools), collaborate in teams, empirically explore a specific engineering phenomenon, and have fun.	
One Tool to Support Attendance, Engagement, Metacognition, and Exam Preparation	Kathleen Harper Kurt R Rhoads
The first-year engineering experience at Case Western Reserve University is one course that combines twice-weekly laboratory modules and a weekly lecture. The lectures serve two primary purposes: to instruct students in MATLAB coding and to introduce them to each engineering discipline on campus. As the course grew from a pilot with around a dozen students to an engineering requirement with up to 230 students in one semester, the lecture’s atmosphere naturally changed. It became more formal and less personal, with students less likely to engage as fully as desired. The larger enrollment also necessitated that exams be given through the lecture and that they be administered on paper. The instructional team sought strategies to make improvements in several areas. The first was to improve lecture at-tendance, particularly to insure students learned about all engineering programs on campus. A second was to increase student engagement and give them an opportunity for additional interaction with the guest presenters. Third was to encourage development of metacognitive skills; while the instructors emphasized metacognition early in the semester and shared strategies they hoped students would adopt, there was little modeling of these strategies throughout the semester. Finally, the instructors wished to bridge the gap between the homework, which was almost exclusively creating scripts in MATLAB, and the paper-based exams. One tool was implemented to address all of these concerns. Students now pick up a half-sheet of paper as they enter lecture. In the first few minutes of class, they answer a few short questions on paper about the material from the previous week’s lecture. These formative quizzes illustrate some of the kinds of questions that may appear on exams. The quiz is discussed before delving into the new topic of the week, and students keep the paper with them during the class. Then, when the guest lecturer presents in the final part of class, students are encouraged to write questions for them on the back of the page. At the end of class, the papers are collected. Students receive modest credit toward their course grade for simply attempting the formative quiz. The questions for the guest lecturer are compiled, and the most popular ones are sent to the presenter, who writes responses. The resulting document is posted on the course management system. Since the advent of this approach, lecture attendance is markedly improved. Many of the guests have commented on the high caliber of the student questions. On a course-end survey, students rated the exercise as helpful to their learning, but it was not one of the highest ranked activities in the course. While it is not possible to isolate this innovation to determine if it alone had positive impact on student learning, a modest analysis found reasonable alignment between the styles of questions on the quizzes and on the exams. The authors will continue using this tool and will be making improvements to the way it is used in the hopes of increasing its impact.	

MONDAY, JULY 29, 2024. 3:45 PM – 5:00 PM

Full Papers II: Teaching Methods and Assessment Approaches	
A Generative AI Approach to Better Teamwork in First-Year Engineering	Ethan Danahy Mehek Kunal Vora Yume Menghe Xu William Church
This Full Paper will describe a new method of facilitating teamwork in a first-year engineering course using generative AI. This work is inspired by, and builds upon, the many existing techniques and tools currently supporting engineering instructors in the forming of teams, overseeing of team dynamics, supporting interpersonal dynamics within teams, and evaluation of team members (e.g. CATME from Purdue University, Tandem from University of Michigan, etc). This work discusses new enhancements to each step of the process via generative AI tools and technologies. Through student data collected at different stages of the project development cycle, and specific prompts used to interact with generative AI, it was possible to customize and personalize the teamwork groupings, recommendations, feedback mechanisms, and individual evaluations in a scalable way across the entire class. Research data was collected from a single section of a first-semester introduction to engineering course at a small, private engineering school in the northeast part of the United States. While the semester-long course of 30 first-year engineering students (21 of which consented to IRB-approved research around their course activities and submissions) featured several individual and group projects in Fall 2023, two group projects in particular are the focus of this re-search. The first (the initial group project of the semester, occurring one month into the semester) was orchestrated leveraging generative AI to process student input and formulate the student groups; the second group project of the semester (the subsequent project in sequence) allowed students to self-pick collaborators and self-orchestrate their groups. A post-survey was issued after the two projects to collect data on students' perceptions of the experience. Artifacts used in this analysis include students' initial survey, chatbot logs from a generative AI system provided to the students for use during the projects ([REF REMOVED], 2024), students' group project assignment submissions, and a post-project reflection survey. This research first explores the various strategies used by the instructor in this introduction to engineering design course to introduce the use of OpenAI's ChatGPT to the team facilitation process. Due to the capabilities of large lan-guage models (LLMs) to process, summarize, and identify thematic commonalities across large collections of rich text, traditional simplistic surveys (e.g. consisting of numeric self-reported Likert scales, already known to be problematic in this type of data collection) were replaced by open-ended short-answer questions where students reflected, across a variety of dimensions, on prior group work experiences in their lives. This provided the opportunity for deeper insights into the individual abilities, personalities, experiences, and needs of each student with regards to their engagement in group work. These anonymized class-wide trends were created and shared with students to form mutual class-wide understandings and develop common collaborative culture prior to the start of group work. The chatbot's inherent clustering capabilities was then leveraged to form initial teammate groupings based on individual recommendations. For each of these teams, personalized strengths and weaknesses were identified and shared internally to each group. Teamwork strategy summaries and warnings, generated from both internal and external sources, were also shared. The theory underlying this work is that more insightful (and transparent) formulation of groups would create suc-cessful collaborative experiences, and by leveraging generative AI technologies these tools and techniques could be both scaled across larger numbers of students and open to a wider range of instructors. This initial experiment, cre-ating 10 groups of 3 students each, demonstrates the feasibility of this methodology. A subsequent group project where students "picked their own partners" allowed students to subsequently reflect directly on the two experiences (albeit on different assignments with different scopes and scales) to compare and contrast their perceptions of how the AI-generated groupings fared. A project postmortem analysis of both team-level interactions (e.g. chatlogs from the generative AI system supporting in-class work) and individual reflections were evaluated in order to give more meaningful summative feedback on the experience. This in turn was used to generate other formative suggestions for future implementations. Analysis and evidence from this work demonstrates the following: the generative AI system was able to success-fully process the input data and generate the requested reports (class-wide summaries, individual assessments and recommendations, and group formations with characterizations and suggestions). Implementation details in the pro-cedure section of the paper document instructor techniques for chatbot interactions to facilitate higher-quality output (e.g. adjusting chatbot responses to protect student identities and deliver results in more appropriate ways). Student reflections after both assignments indicate overall student approval of the AI-formed groups, with multiple students highlighting the alleviation of social anxiety when the AI identified groups for them. However, student sentiment included wariness of a fully-automated system (multiple requests for "human in the loop") and concerns over the AI summaries and decisions being based on so little input information (which also was prone to having errors, false information included, or being manipulated by students since self-reported). After completing a project with groups selected by AI and then a project with groups formed via self-selection, students proposed a hybrid approach that allows some automation but both teacher-informed influence and includes more student choice. Details of range of ideas and suggestions are included in the full description of results. From the experiences and findings presented, several more generalized recommendations for use within other contexts are also included.	

MONDAY, JULY 29, 2024. 3:45 PM – 5:00 PM

Full Papers III: Wellness and Student Success	
Impacts of a Wellness-Focused First-Year Course on Student Retention and Academic Success	Matthew Cavalli Anetra Grice
Particularly since the COVID-19 pandemic, an increasing amount of focus has been placed on concepts like student mental health and holistic wellness when discussing academic success in higher education. Across all student demographics, backgrounds, and majors – including engineering – researchers have explored potential links between aspects of wellness and outcomes like retention and graduation. At [University], a wellness-focused first-year course has been expanded to be available for all incoming students in [College]. This paper explores students' perceived wellness and academic outcomes for those who are enrolled in the class and those who are not. University has adopted the eight dimensions of wellness model as the basis for both wellness-focused courses and other student success-focused programming. Starting in Fall 2023, a three-credit, wellness-focused course, [Course] was offered to all new students in the college. [College] uses cohort scheduling for incoming first-year students, and most students will now take [Course]. However, about half of the new students will take the course in their first fall semester and half will take it in their first spring (second college) semester. For both enrolled and non-enrolled students, perceived wellness will be measured using questions from the Perceived Wellness Model (PWM – Adams et al. 1997, 2000) and the Interpersonal, Community, Occupational, Physical, Psychological, and Economic instrument (ICOPPE - Pril-leltensky et al. 2015, Esposito et al. 2022). Neither the PWM nor the ICOPPE alone captures the full breadth of the eight dimensions of wellness model. While the instruments use different approaches to defining and measuring a respondent's perceived wellness, together they allow the range of eight dimensions of wellness to potentially be quantified. Questions from the Perceived Wellness Survey (Adams et al., 1997, Adams, 2022) and the ICOPPE wellness scale (Prilleltensky et al., 2015) were used to create two electronic surveys in Qualtrics, one administered at the start of the Fall 2023 semester and one at the end. Additional questions related to student mindset (Yeager and Dweck, 2012) and self-efficacy were added to the surveys. All new students (first-time-in-any-college and transfer) in the [College] were invited to participate in both surveys. Statistical analysis (ANOVA) will be used to explore correlations between survey responses and academic outcomes (first semester GPA and retention to second semester). Additionally, changes in survey responses for students completing both surveys will be analyzed. Correlations for students enrolled in the wellness course or not enrolled will be compared. Based on prior research, self-efficacy is expected to be correlated to both first semester GPA and retention to the second semester. Students enrolled in the wellness course during the fall semester are expected to demonstrate larger gains in both measures of wellness (Perceived Wellness Survey and ICOPPE) compared to non-enrolled students. Results from the second survey administration (end-of-fall semester) are expected to be more strongly correlated to positive academic outcomes compared to the start-of-semester data.	
Impact of Math Placement on Persistence and Time to Graduation In Engineering	David Gray Olivia Ryan James Nathaniel Newcomer Hamidreza Taimoory
Universities, particularly land-grant or other public institutions, are increasingly coming under pressure to demonstrate the value of an undergraduate education to society. The escalating cost of student loan debt and the perceived increased cost of an undergraduate degree have intensified pressure for academic institutions to reduce time to degree and total student debt at graduation. A critical factor often overlooked in engineering program assessment is the initial math readiness of incoming students. Our study examines the implications of students' first-year math class on their persistence and eventual graduation rates. For many engineering students, beginning their academic journey at the Pre-Calculus level results in the need for remedial measures, such as summer classes or additional semesters, adding a financial burden that many cannot bear. Underrepresented minority students are disproportionately affected by inadequate Pre-Calculus preparation, as math readiness is not merely an achievement gap but rather an opportunity gap, influenced by systemic inequities in ed-ucational resources and support. The COVID-19 pandemic has only exacerbated these disparities, underscoring the urgency of addressing the systemic issues perpetuating these inequities. Shifting demographics in the US have resulted in an overall decreased population of college-aged students, intensifying competition for students and decreasing ad-mission requirements. Consequently, a higher percentage of students admitted to four-year engineering degrees are entering university without prerequisite math credits, exacerbating the challenges associated with math readiness and its impact on student success. Further, engineering students' sense of belonging has been shown to be particularly important for retention. Therefore, there is a need to understand how engineering students' math readiness, coupled with their sense of belonging impacts persistence in the major. In this paper, we explore pre-pandemic and post-pandemic math placement, sense of belonging, and second year placement (in engineering or out of engineering) for students entering a first-year engineering program to examine historical trends. Our data collection consists of engineering students' self-reported sense of belonging, institutional data on math placement and minority status, and national educational statistics to highlight some of the contributing factors and short-term impacts on students as a function of their initial math placement at admission. In light of these findings, we propose a need to destigmatize alternative pathways to degree as a function of math placement at admission and highlight the imperative for inclusive curricular approaches and institutional support mech-anisms to foster equitable opportunities and enhance the success of all engineering students, irrespective of their initial math placement.	

MONDAY, JULY 29, 2024. 3:45 PM – 5:00 PM

Full Papers III: Wellness and Student Success	
Self-Regulated Learning in First Year Engineering: Opportunities for Practical Implementation	Mohammed Kihal Cassie Wallwey Juan David Ortega Álvarez James Nathaniel Newcomer
This complete evidence-based practice paper discusses the challenges of teaching and helping first-year engineering (FYE) students practice self-regulatory skills and provides actionable recommendations for curriculum common across FYE programs. Self-regulated learning (SRL) comprises critical skills for success in engineering education such as time manage-ment, study habits, and metacognition. The incoming FYE student landscape is growing and changing from previous decades as students enter with more diverse educational backgrounds and experiences (e.g. hybrid, online learning) than the field has previously seen. While this growth in engineering diversity is encouraging, it has also been observed by those who work with first-year engineering students (faculty, advisors, etc.) that many are struggling with the identification and development of SRL skills such as time management, learning strategies, and help-seeking, needed to succeed in an undergraduate engineering curriculum in their first year. While the literature on SRL in engineering education discusses the importance of SRL for students, it provides less actionable recommendations oriented toward the curriculum of FYE programs. Through a strategic collaboration between first-year engineering instructors and academic advisors, the need for more explicit instruction and practice of self-regulated learning habits and skills was identified. The goal of the instructor-advisor collaboration was to more holistically facilitate students' academic development as they transition to an environment in which they must be more independent learners. This paper aims to summarize existing literature about SRL and intentionally tie foundational concepts of SRL to common curriculum elements within FYE programs. Additionally, we provide practical opportunities to weave the development of SRL skills—such as planning, goal setting, growth, reflection, and metacognition—into existing, al-ready densely packed, FYE curriculum. In other words, we aim for practicality from the instructor's perspective by making SRL-related outcomes transversal to the existing curriculum. Throughout these opportunities for integration, we discuss the importance of creating a learning environment that 1) considers students' interest as a powerful motivator for learning; 2) prompts students to take responsibility for their learning and to seek out help when needed; and 3) helps students find motivation to learn and persist against challenges. These practical suggestions provide an example of how instructors can help FYE students develop SRL skills that foster their academic and professional success.	
Students' Self-Reported Self-Regulated Learning Skills Across a First-Year Engineering Program	Cassondra Wallwey David Gray
First-year engineering students are often in a highly developmental period of their life. Many times, it may be the first time a student has lived away from home, or been entirely responsible for their own meals, chores, or schedule, or had complete autonomy in navigating their academic experience. While these students are in our classrooms tak-ing their first steps to develop themselves as aspiring engineers, they are also in other classrooms developing their identities as learners and functioning outside of classrooms developing skills at living more independently than they previously had. This multitude of changes paired with increased levels of responsibility and decision making can be overwhelming to students, causing stress, anxious feelings, and confusion One attribution assigned when someone has trouble adjusting to their new environment is a struggle with self-regulation, which is a person's ability to manage their own thoughts, emotions, and behaviors in an appropriate way through monitoring, evaluation, and reinforcement. An education-specific extension psychology's self-regulation is the concept of self-regulated learning (SRL), which a student plans, monitors, and evaluates their own learning process and progress as a learner. A recent observation within a large, public, southern university's first-year engineering program is that when students struggle academically in their first year, these struggles often stem from a lack the self-regulatory and self-regulated learning habits, skills, and behaviors. These observations came from a combination of instructors, teaching assistants, and advisors. To further understanding of this phenomenon, questions were added to a survey administered to stu-dents at the beginning and end of each semester related to students' self-regulated learning skills, habits, and behaviors. This full paper aligned with the "Transiting from High School to the First Year" strategic pillar of the FYEE con-ference will report the results of those surveys, mapping students' self-reported SRL levels at the beginning of their first semester in an undergraduate engineering program, at the end of their first semester in an undergraduate engi-neering program, and at the end of their second semester in an undergraduate engineering program (this would also be at the end of their first complete academic year in an undergraduate engineering program). These results are dis-cussed with an emphasis on the implications for practice as instructors of students in first-year engineering programs. Self-regulation and self-regulated learning habits, skills, and behaviors are essential foundations for becoming a well-rounded engineering student, but also for personal growth and life-long learning. Understanding the experiences of our students in this respect will open doors for how first-year engineering programs can enrich the student experience to encourage holistic learning and growth of these self-regulation skills.	

Panel II (5:15 PM - 6:15 PM)	
Unlocking the Power of Entrepreneurial Mindset (EM) in the First-Year Experience	Blake Hylton Jack Bringardner Kaitlin Mallouk Krista Kecskemety
Embark on a transformative journey into the realm of Entrepreneurial Mindset (EM) with our esteemed panelists. What is an Entrepreneurial Mindset (EM)? Defined as "a set of attitudes, dispositions, habits, and behaviors that shape a unique approach to problem-solving, innovation, and value creation" [1] by the Engineering Unleashed (KEEN) website, EM holds the key to amplifying engineers' technical skills. Join us to explore how EM empowers engineers to identify opportunities, target their impact, and consistently create value, all while embracing the 3C's: Curiosity, Connections, and Creating Value. Our panelists, integral members of the KEEN Project known as EMIFY, will share their expertise and extensive experience in not only teaching first-year students but also in seamlessly integrating Entrepreneurial Mindset (EM) into the curriculum. Discover how effortless, enriching, and rewarding it can be to cultivate an entrepreneurial mindset from day one of the engineering journey. Harnessing the insights shared by our panelists, attendees will leave em-powered to not only navigate the complexities of the modern engineering landscape but also to innovate, create value, and make a meaningful impact in their respective fields. Join us as we embark on this transformative exploration of Entrepreneurial Mindset (EM) and unlock the boundless potential it holds for the first-year experience and beyond. Over the course of the workshop, participants will develop an EngineeringUnleashed.com card to share a project, activity or other content from their first-year engineering course or program. **Please bring a laptop to support your participation in this workshop**)	

MathWorks®

QUANSER INNOVATE · EDUCATE

ENGINEERING UNLEASHED POWERED BY KEEN

EMIFY Entrepreneurial Mindset in the First Year

ACUITY INSIGHTS

Feedback Loop

onshape™

engineering 4 us all

eGrove Education, Inc.

LVX VERITAS VIRTVS Northeastern University College of Engineering First-Year Engineering

FIRST-YEAR PROGRAMS DIVISION

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S1: Great Ideas for Teaching (GIFTs) or Talking With Students!	
A Hands-on Activity for Improving the Students' Understanding of Centroids in a Freshmen Engineering Mechanics Course	Roshina Babu
Centroids of rigid bodies are one of the fundamental concepts taught in freshmen engineering mechanics courses. However, some freshmen students fail to connect the value of the centroid calculated with its significance in the actual rigid body. In this work, a hands-on activity and corresponding teaching materials were developed to provide students with an opportunity to see and feel a rigid body and appreciate the concept of its centroid. Unlike traditional methods, where students calculate the centroids of different shapes displayed on a screen or paper, this work describes an active learning strategy where students physically handle rigid bodies and identify the centroid using different methods. At the beginning of the class, the theory of centroids and applications in engineering systems were explained. Then the class of 40 students was divided into 10 groups. Each group was provided with different shapes cut out of form boards, a weight tied to a string, and push pins. The students were also provided with a handout that guided them through the entire activity. As a first step, each group discussed and made a guess on the location of the centroid. In the second step, they used the weight attached to the string as a plumb line to experiment and find the location of the centroid. In the third step, students calculated the centroid using the summation method. As a final step, they compared the different results, including their initial guesses, and summarized their inferences. This activity was implemented in the Freshmen Engineering Mechanics (Statics) course in Spring 2024 and received a positive response from students. Mechanisms to assess the effectiveness of this hands-on activity in improving student outcomes will be implemented in future semesters.	
Concrete Is My Jam!	Christopher Frishcosy
Concrete Is My Jam! is an engaging activity in which participants are instructed through their preparation of a no-cook freezer jam while the facilitator relates the ingredients and interactions (physical and chemical) for jamming to the basic constituents in and processes essential for mixing concrete. The four ingredients used to make jam, based on a box recipe, are: a type of fruit, sugar, added pectin, and lemon juice. In recipe order, strawberries have proven to be a tasty and appealing fruit option for this activity as they, considering their size, are easily compared to coarse aggregate used in concrete. Subsequently, granulated sugar is juxtaposed with fine aggregate, pectin powder with cement, and lemon juice with admixtures. The water that is required to hydrate the pectin is introduced through the ’mixing process’, i.e. smashing the strawberries. This water is analogous to the, well, water that is used to hydrate cement when mixing concrete. Throughout ”Concrete Is My Jam!”, the facilitator can discuss the value of each jam ingredient and how its compared equivalent affects the performance of concrete. For examples: gradation, density, air voids, particle packing, and granularity, can be introduced during the aggregate portion, while the pectin / cement comparison allows for hands-on association with concepts such as workability, set time, and concrete curing. In conclusion of this activity, it is critical to mention or reiterate the importance of a concrete mix design. Just as a recipe was followed while making the jam, engineers and mix designers study the material constituents and proportion them to meet specific performance criteria. The analogies encompassed in ”Concrete Is My Jam!” can be expressed to interest and inform a range of educational levels. While this activity has primarily been conducted as a fun civil materials activity for a college-level Introduction to Civil Engineering course over the past two years, it has also been used to engage visiting intermediate and secondary student groups with the science of mixing concrete.	
Expanding Laboratory Experiences in Circuits and Networks	Mark Cambron
This abstract is for a GIFTS paper. The Electrical Engineering Program at Western Kentucky University has a commitment to project based learning. A part of this commitment is to provide strong laboratory experiences throughout the entire curriculum. Efforts must be continually made to widen our curriculum and labs to better prepare students for life-long learning. Curriculum development requires the ability to balance the desire to increase learning with a limited number of credit hours. Western faces an additional challenge of expanding a curriculum while the Kentucky’s Council for Postsecondary Education is pushing for a decrease in the number of credit hours required to earn a bachelor’s degree. In the past year we have begun to spread out laboratory experiences into more courses. This paper will look at the first curricular change being implemented using this concept. The change is to our foundational circuits sequence. We offer a two course seven (7) hour sequence in circuits and networks. Previously the two course circuit sequence consists of two three lecture with a 1 hour lab offered with the initial course. It was determined through the assessment process that the students would benefit from having a lab experience with both circuit courses. The faculty believed that a hands-on experience in the first course was valuable for students being introduced to circuits for the first time. It would also be valuable to have hands experience involving the concepts presented in the second course. A new circuits sequence was developed and is currently being implemented which split the lab hour between the two courses thus making each course three lectures hours and a half hour lab experience. We believe that the sequence strengthened the curriculum. The faculty believe that the number of labs will increase and the students will benefit from exposure to more concepts.	
Matching 2D Engineering Drawings and 3D Objects	Danielle Barker Catherine Hamel
In this Great Ideas for Teaching, and Talking with, Students (GIFTS) paper, the author presents an engaging educa-tional activity designed to enhance students’ understanding of engineering drawing creation and the importance of clear design communication. In this activity, students are tasked with matching 2D engineering drawings to corre-sponding 3D physical objects within their class. The challenge lies in the deceptive similarity between the drawings and components, compelling students to scrutinize the details meticulously. Paired with a lesson on understanding and creating engineering drawings, this activity underscores the significance of both isometric and orthographic views in conveying engineering design information effectively. The activity incor-porates three distinct differentiators between objects: shape, color, and scale. Students encounter variations in base shapes and mirror images, highlighting the necessity of comprehending multiple views to understand part geometry fully. Furthermore, the introduction of different colors and scale variations reinforces the significance of material description and precise scaling in engineering documentation. Students gain insights into interpreting crucial written details such as notes, title blocks, and scale on 2D engineering drawings, emphasizing the comprehensive nature of engineering documentation. By engaging in this hands-on activity, students not only develop a deeper understanding of engineering drawing prin-ciples but also cultivate essential skills in carefully analyzing engineering documentation, a vital skill for success in the field of engineering design.	

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S1: Great Ideas for Teaching (GIFTs) or Talking With Students!	
Tools to Help Students Prototype and Test Autonomous Robot Navigation Algorithms	Giang-Nam Facchetti
In this GIFTS paper, we present three instructional tools that were developed at INSTITUTION to help students proto-type and test autonomous navigation algorithms. All students at INSTITUTION are required to complete the first-year engineering design course and work in teams of about eight students to design, build, and test a vehicle that can navi-gate an arena using an internally developed vision system that provides student teams with the equivalent of compass (heading) and GPS (location) information for their vehicle within the arena. One of the biggest challenges we have observed is that students often wait too long to begin developing and testing their navigation algorithms while their vehicle is still being assembled. To account for this downtime, some resources our INSTITUTION has created to help students learn the fundamentals of navigational algorithms and stay on track with the course project include: 1) Clipboard Tanks, 2) Physical Tanks, and 3) an online simulator. In this GIFTS paper, we detail these three instruc-tional resources and describe how these tools help students to continually educate themselves and put into practice their programming algorithms at different stages of the course.	
Three Methods to use Podcasts as Effective Learning Tools	Haritha Malladi
A podcast is a program—typically in audio medium—that is available for download to personal devices from the Internet. They are like radio programs that can be played on demand. Podcasts are distributed using RSS feeds and are available to stream on popular streaming services like Spotify. Listen Notes, a podcast search engine and database, reports that there are over 3,000,000 podcasts in the world. There are a multitude of podcast episodes relevant to engineering that can be used as high-quality free educational resources. This Great Ideas for Teaching, or Talking with, Students (GIFTS) paper describes three ways to incorporate podcasts in an engineering classroom and ways to scaffold their use to enhance learning. The first method involves assigning students to listen to a podcast episode accompanied by a written reflection response. The second method is an instructor-created regular podcast series or a weekly talk show for the course. This method is an effective alternative to bringing guest speakers to the classroom. The third method involves assigning students to create their own podcast as a summative assessment for a course. Many podcasts provide access to full transcripts for each episode, which can be provided to the students. Enabling student choice in listening to podcasts, reading the transcripts, and/or creating podcasts or podcast scripts is in line with Universal Design for Learning (UDL) guidelines of creating multiple means of engagement, representation, action and expression. The author has successfully implemented all three types of podcast assignments to positive student feedback. Associated assignment descriptions and other resources will be detailed in the draft paper.	
An example implementation of web-based, in-class polling as an active learning and formative assessment tool	Paul Anderson Catherine Hamel
In this GIFTS paper, the authors discuss the use of web-based, in-class polling platforms for active learning and formative assessments in fundamental engineering courses. Referred to by various terms, such as polling software, clickers, and audience engagement platforms, the in-class delivery of interactive questions to students' internet-enabled de-vices is an established pedagogical tool. Having used such applications in a variety of courses over multiple years, both online and in-person, the authors offer several observations and best practices that are broadly applicable to all engineering courses, including those in a student's first year. We highlight the use of two tools that have been used to deliver a roughly even mixture of active learning activities (which extend comprehension of new concepts) and formative assessments (which check understanding of past material). We have found that the timing of the questions can assist with achieving desired student behaviors, such as administering a question at the beginning of the class to incentivize student attendance. Additionally, the tools have aided in enhancing student engagement in both in-person and online courses, especially when delivered with a predictable rhythm.	
Integrating MATLAB Grader into an Engineering Computing Course	Andrew Bartolini
This GIFTS (Great Ideas for Teaching Students) paper discusses the implementation of MATLAB Grader into a first-year engineering computing course. MATLAB Grader is an automatic grading platform for MATLAB files that is offered by MATHWORKS. MATLAB Grader allows students to submit code that is assessed through a variety of instructor created tests. The student submissions can be specified to be in the form of a user-defined function or a script. The tests typically check the values of variables, inclusion of keywords or functions, the absence of keywords or functions, or custom code with assessments created by the instructor. MATLAB Grader was introduced into an engineering computing course at a medium-sized, private, Midwestern, residential university in the Spring 2023 and has been used again in the Spring 2024 semester. MATLAB Grader has been utilized to replace smaller active learning activity assignments. These assignments are started before the end of a given lecture and completed before the start of the next lecture. The assignments are a means to promote retrieval learning and ensure that the concepts from the previous lecture are reinforced before the next lecture. MAT-LAB Grader is used for problems including variable assignment, mathematical operations, loops, conditionals, data structures, cell arrays, user-defined functions, plotting, arrays, and vectors. MATLAB Grader was not used to replace the longer homework assignments. The study will include feedback from students about their thoughts and opinions of using MATLAB Grader instead of the alternative method of submitting the files that were then hand graded within a week's time period by teaching assistant graders. The paper will also outline opinions of the teaching assistant graders on their observations of using MATLAB grader from a grading perspective.	

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S1: Great Ideas for Teaching (GIFTs) or Talking With Students!	
Helping Students to Advise Themselves Using a Graded Curricular Map in the First Year	Melissa Kenny
Although teaching first-year engineers generally involves introducing engineering concepts, problems, and skills, it also regularly includes advising students as they assimilate to college life. Students are desperate for advice from their peers, teaching assistants, and professors on course selection, majors, minors, studying abroad, getting internships, and many other topics that could affect their future. Most engineering curricula require a significant amount of coursework that makes fitting in additional studies and opportunities a bit more complicated. This can lead students to choose more flexible majors or leave engineering entirely in order to pursue their other interests. To combat this issue, our first-year engineering course includes a graded assignment in which students develop a curricular map describing when they will take all of the required courses to graduate with the major(s) and minor(s) they hope to achieve. Students use an excel template which is programmed to add credits based on engineering major requirements and provides warnings when students don't meet these. The goal of this assignment is not to simply have a set plan for their remaining semesters, but to guide students towards the resources they must use to choose classes and understand what they require. Students must explore major and minor requirements, consider other graduation requirements, find pre-requisite courses, and discover any relevant programs (e.g. study abroad). Students can resubmit their curricular map an unlimited number of times in response to comments until they achieve a final working map and full credit on the assignment in order to develop mastery learning. This GIFTS paper describes this assignment and how it helps students to discover how they can find the answers to many of their advising questions on their own, empowering them to explore the opportunities available to them and pursue all of their interests.	
Team Safety Brief: A tool to promote and enhance teamwork	Mirna Mattjik Carter Moulton
It is crucial for first-year students to undergo a successful team experience in their engineering design course. This is because the ability to effectively collaborate and work as part of a team is not a skill that is automatically acquired during high school. Given the diverse backgrounds and experiences of students, some may not be as proficient in this skill as others. Therefore, it is essential for first-year engineering design educators to provide guidance and support in this area. To address this need and create a level playing field for all students, the Team Safety Brief was developed. This tool aims to help bridge the gap in team collaboration skills among students. This initiative is a Work in Progress under the GIFTS (Great Ideas for Teaching, or Talking with Students) category. Its purpose extends beyond just applying the tool in the classroom; it also involves gathering feedback and insights from minoritized students about how their team experiences were impacted by using this tool. The hypothesis is that a positive team experience with an emphasis on psychological safety can enhance a student's academic sense of belonging. By collecting information from minoritized students, the author aims to understand the nuances of their team experiences better. This information will then be used to create a more inclusive teaching and learning environment, ensuring that all students feel supported and valued in their engineering design course.	
Trial by Fire: GIFTS for Stress-Testing Student Project Management Tools	David Gray
First year general engineering programs often include team-based project or design work to develop essential team-work and fundamental engineering skills. However, students entering these programs bring varying levels of experience in working with teams and with managing projects. Principles of asynchronous/synchronous team communication, task management, and documents/assignment collaborative development are present in a wide range of levels. This GIFTS work introduces an assignment aimed at stress testing and formatively assessing student-selected project management tools. This assignment is administered after students have been placed into teams and subsequent to a team charter assignment where teams indicate group communication methods, file sharing and coworking systems, and task management systems. The assignment is designed to push students to actively engage with their chosen project management tools in a real-time, high-pressure situation. With a constrained timeframe, students are tasked with coordinating tasks, sharing information, and synthesizing individual contributions into a cohesive team presentation. Through this experiential approach, students are tasked with assessing the strengths and limitations of their communication and project management tools and are prepared for the practical demands of project work throughout the semester. By grappling with a challenge in a controlled environment, students develop adaptability, sharpen their problem-solving skills, and work to refine their ability to collaborate in a team setting. Survey results indicate that students perceived the assignment as effective in evaluating their teamwork and communication skills under pressure. Though many acknowledged the highly stressful nature of the activity, the experience was overwhelmingly deemed valuable and insightful. The heightened significance of effective communication, adapt-ability, and resourcefulness were particularly noted by students. Our presentation will detail the implementation and outcomes of this assignment. We will provide tips and strategies for successful implementation and potential pitfalls.	

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S2: Great Ideas for Teaching (GIFTs) or Talking With Students!	
Marching LEGO Ducks towards Critical Ideation	Brian O'Connell
Generating a wide range of solutions can be a difficult challenge for First-year engineering students. Conceptually, exploring more of the solution space is difficult for them to understand as it is not something they've thought criti-cally about regarding how to push those boundaries. Without guidance for what makes solutions further apart from one another in the design space, they tend to focus on variations of their initial ideas to meet arbitrarily set project minimums. This GIFT discusses an in-class activity that introduces ideation metrics to quantifiably assess the variety of the solution space, a measurement of the extent of the explored solution space, and novelty, a measurement of how unusual or unexpected an idea is compared to the other ideas. The activity utilizes ideation metrics established by Shah, Vargas-hernandez, and Smith and showcases them through a LEGO activity in which students are given a set number of LEGO pieces and told to make a duck. We then review their ducks and assess the class data set for its variety and the individual ducks for their novelty using these metrics and an online form and spreadsheet designed to collect the data and showcase the results swiftly. This lesson and activity has been implemented in 8 first-year design courses over the last two years with many pos-itive reactions, noted in student evaluations as a favorite. Even though utilizing these metrics has not yet become a requirement in design projects, several student design teams have used them as evidence of their critical engagement with the engineering design process. They used the variety metric to showcase their exploration of a broad solution space. They incorporated the novelty metric as a rating in their decision analyses when selecting which idea to pursue.	
Crushing Cardboard: A Technical Design Challenge for First-Year Students	Melissa Kenny Patricia Clayton
This GIFTS paper describes a first-year engineering design challenge which allows students to explore and apply technical skills to an engineering problem with minimal pre-requisite knowledge. Introducing technical skills in the first year of engineering education can pose certain challenges. Students in this course enter with no pre-requisite knowledge in math or science and many are not sure if they will continue as engineering majors. Thus, course projects and concepts must provide all necessary information for student success while also providing a glimpse of the problems that engineers solve and the technical tools they may use. In this project, students first explore basic mechanics and statics principles which introduce forces and solving simple static systems. They are then given a problem to solve: how can they build a corrugated cardboard support (like the legs of their chairs or table) which can withstand the largest force before failure? Students quickly go through the design process in small teams, including defining the problem and design constraints, brainstorming a solution, and ultimately building a corrugated cardboard prototype. They then test their prototype using a tabletop hand crank materials testing machine to view in real-time the force withstood by their prototype as it is compressed. They record each failure event of their prototype as it's structure is affected by the load and make observations throughout testing. Students must discuss why they think their prototype behaved how it did and how they might remedy each failure event and ultimately create an improved design. Finally, students begin a basic exploration of programming skills in order to graph and perform a simple analysis of the data. They apply their results to a final statics problem in which they consider how their support may be used to hold a load on a bench with a specific factor of safety. This project applies mechanics principles, the design process, experimentation, introductory programming, and consideration of failure and factor of safety into a simple hands-on project with minimal pre-requisite knowledge.	
Designing and Making an Olympic Cauldron: A First-Year Mechanical Engineering Design Challenge	Micah Lande
This GIFTS paper will discuss a design challenge in a first-year engineering class to design and rapidly prototype a cardboard tower in the spirit of the Olympic cauldron. Student design teams work together with material constraints to work through a creative design process to imagine and build their structure. To any given design challenge, students may have multiple feasible ideas for success. They can imagine multiple possible concepts, down select and move forward with a solution. Time may also be a factor to move forward, with often limited allowance for iteration, particularly within the constraint of a class. It is interesting to see how their concepts evolve and mature to prototypes along the way; we implemented a broader timeframe for a design challenge to both allow students to practice iteration and better understand what types of learnings helped to revise their concepts along the way. Over a week, students are introduced to design process steps like brainstorming and prototyping, and then given sufficient time to imagine, design, and fabricate multiple iterations. With a this system-level engineering design challenge in an introductory design course, concepts and prototypes imagined and created by students were tracked and their design processes were captured, supplemented by follow-up reflective interviews. In general, it is useful to better understand the possible scaffolding of design challenges with additional information or probes to get students thinking about their assumptions and making tradeoff considerations to a more successful solution. There are implications for such an approach to design challenges to allow for both engineering analysis and iterative design through tinkering to achieve well-balanced set of considerations and appreciation of context in which design solutions can be considered.	
A Multi-Disciplinary First-Year Design Project with Systems Integration, Standard Requirements, Creativity, and Impact	Shaz Vijlee
We present an example of a first-year introduction to engineering project that incorporates elements of design, systems integration, standard requirements, creativity, and impact. The students design and build a table-top wind turbine via two levels of 'challenges.' In Level 1, we scaffold the students through learning, designing, and building four wind turbine subsystems (Mechanical, Electrical, Software, and Subsystems). Each subsystem has specific standardized requirements, so after Level 1, the wind turbines are all relatively similar and complete the same functions. Level 2 challenges the students to improve their turbine in any way, allowing them to diagnose problems and be creative with solutions. During these challenges, the students also complete research assignments to help familiarize them with the energy problem in our developed and developing societies.	

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S2: Great Ideas for Teaching (GIFTs) or Talking With Students!	
Getting Aloft in Engineering	Mary Bowden
Every first-year student needs a support group to learn the ropes and be successful as they enter engineering. While this function could be provided by the squad at the dorm, by fraternity brothers or sorority sisters, or maybe members of the marching band, it is proposed that an engineering design and test team, structured properly, may be the most effective support group. The example used to illustrate this concept is a Ballooning Team, hosted as an under-graduate arm of the Space Systems Lab in the Aerospace Engineering Department and funded by the NASA Space Grant Consortium. The nominal research goal of the team is to design, build, test, and fly small engineering payloads on helium-filled weather balloons up to the edge of the atmosphere, and recover them when they return to earth by parachute. But the real purpose of this team is to provide a supportive environment for all students who join, and especially for first- and second-year engineering students who develop problem-solving, teamwork, and social skills, in addition to confidence, resiliency, and basic hands-on engineering abilities. Some of the key characteristics of the Ballooning Team are as follows: 1) everyone is welcome, no matter how much or how little experience they bring, no matter what their personal, ethnic, or cultural background is, and no matter how much time they can devote to the team; 2) the work is technically challenging, and requires many different skills and many different people working together to accomplish not just building experiments, but also actually launching them, tracking successfully, and recovering them; and 3) every experiment or event that is not immediately successful is an educational experience which is recognized as at least as valuable (ie, "failure IS an option")! These characteristics could easily be duplicated in many other undergraduate engineering groups, for example a rocket club, a race-car crew, or a robotics team – but there are two additional essential elements: the students and the leader-ship. All the students, upperclassmen as well as first and second-years, must embrace and implement the concept that everyone is welcome and worthy, and that they need to work together and teach each other skills. And the leadership has to set the tone, be engaged, recognize the value of each individual, allow failures to happen with good humor, and always appreciate the educational benefit of every experience.	
Awards & Recognition to Shape Values & Drive Behavior	Lee Rynearson
Extrinsic motivation in higher education environments including FYE classes is frequently provided by grades and their follow-on effects such as the ability to progress through the curriculum. While providing powerful extrinsic motivation in many circumstances, grades have limitations. For instance, FERPA prevents public discussion of student grades, which can limit the ability to publicly recognize students for specific exceptional work. Other limitations include that it is not realistically possible to grade all elements of student behavior that may be desirable, and that grades are limited to classwork when desired behavior or outcomes could be taking place outside of the context of specific classes or over longer time periods than a single marking period. Awards and public recognition, inside or outside of specific classes, are potentially useful in ways that grades can be limited – awards are not limited by FERPA and can be publicly recognized, and they can be targeted at areas that may be difficult, inappropriate, or logistically infeasible to grade. The engineering program at [University Name] has created a set of awards that are given each year to selected students or teams in each year level (first-year, sophomore, etc.) that align with targeted values and behaviors to allow the program to repeatedly recognize and emphasize the outcomes we wish to see in students. The awards program is integrated closely with key classes in some cases (including first-year design and senior design sequences). The author looks forward to sharing details of this program and enumerating methods that comparable processes could be integrated into other classes or programs. This may be of interest at the level of individual instructors and classes, concentrations / majors, or entire engineering schools depending on the targeted outcomes and the resources available. While the concept of awards for students is not novel, there remain opportunities to benefit from wider discussion and more creative implementation of awards and recognition for students to shape values and drive behavior.	
Career Guidance 101	Katherine Pettrey Andrew Becnel
Students are frequently under the assumption that an engineering degree guarantees a job at graduation. Our department began embedding career planning into the freshman engineering courses during the 2022-23 academic year. The goal is to provide a model for what it takes to be a top-tier job candidate at graduation. By providing students with the tools to set themselves up for success early in their college careers, they have the time to strategically tailor their experiences over the next 8+ semesters. During Semester 1, students learn from an industry representative who provides them with employer insight into what makes a good job candidate for hire. Starting with "is engineering right for me," the students are given several metrics by which they can self-assess if engineering is a good fit. Students then analyze a sample resume to determine what makes a strong resume, which leads into an analysis of how to tailor the next several years toward building a strong resume. Outside of class students create a resume and a 4-year plan, which are turned in for assessment by instructors. During Semester 2, students update and refine their resumes, and attend two sessions offered by Career Services:(1) Networking, and (2) Job and Internship Search. At the end of the freshman year, all students have a good resume, a plan for the next few years, knowledge of resources available from the university to improve grades and gain experience, an electronic portfolio showcasing their engineering communication skills, and are ready to hit the ground running for the career fair during the fall of their sophomore year. Participants will be provided with a copy of our template for career planning, including links to resources.	

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S2: Great Ideas for Teaching (GIFTs) or Talking With Students!

“What’s Your Superpower?”: Connecting Entrepreneurial Mindset, DEI, and Character	Krista Kecskemety Tyler Stump Peyton OReilly Sydney Cooper

This GIFTS paper aims to connect first-year engineering students with STEM figures through shared character strengths. A character strength acts as a figures ”superpower” or exemplary value they exhibit in their contributions to STEM The intention of the activity is to support student connection building in how one’s values can be intertwined with professional engineering practice by showcasing exemplary examples of STEM figures how have done so. These STEM figures were intentionally designed with Diversity, Equity, and Inclusion (DEI) in mind to represent a diverse population of professional engineers to support the diverse population found within first-year engineering. The profiles include present day and historic figures and also intentionally highlight the stories of members of minoritized populations, LGBTQIA+, people with disabilities, and neurodiverse people. Since these figures are more than a singular character strength care was taken to include the figure’s journey, as these STEM figures all are multidimensional with unique lives, behaviors, personalities, and stories. This journal was accompanied by identifying the ways in which their character strength, motivation, impact and the 3C’s (Curiosity, Connections, and Creating Value) are demonstrated in their impact to engineering and the world. Students in the second course of a first-year engineering sequence were assigned to complete a survey and engage in the connection of their identified character strengths through reflective practice. Students were asked to complete the VIA Character Strength survey, which asks students a series of character alignment questions to report students’ top character strengths. After receiving their character strengths, the students were then given the profiles of three Engineering/STEM figures that exhibit similar traits to highlight examples of how their identified value have been showcased in the engineering workforce. Students then reflect on the value they created by connecting their character strengths with other STEM figures while engaging with curiosity. The assignment exists at the intersection of Entrepreneurial Mindset, DEI, and Character to give students a chance to intertwine their personal values in hopes of supporting their identity alignment with engineering.

Implementing High Impact Practices to Support Transition from High School to First-Year Engineering Courses	Gretchen Scroggin Heath Schluterman Aysa Galbraith Leslie Massey Latisha Puckett

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 over 70%. Our latest 2nd year retention rate was 76%. FEP faculty continually explores new ways to partner with the university community to support first-year engineering students and increase the retention rates. This University has a strong collaboration among the faculty and staff from multiple disciplines that emphasize the positive impact of implementing High-Impact Practices on student success and wellness. FEP faculty has been actively contributing towards these efforts. This paper explores our integration of High-Impact Practices into our courses’ curriculum. The Association of American Colleges and Universities (AAC&U) states that teaching and learning practices designated as ”high-impact practices,” or HIPs, provide significant educational benefits for students who participate in them—including and especially those from demographic groups historically underserved by higher education. The HIPS practices are de-signed to cultivate substantive relationships, promote engagement across diverse perspectives, deliver comprehensive feedback, facilitate the application of acquired knowledge in novel contexts, and foster reflective processes aimed at personal development. While First-Year Experience courses are instrumental in facilitating academic growth, they also play a pivotal role in nurturing social development and emotional resilience. By providing a structured framework for self-reflection and personal growth, these courses empower students to navigate the complexities of university life with confidence and resilience. Through experiential learning opportunities and real-world applications, students gain practical skills and competencies that are essential for success in both academic and professional settings. FEP has adopted various HIPs into our curriculum, with a primary focus on establishing a first-year experience. We have also implemented (with varying degrees) collaborative assignments and projects, common intellectual experiences, diversity/global Learning, e-Portfolios, first-year seminars, learning communities, service learning, and undergraduate research opportunities. In this paper, we will discuss the specific HIPs incorporated into our curriculum, explain the rationale behind our implementation, how we can adapt them to better meet the changing needs of our students, and offer insights and resources for other institutions seeking to implement similar practices. By sharing our experiences, we aim to empower engineering students across diverse educational environments to excel.

TUESDAY, JULY 30, 2024. 8:45 AM – 10:45 AM

S2: Great Ideas for Teaching (GIFTs) or Talking With Students!		
Developing a Community of Learners with Incoming Engineering Students that Initially Were Not Calculus Ready		Leah Rineck
Engineering students entering college who are not calculus-ready encounter many barriers in their academic development as compared with their calculus-ready peers. Typically, engineering students who are not calc-ready must take a longer path to graduate, are not able to take classes with their incoming peers, and often experience added barriers as students from underrepresented backgrounds. Some schools attempt to prepare students for calculus in the summer before they matriculate with a summer math bridge program. These bridge programs focus on math instruction, and some include engineering activities. The current research on such programming does not discuss the value and importance of community that that can be built and maintained through a summer bridge program. Additionally, many of these programs do not include any support for students after the summer program concludes. We have developed a summer bridge program for incoming engineering students designed to foster community and prepare them for retaking their placement exam. Every part of the in-person experience was designed to promote community building: collaborating on group assignments in math instruction, taking part in engineering activities, and attending a kick-off dinner with parents and families. The students worked with each other to both study and have fun. At the end of the program twenty-two of the thirty-three students increased their placement scores and twenty-eight of the thirty-three students placed into either the one-semester or two-semester Calculus I class. In the Fall semester students were encouraged to attend study tables for math and chemistry reserved mainly for their cohort. After completing Fall semester, the average GPA of the students was a 2.96 with nineteen of the students above a 3.0. At the end of the summer the students were asked about what was most beneficial about the program. They shared that the events outside of instruction, such as meeting people and getting to know the campus and classes, were more beneficial than their exam preparation. While this program's purpose was to prepare students to be successful academically as engineering students at their first semester, we have found they have also developed a community of learners to rely on for the rest of their college career. We will present methods for this community, strategies for community building, results of the program and future work.		
First Year Foundations Learning Community		Edward Bednarz
The first semester of college is challenging for engineering students. The goal of the First Year Foundations (FYF) at Wilkes University is to help students transition from high school to college. General student learning outcomes of the FYF course is to provide students with communication skills (both written and oral), quantitative reasoning, diversity awareness, critical thinking and computer literacy. Engineering students need to enroll in fundamental classes such as Calculus, Physics and Chemistry but may not see where these courses fit into engineering as a profession. A learning community creates a common project between the basic Computer Aided Drafting and Design (CADD) course and the FYF Engineering Design course. It is a fun experience for students to learn about engineering, teamwork, technology and testing. They work with the same group across two different classes on the same exact project. The project involves designing a bridge with certain constraints. There are three phases to the project: 3D CADD model, Bridge Designer software and the physical build. Students use the Bridge Designer software to optimize their design for the lowest cost. They employ trial and error methods to explore trusses, arches, different materials and cross sections. The next phase of the project is to model their design in 3D CADD. They get to see how the different members form an assembly. Finally, students physically build their bridge out of popsicle sticks. As a class, each bridge is tested to failure with a machine that can measure force vs. deflection. It is also a fun competition to see which design is the cheapest in the Bridge Designer software and holds the most weight in the real world test. Overall, the bridge project through the learning community has been very successful in engaging engineering students early on in their curriculum. It gives them experience in designing an optimal product under constraints in a team environment.		

FULL PAPERS

TUESDAY, JULY 30, 2024. 11:00 AM – 12:00 PM

Full Papers IV: Curriculum and Course Design	
Comprehensive Analysis and Assessment of An Introduction to Engineering and Computing Course	Longfei Zhou Varun K Kasaraneni Longyan Chen Ahmed Abuhussein
In fall 2022, for freshman undergraduate students majoring in Engineering and Computing studies, Gannon University's School of Engineering and Computing (SEC) implemented the Introduction to Engineering and Computing course, replacing the traditional first-year seminar. The focus of the 2-credit first-year seminar course was to assist students in adjusting to the college environment and Gannon University, with an emphasis on the liberal studies components. The new Introduction to Engineering and Computing course is a 1-credit course that provides students with an overview of engineering and computing as professions and disciplines. The course is designed to serve as a foundational exploration into the interconnected worlds of engineering principles and computational problem-solving. The course covers professional and ethical considerations, career development, and communication skills vital for success in these fields. Students are also introduced to the resources available in the Makerspace, including but not limited to 3D printing, laser cutting, and microcontroller applications. Through hands-on projects and instructional activities, students explore fundamental concepts in engineering while fostering critical thinking and problem-solving skills. This paper outlines the course, and the project structure details, and provides a summary of student feedback gathered from course evaluations and surveys conducted at least one semester after completion. Future work on how to modify the course structure is also discussed according to the student feedback.	
Nurturing Interdisciplinary Engagement: A Case Study of Resourcing and Recruiting Strategies in an Early Academic Career Interdisciplinary Project-Based Learning Course	David Gray Lisa D. McNair Atlas Vernier
In response to growing demands for interdisciplinary education and experiential learning, we developed the Inter-disciplinary Projects Course (IDPro). IDPro was designed to provide early academic career experiential learning to students across the university. During the pilot semester of the course, students were recruited into scenarios where new interdisciplinary teams of students were tasked with scoping and executing a real-world problem originating with students, proposed by fac-ulty, sponsored by industry, or in collaboration with government or community partners. Teams were challenged with developing a working culture, navigating the uncertainties of a new course with a novel assessment structure, and scoping their near- and long-term objectives and tasks for the projects. In the second semester of the program, teams consisting of a blend of returning and new students faced new challenges of integrating new members to the teams and recalibrating their scope and objectives in light of new skills and aptitudes brought by new members and considering technical progress attained in the previous semester. One of the particular challenges in operating a project-based learning course like IDPro is in recruiting and onboarding students from a diverse group of participating majors, including those housed outside of the home academic unit. Our recruitment process involved a multi-channeled approach, with recruitment materials disseminated through academic advisors, student organizations, and faculty networks. In this study, we explore qualitative survey data from the first two semesters of IDPro to shed light on student motivation for participation. Preliminary insights suggest certain struc-tural incentives for participation and a broad desire for practical, hands-on and social team-based learning experiences. Findings will highlight the importance of developing a supportive and inclusive environment, as particularly evi-denced by the participation of non-engineering and underrepresented minority students. This work will explore the evolution of student motivation over multiple semesters, with a goal of providing insights into effective strategies for building broad interdisciplinary engagement and creating a brand exhibiting a culture of inclusivity and collaboration	
Assessing transformative learning outcomes of a First-Year Engineering Program using TROPOS	Sukeerti Shandliya Cedrick Kwuimy
Transformative learning methods aim to equip students with the necessary skills to address 21st-century challenges by fundamentally altering their frame of reference (Kegan, 2000). A student's frame of reference encompasses their habits of mind and personal point of view, which are influenced by past learning experiences and cultural norms (Mezirow, 1997). This paper explores the extent of transformative learning experiences in a first-year engineering program at a mid-western (USA) institution. The study employs two key instruments: the Learning Activity Survey (LAS) and the Transformative Outcomes and Processes Scale (TROPOS). The LAS assesses whether and to what extent the first-year engineering experience has led to a perspective transformation in the students and identifies the specific learning activities contributing to this change. TROPOS, comprising 30 items, evaluates students' overall transformative learn-ing outcome, focusing on four subscales: social support, attitude towards uncertainty, criticality, and transformative outcomes. The study sample includes 110 students participating in the First-Year Engineering Experience (FYEE). They com-pleted the King's Learning Activity Survey, providing insights into their transformative learning journeys. Analysis of the LAS data facilitated the categorization of students into four distinct transformation clusters:1. Students who experienced Profound Transformation through disorienting dilemmas, self-reflection, experiment-ing, and acting. 2. Students who experienced a disorienting dilemma without subsequent action. 3. Students who experienced Straightforward Transformation, characterized by experimenting and acting without a disorienting dilemma. 4. Students who experienced no transformation.The study correlates these clusters with the TROPOS subscales and examines demographic factors, including gender, race, ethnicity, international status, and the traditional versus non-traditional student status of the students. Prelimi-nary findings indicated significantly higher overall TROPOS scores for first-generation students and female students compared to their peers. Notably, students who did not undergo transformation exhibited substantially lower TROPOS scores than those experiencing profound or straightforward transformations. The study contributes to the relatively limited literature on transformative learning within the field of engineering education.	

Full Papers IV: Curriculum and Course Design	
Future-Ready Students: Providing Opportunities for Remote Collaboration on an Engineering Design Project	David Feinauer Michael Cross Ali Al Bataineh Toluwani Olukanni Majd Khalaf
Successful engagement and collaboration on projects where members of the team work remotely is an essential skill for students to develop. Having students collaborate with partners from another institution can add elements of reality and relevance to a class project, creating further opportunities for instructors to prepare students for the expectations of the modern workplace. This paper details the design and execution of a class project for first-year Electrical and Computer Engineering students, with project teams comprised of students from two institutions. While the organization effort is slightly higher for the instructors than other course projects, the observed value to the students is notable. Students report more communication, coordination, and teaming difficulties on this project than they do for other course projects, but they also report satisfaction and a sense of accomplishment, and their responses to end-of-project surveys show a maturing of their understanding of effective teaming skills.	
Full Papers V: Professional Development and Skill Building	
Applying Vertically-integrated Project as a Sustainable Pathway for First-year Student Professional Development	Rui Li
In this complete evidence-based practice, a new course framework is explained to help with first-year students' professional development. A common practice of growing professional skill sets is to obtain internship opportunities as the industry is generally looking for applicants who are at intermediate or advanced levels. However, the first-year students generally would have few solid technical skills. Therefore, the research question is: how to help first-year students in gaining essential skills before they apply for the internships and become future workforce. In a large private university, the first-year students are allowed to participate in Vertically-integrated Projects (VIPs). The VIPs are multi-year cross-disciplinary projects that enable students to be part of the research projects. It opens entry level opportunities for first-year students to work with senior peers and directly with professors. It is a learning platform for students to build professional skills via peer learning and active learning activities. The peer learning activities include group project events. A group leader is assigned to each group activity. His or her role is to monitor and ensure the students document research progress in their engineering notebook. The peers' support enables a smoother knowledge transfer and sharing of information. On the other hand, active learning experiences involve structured team presentations and faculty feedback on the presentation. Faculty would also schedule project discussion hours with the students and ensure guide the group discussions. Also, Faculty would take individual students to different research labs for an immersive research experience. Constructivism is the theory that states that learners could construct knowledge rather than passively absorbing in-formation from the educators. As people experience the world and reflect on those experiences, they construct their own representations and incorporate new information into their pre-existing knowledge. The VIP students could con-struct their personalized knowledge base or skill sets from the resources such as flexible enrollment, hybrid project schedule and adjustable topic of interests. The first-year students have the option to take 0 or 1 credit for VIPs. Moreover, the VIPs' group activities could be in a hybrid format, combining in-person students on campus with remote students from different campuses, even different universities, so students have the flexibility of planning their academic schedules with their personal development. The VIP team also allows students to pick their interesting topics to pursue and they are allowed to change the topic of interest every semester. During the 2-year VIP operation, many first-year students have received benefits of being part of an active community. The VIP is designed to be differentiated from student clubs and research labs. VIPs have project deadlines as it is an undergraduate course, compared with the student clubs. However, there is no time limit to publish the work, compared with the research labs. This unique opportunity would allow students to fully explore their skill sets according to their own career pathways. By the end of the VIP course, the faculty could introduce them to the industrial collaborations as well as university research labs once they become competent in the fields of their interests. In this paper, a detailed pathway is provided and student feedback is also considered.	
The Professional and Technical skills that engineering students find most important for success in their major	Atheer Almasri Akua B. Oppong-Anane Carter Hulcher Todd R Hamrick Xinyu Zhang Lizzie Santiago
The purpose of this study is to identify soft and technical skills perceived as important by engineering and computing sciences students. Soft skills are interpersonal skills that support the relationship between people and complement the technical skills. Soft skills are essential to achieve organizational development and effectiveness. Technical skills are specific expertise and knowledge needed to accomplish certain tasks or to solve certain problems. Specifically, this study was guided by the research questions, what are the technical and non-technical skills required by students to succeed in their engineering or computing sciences courses?, and how do those relevant skills differ by engineering major of study? This project was conducted in an R1, land-grant, public institution in the Mid-Atlantic Region. One-hundred fifty three (153) engineering students completed a survey that was made available via weekly newsletter, flyers, and email. Participants were undergraduate students enrolled in a variety of engineering majors offered at the institution, includ-ing Mechanical and Civil Engineering. The survey contained likert-scale and open-ended questions. The study was acknowledged by the Institutional Review Board. All students surveyed in this study valued time management and teamwork. The top technical skills valued by students were computer programming and math problem solving skills. Differences based on major of interest were observed in terms of which soft and technical skills considered as important by students. This study will be used to define which soft and technical skills must be emphasized in first year engineering courses to support student success in upper level courses. These essential skills will be discussed in this paper.	

TUESDAY, JULY 30, 2024. 11:00 AM – 12:00 PM

Full Papers V: Professional Development and Skill Building	
Gender and First-Generation Status Impacts on the Perceived Importance of Technical and Non-Technical Skills for Upper-Level Undergraduate Engineering and Computer Science Courses	Carter Hulcher Akua B. Oppong-Anane Xinyu Zhang Lizzie Santiago Todd R Hamrick Atheer Almasri
As college attendance by first-generation students as well as women continues to increase, understanding the perspectives of these student populations and how to help them succeed has become a focus of many college institutions. A student's gender and their first-generation status can have a significant impact on how they view the importance of various skills necessary for success in engineering and computer science majors. In this paper, the results of a mixed-method survey collecting students' opinions on important technical and non-technical skills at a public, 4-year university in the Mid-Atlantic region of the United States are detailed and discussed. Surveys were distributed in the engineering and computer science buildings on campus and were sent via email to students in the College of Engineering. This research aims to investigate the following: (1) what skills do men, women, first-generation, and non-first-generation undergraduate engineering and computer science students find most important to succeed in upper-level coursework? (2) what differences in the importance of various skills exist between men and women? (3) what differences in the importance of various skills exist between first-generation and non-first-generation students?(4) how do men, women, first-generation, and non-first-generation students view the importance of technical versus non-technical skills? Preliminary results show that women find technical skills to be more important than men. Similarly, first-generation students also find technical skills to be more important than non-first-generation students. In addition, first-generation men tend to place more importance on non-technical skills than non-first-generation men. The findings from this work can be used to help the authors' university and other universities update first-year engineering courses to better address the needs of students of different genders and first-generation status as they progress into their upper-level coursework.	
A new procedural laboratory to demonstrate tool utilization for first-year engineering students	Adithya Jayakumar Raymond Brooks
In the current engineering education landscape, there is an increasing need for students to possess practical hands-on skills in addition to theoretical knowledge. One aspect of this practical skillset is the ability to effectively use basic hand tools. This paper outlines the implementation of a laboratory activity aimed at teaching first-year engineering students how to safely use some basic hand tools. There is significant value in training engineering students to be able to handle tools safely and effectively. It can empower students to not only design innovative prototypes but also brings them one step closer to realizing these de-signs. By learning how to use tools like saws and drills, engineering students can fabricate prototypes, translating their theoretical knowledge into physical models. These prototypes can also serve as an important means of communication, allowing students to convey their ideas and concepts to stakeholders. While maker spaces are becoming common across universities in the United States, the focus often leans towards advanced technologies like 3D printers and laser cutters, over more basic tools that are equally essential to ground students in the fundamentals. Also, without an intro-duction to tools in an introductory engineering course, barriers may still exist for students who do not traditionally feel welcome in workshops and makerspaces preventing them from participating in future years. Likewise, while students come to the university setting with varying degrees of experience in tool utilization, purposefully allocating time in a first-year fundamentals of engineering course for all engineering students can close this capacity gap. Teaching all students how to use basic tools provides the foundational skills that can serve them throughout their academic journey and into their professional careers. However, despite the potential benefits of introducing tool utilization skills to first-year engineering students, the practical incorporation of such an activity into an existing fundamentals of engineering course can have many challenges. The large class sizes of these courses, the required resources, insufficient class time, safety concerns, and the need for comprehensive training can be formidable obstacles. This paper provides an overview of the laboratory activity that was implemented and goes over the multi-faceted challenges and obstacles that needed to be overcome. Results in the form of student feedback about their experience in the lab are also included. Through this paper, we aim to share our experiences and insights, while providing a roadmap for educators with similar goals and facing comparable challenges.	

TUESDAY, JULY 30, 2024. 11:00 AM – 12:00 PM

Full Papers VI: Tools for Learning and Engagement	
Exploring Instructors Insight' to a MATLAB Code Critiquer	Laura Albrant Mary Benjamin Michelle E Jarvie-Eggart Jon Sticklen Laura E Brown Leo C. Ureel II
This study investigates the effectiveness of WebTA, a MATLAB-based code critiquer, in enhancing programming education for first-year engineering students. WebTA aims to identify and provide feedback on antipatterns, promoting better coding practices. The research involved three classroom interventions at Michigan Technological University during the Spring and Fall semesters of 2023. In the Spring, WebTA was integrated into three MATLAB assignments in ENG1101, and student interactions were observed. Key areas of focus included student engagement, usage patterns, challenges, behavioral responses, and instructor interactions. Pre- and post-interviews with instructors were conducted to assess baseline knowledge and capture reflections on WebTA's impact. Thematic analysis of these interviews revealed varied abilities among instructors to identify antipatterns, diverse teaching approaches, and mixed feedback on WebTA's utility. Findings indicate that WebTA effectively reduces coding anxiety and instills good programming habits but also highlights the need for better integration with educational platforms and a balanced approach to feedback. Future research focuses on expanding WebTA's application across different programming courses and objectively measuring its impact on student and instructor perceptions. Addressing the identified challenges will enhance WebTA's usability and overall effectiveness, contributing to improved programming education outcomes.	
A Cloud-Based Approach to Introducing Machine Learning in Project-Based Learning Environments	Joshua Stone Forrest Milner Abigail Guicheteau
Machine learning (ML) has seen a drastic increase in relevance across all engineering disciplines. As such, engineering students must explore this emerging technology early in their engineering journey to provide students with the necessary background and tools to undertake this new dawn of technological advancement. By introducing machine learning during first-year coursework, engineering educators are provided a unique position to properly and effectively introduce students to the unique problem-solving capabilities of ML. The University of Maryland's Introduction to Engineering class is a 3-credit project-based, introductory engineering course that challenges first-year students to develop and employ skills such as modeling, prototyping, manufacturing, troubleshooting, project management, coding, electronics, and teamwork, to ultimately build an Over-Terrain Vehicle (OTV) capable of autonomous navigation and completing mission-specific tasks. Through a pilot semester, the course exposed students to machine learning using NVIDIA Jetson Nanos. However, the steep learning curve required to operate the Jetson Nanos coupled with integration complexities ultimately impeded students from fully grasping machine learning concepts. Because of this, a cloud-based instructional approach using Google Colab was adopted to bridge the gap for students without prior programming knowledge whilst still allowing them to get hands-on machine learning experience. Around 420 first-year engineering students interacted directly with machine learning by first completing an introductory lesson via Google Colab that provided the necessary background information and creative autonomy to explore fundamental machine learning concepts. Student teams were then able to apply the lesson by creating custom image-based ML models for their project's design. To make decisions autonomously, the teams' OTVs would transmit live images via a wireless camera that their trained model then processed to form a prediction. Full technical support was provided to facilitate machine learning integration as a project solution. Students were surveyed on their knowledge of machine learning before and after the initial lesson and at the end of the semester. The efficacy of the curriculum was evaluated through these surveys, instructor observations, and student feedback. This paper explores the details of the material, the technical efforts and support necessary, and the student learning outcomes from the renovated machine learning curriculum.	
Integration of Digital Tools and Technologies in First-Year Engineering Courses	Kapil Gangwar
In a 15-week semester at Wentworth Institute of Technology, the utilization of digital tools and technologies in first-year engineering courses has proven to be quite beneficial in response to the demanding requirements of higher-level classes, the engineering profession, and the broader technological landscape. This paper, currently a work in progress (WIP), aims to highlight the importance of integrating digital tools and technologies into the curriculum for first-year engineering students. Digital tools such as CAD, simulation and modeling software, virtual laboratories, interactive learning modules, SharePoint, data analysis and visualization tools, and programming environments offer diverse opportunities to enhance the learning experience, engage students, and prepare them for the challenges of engineering practice, particularly in the higher level classes. These tools enable students to visualize and experiment with complex engineering concepts, conduct experiments remotely, access interactive learning materials, collaborate with peers, analyze and interpret data, and develop programming skills. Through the integration of digital tools and technologies, first-year engineering students can benefit from hands-on learning experiences, gain opportunities for collaborative learning and communication, and prepare themselves for the digitally-focused modern engineering industrial world.	

Full Papers VI: Tools for Learning and Engagement	
Supporting Students' Educational Robotics Experiences through Generative AI Chatbots	Ethan Danahy Mehek Kunal Vora Yume Menghe Xu William Church

This full paper proposal describes a first-year engineering course that leveraged Generative Artificial Intelligence (AI) chatbots to support students' educational robotics experiences. Analysis of surveys, course work, and chatbot logs resulted in a categorization of experiences and classification of students within the course, and a proposed set of recommendations for enhancing the experience in order to better utilize the technology across all types of students (specifically those with less prior engineering/coding experience who subsequently struggled to leverage the genera-tive AI technology to their full benefit). With the release of and widespread availability of generative artificial intelligence interfaces, education (in general across ages, and within engineering education at the university level more specifically) is starting to experiment with new teaching and learning paradigms around the incorporation of these tools and exploring the effect (both good and bad) they can have on the classroom experience. This paper presents how generative AI chatbots, specifically primed with particular domain knowledge, can be used to support various steps of the engineering design process within a university-level first-year introductory engineering class. Research data was collected from a single section of a first-semester introduction to engineering course at a small, private engineering school in the northeast part of the United States. The semester-long course, consisting of 30 first-year engineering students (21 of which consented to IRB-approved research around their course activities and submissions), occurred during the 15-week Fall 2023 semester (September 6th through December 22nd, 2023). Arti-facts used in this analysis include students' self-reported responses to class surveys (beginning and end of semester), assignment submissions to projects and other course work (14 different tasks), and logs of generative AI usage cap-tured by the custom chatbot interface developed for use in the course. Throughout the semester, the students in the class initiated 1,014 different conversations with the generative AI chatbots and the system captured a total of 3,245 individual messages. The course is themed around using robotics to solve a variety of engineering challenges, with focus on students' introduction to and engagement in engineering design. In Fall 2023 the same set of robotics challenges was presented (as in previous years) but several different custom chatbots (built on OpenAI's ChatGPT-4 platform but primed with course-specific information and accessed via a course-specific interface) were created and made available to the stu-dents in order to enhance the experience and supplement, replace, or circumvent some of the traditional instructor provided content. For instance, as this particular course utilizes a LEGO-based robotics platform (LEGO Education's SPIKE Prime), two chatbots (coined "BuildBot" and "PrimeBot" respectively) were created to assist students in the construction and programming tasks associated with the platform. This shifted the need away from class instruction time to require focus specifically on details of the hardware kit or the Python-based coding language. Similarly, the following chatbots were also provided to students: "GeneralBot" which could be used to ask for general questions of the generative AI, "WebDeveloperBot" that assisted in updating HTML/CSS/JS code for creating web pages and web-based digital portfolios that were required for project documentation submissions, and "SyllabusBot" which was primed with course-specific logistical information direct from the course syllabus. Students were granted permission to leverage these new resources (the 5 custom chatbots) as needed to accomplish any of the semester tasks presented, and examination of the usage logs show that many did for things such as designing and building mechanical solutions, coding the robotic system, customizing their digital project documentation, and navigating class-specific logistical information. This paper introduces the new technologies developed (detailing the platforms on which these systems were created and the interface design for chat interactions) and an analysis of the usage by the students (breakdown of use across the different chatbots, and a temporal analysis of when in the semester different resources were leveraged and in what way/to what extent). Previous work ([REF REMOVED], 2024) looked at pre-post changes in perceptions and attitudes of the students with regards to use of AI in education, and this work will build on that class-wide analysis to examine in more detail at the student-level, combining the pre-post survey data with the data from usage logs. A classification of the data has resulted in four characterizations of students across two dimensions (in-coming engineering experience and in-class utilization of the generative-AI platform): (1) students with high-levels of prior engineering (or coding) experience who successfully leveraged AI a lot in their work to enhancing their abilities, (2) students with high-levels of prior engineering (or coding) experience who had low utilization of AI and manually completed many of the tasks, (3) students with low-levels of prior engineering (or coding) experience who engaged with the AI a lot to successfully accomplish difficult tasks, and (4) students with low-levels of prior engineering (or coding) experience who had minimal usage or less successful patterns of use with the tools. This work theorizes that, for this fourth group, issues during early attempts at using the generative AI for tasks discouraged them from future use and, overall, they didn't experience the potential for how the AI could augment their work and assist in completing the course tasks. Implications of this chatbot usage analysis (and connections to individual student perceptions and overall class experience) indicate a need for thoughtful introduction and integration of generative AI tools in engineering education, especially in the first-year during formative engineering experiences. To address this, this work proposes early assignments that help students learn beneficial styles of interaction (e.g. prompt formulation strategies that produce higher quality output) and general experiences that facilitate students in understanding the value of using such tools, in the theory that these will provide skills and motivation to continue sustained successful usage throughout the semester across all categories of students.

FIRST-YEAR
FYEE
ENGINEERING EXPERIENCE

LVX VERITAS VIRTVS
Northeastern University
College of Engineering
First-Year Engineering