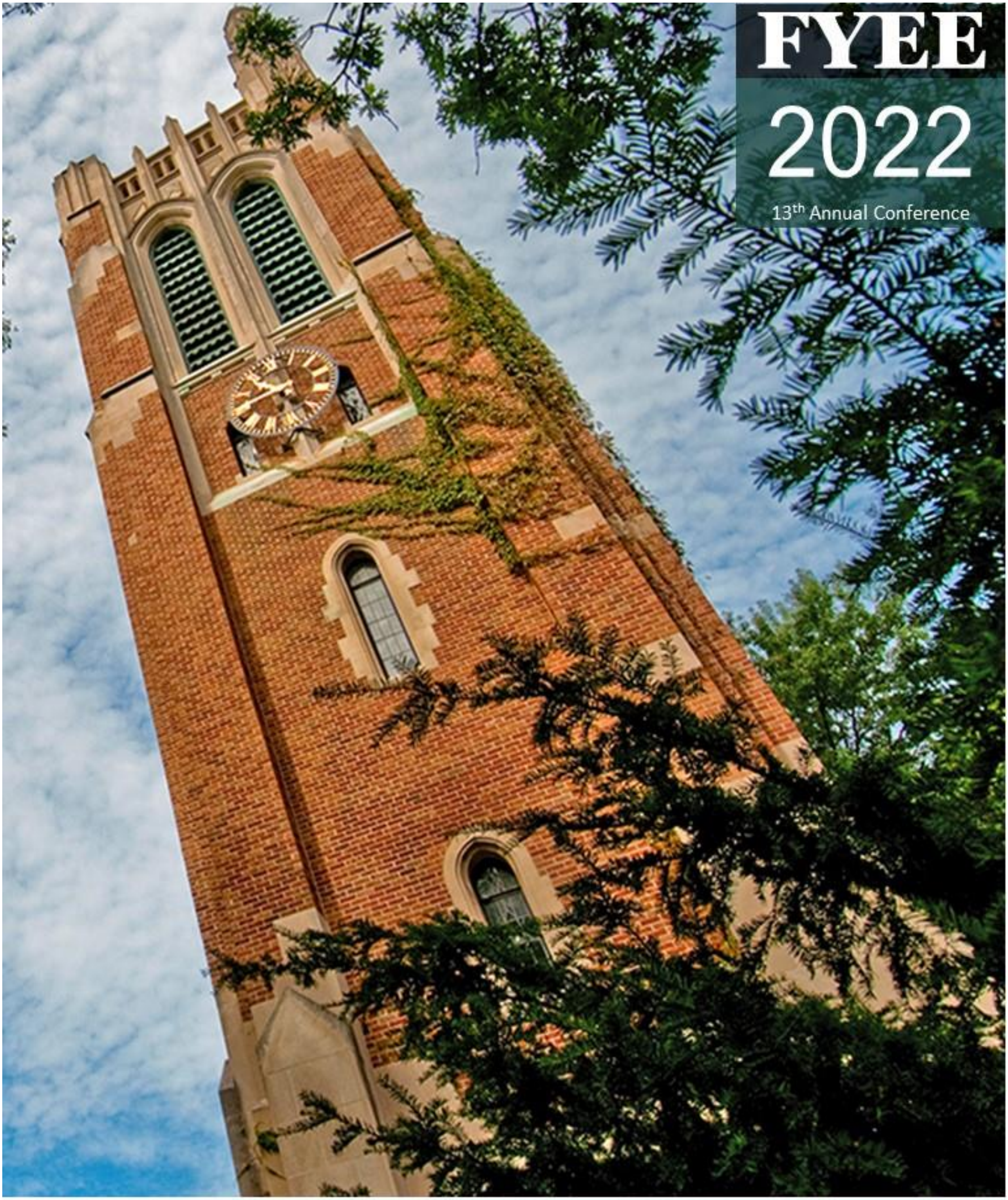

FYEE 2022

13th Annual Conference

July 31 to August 2

Kellogg Hotel and Conference Center
Hosted by Michigan State University
College of Engineering

MICHIGAN STATE UNIVERSITY

Welcome from the General Chairs

Timothy Hinds
Director, First-Year Engineering CoRe Experience, College of Engineering, Michigan State University

Jaskirat Sodhi, Ph.D.
Senior University Lecturer, Mechanical and Industrial Engineering, New Jersey Institute of Technology

Welcome to the 13th Annual First-Year Engineering Experience Conference hosted at Michigan State University. We are excited to be able to meet in-person for the first time since 2019. The conference has a long history of sharing of ideas developed by innovators in first-year engineering education from around the country and beyond.

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

First-year engineering at Michigan State underwent a major transition in 2007 with the inauguration of the Cornerstone Engineering and Residential Experience (CoRe) program. This fully-integrated academic, residential and student services initiative strives to meet the educational, professional and personal needs of nearly 2000 students annually. We are pleased to be able to hold a portion of the conference in some of our facilities.

The FYEE conference will take place in the Kellogg Hotel and Conference Center, starting with workshops and a meet & greet session on Sunday. Monday will feature works-in-progress and poster presentations followed by workshops and paper presentations in the new MSU first-year engineering classrooms and labs. A keynote address will be part of the Monday evening dinner session. The conference will conclude on Tuesday with additional paper presentations and discussions.

We hope the conference will be beneficial for all!

Conference Committee

The FYEE conference is made possible by the dedication of many volunteers

Conference Chair: Timothy Hinds, Michigan State University

Program Chair: Jaskirat Sodhi, New Jersey Institute of Technology

Sponsorship Chair: Timothy Hinds, Michigan State University

Website Management: Jack Bringardner, New York University

Conference Program Development: Jason Smith, Michigan State University

The FYEE Conference Steering Committee:

Sean Brophy, Purdue University
Kris Craven, Tennessee Tech
Lee Rynearson, Campbell University
Katy Schulte Grahame, Northeastern University
Ashwith Chilvery, Xavier University of Louisiana
Scott Streiner, University of Pittsburgh

Welcome from the Dean

Dear FYEE Attendees,

Welcome to the Michigan State University College of Engineering. We are honored to be hosting the 13th annual First-Year Engineering Experience (FYEE) Conference.

Michigan State has been graduating Spartan Engineers since 1888 and granting advanced degrees in engineering since 1901. It is a legacy we honor and embrace as we continue to experience tremendous transformational growth.

This past year we were privileged to have 6,100 undergraduate and 900 graduate engineering students in our college. These bright, innovative and industrious students are taught by a world-class academic team which includes 235 tenure-system faculty across eight departments and one interdisciplinary program. We continue to focus on engaging more women and underrepresented minority populations with the engineering profession and are working hard to steadily improve our diversity, equity and inclusion status.

For fall 2022, we are expecting over 1,900 incoming students to join our First-Year Engineering Cornerstone and Residential (CoRe) Experience. CoRe is a fully-integrated academic and co-curricular program that regularly draws attention for the robust support and opportunity it affords students just beginning their engineering journey. And, we are excited to hold a portion of the 2022 FYEE Conference in our recently-refurbished CoRe classrooms and laboratories in Wonders Hall.

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

Leo Kempel
Dean, MSU College of Engineering

Table of Contents

Conference Sponsors

Conference sponsors and affiliates play an important role in supporting the FYEE conference. We are grateful to these organizations whose support of the FYEE 2022 conference enhances the experience for all attendees! Please visit our exhibits area and attend the sponsored workshops to express our appreciation.

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FIRST-YEAR PROGRAMS DIVISION

Conference at a Glance

**All times Eastern Daylight Time (EDT)*

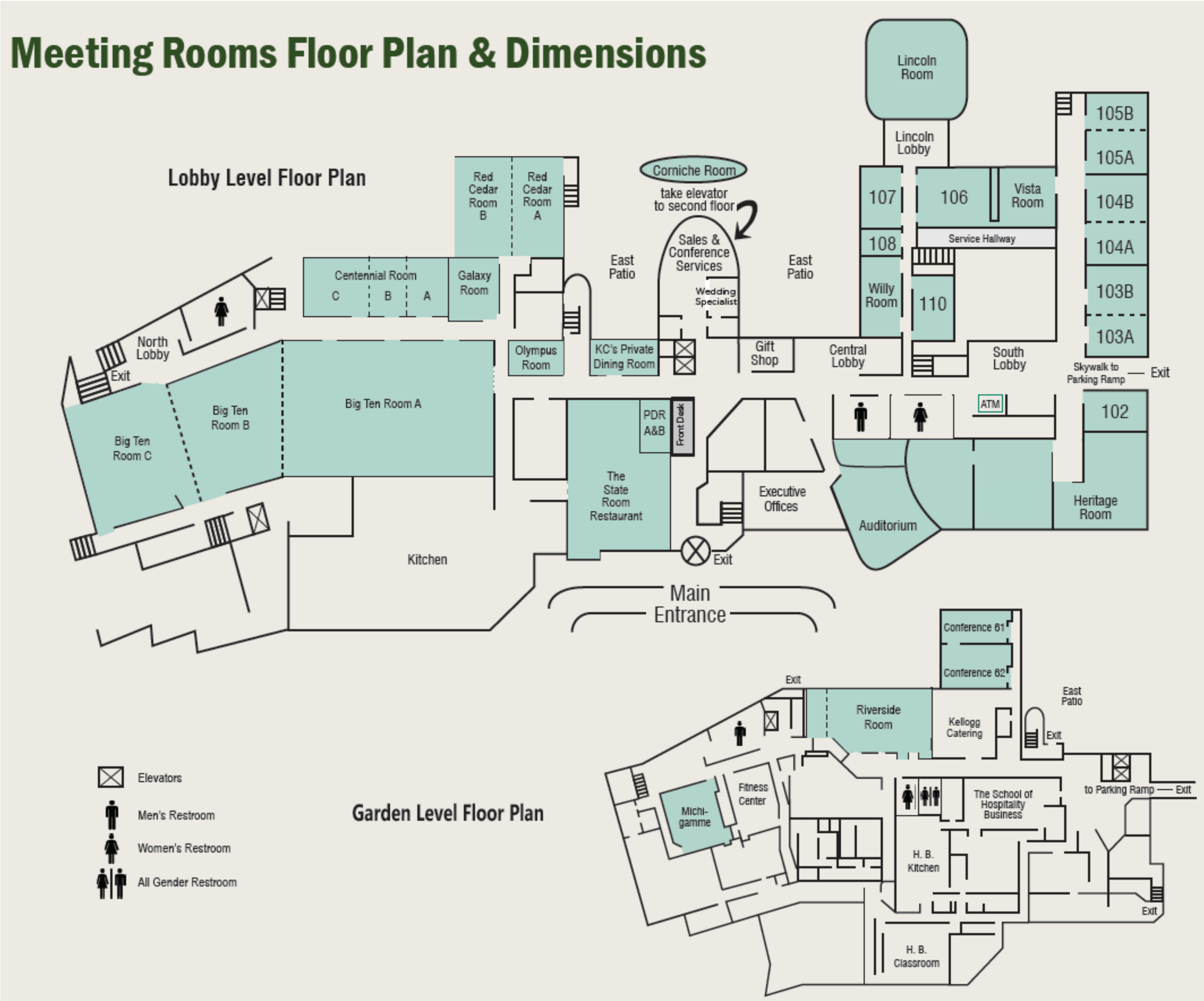
Sun, July 31	Event	Lead Author	Location
2:00-8:00 PM	Registration		Lincoln Lobby
2:30-4:00 PM Technical Session S1	**S1A – Workshop I**		Kellogg 103AB
	The Integration of Technical Skills Within a First-Year Engineering Design and Innovation Course Featuring Hands-On Electronics	Tracy Jane Puccinelli	
	S1B – Workshop II		Kellogg 104AB
	Student Success Beyond COVID: Teaching The Workforce Of 2026	Todd Hamrick	
	S1C – Workshop III		Kellogg 105AB
	Low Cost—High Impact: Success Skills Students will Actually Use	Peter Shull	
4:00-4:15 PM	Networking Break		Lincoln Room
4:15-5:45 PM Technical Session S2	**S2A – Workshop IV**		Kellogg 103AB
	Holistic Retention Programming for First Year Students	Whitney Gaskins	
	S2B – Workshop V		Kellogg 104AB
	Let's Talk to Our Rubber Ducks: A Unique Approach to Tackling Computational Thinking, Analyzing Code, and Debugging using a Scavenger Computational Thinking, Analyzing Code, and Debugging using a Scavenger Hunt	Stephany Coffman-Wolph	
	S2C – Workshop VI		Kellogg 105AB
	Community-Engaged Learning in First-Year Engineering	William Oakes	
6:00-8:00 PM	Meet and Greet		Lincoln Room

Mon, Aug 1	Event	Location
7:00 AM-12:00 PM	Registration	Lincoln Lobby
7:00-8:00 AM	Breakfast	B1G 10 BC
8:00-8:30 AM	Welcome	
8:30-8:45 AM	Group Picture	Lincoln Room
8:45-9:30 AM Technical Session M1	M1 – Works-in-Progress Presentations	Lincoln Room
9:30 -10:30 AM Posters and Exhibits M2	M2 – Posters and Exhibits	Lincoln Room
10:30-11:00 AM	Transport to Wonders Hall	

Mon, Aug 1	Event	Lead Author	Location
11:00 AM –12:30 PM Technical Session M3	**M3A – Workshop VII**		C211 Wonders
	Hands-On Design Activities for Introduction to Engineering Courses to Accommodate Students of Varying Backgrounds	John Krupczak	
	M3B – Workshop VIII		C213 Wonders
	Fully Engaged: Integrating Mindfulness and Meditation in Engineering Classes	Kathryn Schulte Grahame	
	M3C – Workshop IX		C215 Wonders
	Helping Students Develop their Cross-Cultural Communication Skills to Promote a More Diverse and Inclusive Learning Environment	P K Imbrie	
12:30-2:00 PM	Box Lunch & Tours		Wonders Hall
2:00-3:30 PM Technical Session M4	**M4A – Sponsored Workshop I**		C211 Wonders
	Top 5 "Soft Skills" Every First-Year Engineer Needs to Know	Danny Rubin, Rubin Education	
	M4B – Sponsored Workshop II		C213 Wonders
	From First Year to the Workforce: A Guide to Computational Skills for the Future	Hoda Sharifi, MathWorks	
	M4C – Workshop X		C215 Wonders
	Introduction to Adaptive Comparative Judgement: A Holistic Assessment tool for Design Problems	Clodagh Reid	
3:30-3:45 PM	Networking Break		C202 Wonders
3:45-5:00 PM Technical Session M5	**M5A – Computer Oriented First Year Courses**		C211 Wonders
	The First-Year Computer Science Experience Project	John Cole	
	First-Year Computing Course with Multiple Computing Environments - Integrating Excel, Python and MATLAB	Sean Brophy	
	First Year Engineering Student Definitions of Systems Engineering: A Comparison Between Two Institutions	Katrina Carlson	
	M5B – Remote Learning and Team Building in First Year Courses		C213 Wonders
	Evaluating Freshmen Engineering Students' Experience in a First-Year Engineering Program and Lessons Learned during Covid-19 Pandemic	Heath Aren Schluterman	
	An Investigation of Team Conflicts in a Large-Enrollment Introductory Engineering Course	Haritha Malladi	
	How Can We Make This Work? First Year Engineering Design Team Development in Virtual vs. In-Person Environments	Natalie C.T. Van Tyne	
	Lessons Learned from COVID That Have Been Transferred to Post-COVID Teaching and Learning	Michael Cross	
	M5C – First Year Design Projects		C215 Wonders
	Provision of the practical learning environment via application-based projects integrated with the undergraduate engineering curriculum	Surupa Shaw	
	Community-Engaged First Year Learning Community	Srinivas Mohan Dustker	
	Redesigning an Introduction to Engineering Course as an Interdisciplinary Project-Based Course	Kelly Salyards	
	An International Design Project for First Year Engineering Students at Multiple U.S. Institutions	Thomas J. Siller	
5:00-5:30 PM	Transportation to Kellogg Center		Wonders
5:30-6:30 PM	Networking & Downtime		Kellogg
6:30-8:30 PM	Dinner & Keynote		B1G 10 BC

Tue, Aug 2	Event	Lead Author	Location
7:00-11:00 AM	Registration		Lincoln Lobby
7:00-8:30 AM	Breakfast		B1G 10 BC
8:30-9:45 AM Technical Session T1	T1A – Innovative First Year Curriculum		Kellogg 103AB
	Improving Inclusion and Growth Mindset in First Year Engineering, Science and Mathematics Courses	Jared Oluoch	
	Data And Stakeholder Driven Redesign of a First-Year Engineering Curriculum	James R McCusker	
	Student Perceptions of Involvement, Identity, and Success in an NSF-funded STEM Access Program at Baylor University	Jessica Martin	
	Towards the Use of the MUSIC Inventory for Measuring Engineering Student Engagement	Susan L. Amato-Henderson	
	T1B – Writing and Reflections in First Year Engineering		Kellogg 104AB
	Goal-Setting Reflections for First-Year Students	Charles E. Pierce	
	Student and Instructor Reflections on Integrating Short Mindfulness-Based Meditation Practices into a First-Year Engineering Design Course	Hannah Nolte	
	Familial Influence on the Choice to Study Engineering: Insights from a Cross-University Study	Amanda Singer	
	Student Reflections on Team Experiences in a First-Year Engineering Course	Jenahvive K. Morgan	
9:45-10:15 AM	Networking Break		Lincoln Room
10:15-11:30 AM Technical Session T2	T2 – GIFTS Presentations		Lincoln Room
11:30AM–12:15PM	Closing Remarks		B1G 10 BC
12:15 – 1:00 PM	Lunch		B1G 10 BC
1:00 – 6:00 PM	Depart, Networking or Downtime		Kellogg Center
6:00-6:30 PM	Transportation to Jackson Field		Kellogg Center
6:30-7:00 PM	Dinner on Own at Jackson Field		Jackson Field
7:05-9:30 PM	West Michigan Whitecaps at Lansing Lugnuts		Jackson Field
9:30-10:00PM	Transportation to Kellogg Center		

Conference Location and Map



Monday Keynote – Engaging in Community Design: Teaching, Learning and Justice

Vincent Delgado - Senior Academic Specialist
Director, Program on Sustainability in Costa Rica
Coordinating Director, Network for Global Civic Engagement
Residential College in the Arts and Humanities
Michigan State University

Abstract: The critical role of community-engaged research and design in meeting higher education's responsibilities around justice, diversity, equity, and inclusion goals is well-documented – and growing increasingly important. And, as we exit the lockdown phase of a global pandemic and students return classes, teaching and learning these methodologies to develop engineers that can respond creatively, confidently, and effectively to global challenges in their workplaces and communities has become increasingly urgent. In his remarks, Vincent Delgado will recount the impacts on students and communities of his more than a decade of community engaged design teaching and learning collaboration with the MSU College of Engineering First-Year Engineering CoRe Experience and communities in Michigan and Costa Rica.

Bio: Vincent Delgado has spent nearly 30 years in public engagement - as a public affairs journalist, co-founder of the Refugee Development Center, former Lansing City Council member, and as founding MSU Residential College in the Arts and Humanities (RCAH) Assistant Dean for Civic Engagement. RCAH is "a student-centered college that mobilizes the arts and humanities through our wide range of programming to create collaborative, community-engaged methods for addressing the complex societal problems facing our local and global communities, and to reimagine and build a more just, equitable, and sustainable world." Today, Delgado supports innovations in MSU global university-community partnerships as founding coordinating director for Network for Global Civic Engagement. He integrates and teaches students and faculty from across the university in sustainability-focused research, design, and art projects across Costa Rica as the founding director of the Program on Sustainability in Costa Rica. Most recently, Delgado, along with MSU CoRe Director Timothy Hinds, co-wrote a proposal for one of the first Design Justice minors in the United States. His areas of interest include nonprofit management; international partnership ecosystems; and civic engagement curriculum development and assessment. He is currently working on a new concept for university-community engagement called Radical Reciprocity. Delgado lives on the edge of one of the largest cloud forests in the world in Monteverde, Costa Rica, with his wife Becky Shink and sons Pablo and Diego. He holds a B.A. in English and Communications from the University of Michigan and an MPA from Western Michigan University.

Sunday July 31, 2:30-4:00pm Session S1 Workshops

Workshops S1	Facilitator	Location
The Integration of Technical Skills Within a First-Year Engineering Design and Innovation Course Featuring Hands-On Electronics	Tracy Jane Puccinelli	Kellogg 103AB
Student Success Beyond Covid, Teaching The Workforce Of 2026	Todd Hamrick	Kellogg 104AB
Low Cost—High Impact: Success Skills Students will Actually Use	Peter Shull	Kellogg 105AB

The Integration of Technical Skills Within a First-Year Engineering Design and Innovation Course Featuring Hands-On Electronics

Kellogg 103AB

Dr. Tracy Jane Puccinelli, University of Wisconsin - Madison
Ms. Courtney Lynch, University of Wisconsin - Madison
Dr. Lennon Rodgers, University of Wisconsin - Madison

The purpose of this workshop is to expose and train instructors on how to deliver and integrate this electronics fundamentals module into their courses. While experiencing the fun hands-on activities from a ”student's perspective” the team will share their scalability strategy, lessons learned, and then open up for further discussion regarding other integrative engineering educational approaches. This workshop at the FYEE conference is intended to serve as an additional resource on best practices for adding and scaling effective technical skills modules to first-year engineering design courses, and to foster discussion of integrative education.

Student Success Beyond Covid, Teaching The Workforce Of 2026

Kellogg 104AB

Dr. Todd R Hamrick, West Virginia University

The past two years have been challenging to say the least. There is still much uncertainty about the next academic year and how the changes brought on by the pandemic will influence teaching and the workplace in the years to come. The pandemic is a persistently disruptive event, meaning that the disruptions that it caused will persist long after the event itself. Our students will be the workforce of the future, and they will graduate into a world different than any that we could have imagined only two years ago. Some of the changes were quick pivots, while others were an acceleration of existing trends. This workshop will explore not just the 2022-2023 academic year, but 2026 and beyond when the students of today are the engineers and leaders of tomorrow.

The workshop will begin with a presentation of about 20 minutes, with about 30 minutes devoted to breakout group work and discussion. The final 15 or 20 minutes will bring the breakout groups back together for a summary and reflection. Participants should come away with a longer view of the changes that are likely to persist into the future, and some ways that we can help students to develop the tools that they will need to be successful in it.

The presentation is based on a similar workshop that I conducted at my home university in summer of 2021 and will be updated and conducted again in May, 2022 at WVU's CELEBRATE workshop. The content is based on experience and research into changes that the corporate world has made, and how we in academia can best prepare our students to succeed in it. Sources include works by Harvard Business school on collaboration, Mackensie consulting, Chronical of Higher Education, and others.

When I conducted the similar webinar last year we were still in the middle of the pandemic, but there were many predictions. As the pandemic eases and evolves into its later phases, the post-pandemic world is becoming clearer. Some companies are re-thinking their approach to the new landscape, and many workers are re-evaluating their relationships to their employers. The post-pandemic world is beginning to take shape.

The presentation will discuss topics such as

- Perspective on persistently disruptive events
- Changes that are expected to persist and some which won't
- Evolution of skills based performance and hiring metrics
- Expected changes to corporate culture
- Changes in remote, partial remote, and face to face interactions
- Mentoring and collaboration relationships in a more distanced work environment
- Remote work life balance
- Effects of remote work on under-represented groups

Low Cost—High Impact: Success Skills Students Will Actually Use

Kellogg 105AB

Dr. Peter J. Shull, Pennsylvania State University, Altoona Campus

Modern higher education has always struggled with student academic success rates. Despite significant efforts to improve graduations rates, for the past decade they have remained relatively stagnate.

While most institutions have implemented study skill training (both on line and courses) increased tutoring, and other learning resources, graduations rates remain at ˜60%. So a fair question is "Do these efforts work?" The answer is yes and no. Yes, the skills work but only if used and used consistently. So for many students the answer is no.

This work presents methodologies grounded in current neuro-science that have been developed in response to this dilemma. These success methodologies are termed Low Cost—High Impact success skills. By design, these success methodologies are low cost to both students and faculty. For students, low cost implies the methods must be very efficient, i.e., easy to learn and implement, rapidly implemented, and have a high rate of learning. High impact is related to effectiveness in learning. The crux of effectiveness is not if a particular method works (it wouldn't be used if it didn't work) but whether students will consistently use the method. This crux element—will students use the success skill—is generally overshadowed by how well the method would work if employed.

From a faculty standpoint, low cost consists of a) a small learning curve, b) little disruption to status quo, i.e., readily integrated into any course, c) little to no disruption to faculty's mode of teaching, and d) a universal design for implementation into any disciplines. High impact refers to student performance including student engagement in class as well as overall performance.

This workshop with develop the key elements of low cost—high impact methods and their distinctive features that make them effective and efficient success skills that student will actually use. The second portion of the workshop participants will work in groups to develop new LC—HI methods or modify common success method such that students will more readily employ them.

Sunday July 31, 2:30-4:00pm Session S2 Workshops

Workshops S2	Facilitator	Location
Holistic Retention Programming for First Year Students	Whitney Gaskins	Kellogg 103AB
Let's Talk to Our Rubber Ducks: A Unique Approach to Tackling Computational Thinking, Analyzing Code, and Debugging using a Scavenger Hunt	Stephany Coffman-Wolph	Kellogg 104AB
Community-Engaged Learning in First-Year Engineering	William Oakes	Kellogg 105AB

Holistic Retention Programming for First Year Students

Kellogg 103AB

Dr. Whitney Gaskins, University of Cincinnati

In this workshop, participants will learn how to build a holistic retention program that supports diverse first-year students in engineering. The model retention program is student-focused and developed with the student voice in mind. This workshop will present a working model of a current retention program, lessons learned from developing the program and future paths and opportunities for growth. Participants will also engage in interactive case studies to show the adaptability and flexibility of the retention program.

This will be an interactive working session. Participants will work collaboratively through case studies. In addition to discussing the above techniques, participants will share best practices, collaborate with colleagues, and develop ideas they can implement at their institution.

Learning Outcomes:

- Effective techniques to engage scholars in their success.
- Intrusive advising strategies to improve early warning, intervention, and outcomes
- Practical and effortless ways to use the tools at your campus for student development

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Workshop: Let's Talk to Our Rubber Ducks: A Unique Approach to Tackling Computational Thinking, Analyzing Code, and Debugging using a Scavenger Hunt

Kellogg 104AB

Dr. Stephany Coffman-Wolph, Ohio Northern University
Dr. John K. Estell, Ohio Northern University

A rubber duck can act as a sounding board for programmers to work through difficult concepts or complicated logic sequences. Speaking or explaining code logic out loud is known to be highly beneficial when ”stuck” by an error. Andrew Errington created the concept of ”rubber duck debugging”. A good programmer needs to develop several essential skills including debugging, computational thinking, and code analysis. How do we instill these concepts into first-year programming students? Introductory programming students are often reluctant to try debugging their code independently. Introductory programming instructors watch their students write lines and lines of code without compiling the code or testing the code.

During this workshop attendees will learn how to add fun to their courses by using a code-based scavenger hunt. Each scavenger hunt clue is a small (less than one page) C++ program provided to the students via a hard copy. The students, work in teams of 2-4, are forced to ”think like the computer” and analyze the code (further developing their computational thinking skills). By stepping away from the compiler and unable to just run the program, students must work on understanding the specifics of the material. The output statements within the code provide the location of the next clue, with the final clue leading to the students selecting the rubber duck that ”quacks” to them. The scavenger hunt gets the students out from behind their computers, introduces the students to an industry practice, and opens the door to future assignments on debugging techniques. The scavenger hunt covers a wide variety of topics, including (1) mathematical expressions, (2) mod operator, (3) integer math, (4) switch statements, (5) if statements,
(6) increment/decrement, (7) for loops, (8) while loops, and (9) do-while loops. Typically, the scavenger hunt beings in the

classroom. The instructor ensures all teams have started the scavenger hunt and then ”disappears” to the final location. The scavenger hunt could take students on a journey of their college/university to become more familiar with important locations (e.g., where office hours are held, department office, computer lab, etc.).

Learning Objectives for Workshop: By the end of this workshop, attendees should be able to:

1. Explain what rubber duck debugging is and how it is used
2. Understand the importance of computational thinking in programming
3. Explain how the scavenger hunt allows for graceful failure
4. Create their own scavenger hunt for a course they teach

This workshop will cover background on key concepts discussed (rubber duck debugging, computational thinking, and code analysis), the importance of learning debugging techniques, the specifics of the Computer Science 1 (CS1) scavenger hunt, hints and tips for adapting this for other programming languages, adapting this to courses outside of the computing field, and hints and tips for creating an online version or a version for a course with large enrollment. The workshop session facilitators believe in active learning techniques. Therefore, attendees will have the opportunity to try out a code-based scavenger hunt during the workshop.

Workshop Presentation Schedule:

1. Introduction, Purpose, and Agenda
2. Talk to your Rubber Duck! Rubber Duck Debugging Explained
3. Let’s Go on a Scavenger Hunt!
4. Adaption to other courses or larger class sizes
5. Online Resources, Q & A, Wrap-up

Community-Engaged Learning in First-Year Engineering

Kellogg 105AB

Dr. William ”Bill” C. Oakes, Purdue University at West Lafayette (COE)

Community-engaged learning or service learning has grown pedagogy in higher education and within engineering and related fields. The pedagogy integrates academic learning with service activities and partnerships with local or global communities. It provides a learning environment that is very well-matched with ABET across programmatic outcomes as students can learn strong technical skills while developing teamwork, communication and leaderships skills. The community and human context provides rich learning experiences for contemporary social, global and ethical issues. . Evidence suggests that community-engaged learning also has the potential to increase participation among underrepresented populations within engineering, technology and computing. Evidence also shows that participants increase motivation to stay in engineering offering exciting opportunities for first-year programs. There are however many challenges integrating real community engagement into the classroom including meeting learning outcomes and partner needs. This interactive workshop will provide an introduction to community engaged learning and use a recently developed model to explore approaches that seek to balance value to students and communities as well as resources that are needed from each. Resources, partnerships, benefits and potential barriers will be discussed to provide strategies for successful implementation at the participants’ own institutions. The presenter is experienced in the field and has conducted more than 100 faculty workshops on the subject area.

Monday 8:45-9:30am Session M1: Works-in-Progress (Lincoln Room)

WIP: Developing the next generation expert: What we learned from under-academically prepared students about academic self-efficacy in engineering and computing

Dr. Jennifer I Clark, Montana State University - Bozeman
Dr. Bryce E. Hughes, Montana State University - Bozeman

Preparing the next generation expert (NGE) in engineering or computing is well documented in the literature as a necessary problem of practice to focus efforts. Programs to retain students in these majors have been developed, implemented, and studied to ensure their effectiveness. In Fall 2020, as the world was processing how to move forward while managing a pandemic, a cohort of 3100 students were beginning their Freshman year at a US, land grant university. Of that cohort, 798 students had declared an engineering or computing major and 160 were beginning their academic goals not ready for calculus. This cohort of students is defined by the literature as academically under- prepared for an engineering or computing major and is expected to continue increasing in size in the coming years.

Embracing its mission as the land-grant institution of a Northwestern state in the US, a single application process determines admission to the university and to the College of Engineering. This extends an invitation to students: "Come ready to engage with your academic community and we will help you move forward from any level of aca- demic readiness." Retention programming meets students at the door to help them integrate into the college – including those who are not ready for calculus. This study used a phenomenographic approach and combined two complex theoretical frameworks to explore the student experience with a modified version of an academically under-prepared (AUP) retention program developed to support freshmen in engineering or computing majors. This approach provided a snapshot of eight student-participants' experiences with a structured retention program and its effect on their developing relationship with engineering or computing content. Data were gathered through one-on-one, semi-structured interviews to answer an over-arching research question, with four complementary questions focusing on how sources of self-efficacy influence an individual's engagement with challenging academic content.

This work-in-progress uses the student experience to present support for pairing an invitation to consider engineering or computing as disciplines to pursue with programs fostering an inclusive culture related to academic readiness. Retention programs can do this if they are intentionally structured and there is a culture that normalizes any level of academic readiness as an acceptable foundation for pursuing engineering or computing. Findings from this work share, through the student's voice, their interest and ideas for strong, well-organized programs which help them establish relationships with their academic community.

WIP: Effectiveness of Recruitment Strategies for Underrepresented Groups in an Engineering Bridge Program

Dr. Xinyu Zhang, West Virginia University
Dr. Lizzie Santiago, West Virginia University
Stefanie Paige Hines, West Virginia University

The Academy of Engineering Success (AcES) program at *** University is an integrated supplemental academic success and professional development program, consisting of a week of activities prior to the fall semester (summer bridge program) and a semester-long professional development course in the fall. The program is specifically designed for first-year engineering students who are non-calculus ready, as an effort to promote the retention of these students in engineering. Some need-based scholarships were awarded with the intention of recruiting and retaining a larger number of underrepresented students (female, minorities, first-generation, and low-income). *** University is a pre- dominantly white institution (PWI) where first-time freshmen engineering students are 80% of white non-Hispanic origin (Fall 2021 cohort).

In the academic year 2021 (AY21), the AcES program encountered challenges in recruiting underrepresented students. After two months of marketing the program, there was no first-generation, no low-income, and only one minority student that had signed up. Based on literature and recruitment results from the Energy Land Management (ELM) program at *** University, we learned that early intervention activities in K-12 and targeted marketing are important for the recruitment of underrepresented groups as well as that some recruitment methods are not as effective when recruiting underrepresented students. The AcES program then adopted an inclusive targeted marketing strategy. After this intervention, AcES program's student body was more diverse, resulting in 20% first-generation, 30% low- income, 30% female, and 20% underrepresented minorities (URM) in the enrollment.

This work-in-progress research aims to (1) analyze the past enrollment data in AcES program before and after applying this inclusive recruitment strategy, (2) conduct surveys to understand the reasons for the effectiveness of different recruitment strategies in diversifying the cohort, and (3) devise a plan at different levels to enhance the recruitment of engineering student from diverse background, particularly the underrepresented populations in the future.

WIP: Success and Retention Strategies for STEM Gatekeeper Courses in a Community College

Ms. Nada Veskovic, Lehigh Carbon Community College

The purpose of this work in progress is to develop and implement a three-pronged approach to improve student success and retention in STEM gatekeeper courses. We defined a gatekeeper course as a historically difficult course with high failure and withdrawal rates. Engineering technology courses are especially targeted since early student failure in these courses typically leads to students abandoning engineering technology majors altogether.

Our three-pronged approach will consist of the following: 1) Implement an active learning strategy by starting most lecture classes with a conceptual question, 2) Improve student engagement with academic support services through novel use of learning management system course shells, and 3) Assign a student leader / embedded tutor to a class. Student leaders are students who took the course successfully in the past and who are available and willing to help current students. They run review sessions, share their own experience on how to effectively study for the course, and assist during labs.

Currently, we are testing this approach on one engineering technology course with good results so far. An early observation we have is that in addition to improvement in attendance and projected pass / fail rates, there is an increase in student collaboration in and out of the classroom.

Once the project has been fully defined and select gatekeeper courses have been identified, we will run a pilot program focusing on STEM and engineering technology courses. After the pilot is over, learnings will be analyzed, and the program modified if necessary, before a college-wide rollout.

WIP: Eagle ExCEL-Engineers Connect, Engage, and Learn: An At-Risk Advising Program

Dr. Elizabeth A. Powell, Tennessee Technological University
Mr. Harry T Ingle Jr., Tennessee Technological University
Dr. Kumar Yelamarthi, Tennessee Technological University

To address retention, attrition, and persistence issues, we have created an at-risk advising program for students who are deemed "academically at risk" in the College of Engineering. The designation includes students on warning, probation, or returning from suspension. The program, Eagle ExCEL- Engineers Connect, Engage, and Learn, was created in collaboration with the CoE administration and professional advisors to help improve students' experiences and chances for success. Unfortunately, when students in engineering fail a class or classes or receive a grade of "D" their time to graduation may increase, leading to unsatisfactory outcomes for all stakeholders involved, especially students. The current percentage of students in our CoE who are at risk is currently over 10%. In addition to increased time to graduation, at-risk students may have difficulties returning to good standing and even graduating (Berkowitz & O'Quin, 2006). In fact, historical data from our university shows that CoE undergraduates whose first year GPA is below the 2.0 required to graduate are at very high risk of not continuing: only 5.7% of students whose first year GPA was in this category, throughout the years 2003-2013, graduated (Student Success Collaborative, 2021).This paper describes Eagle ExCEL as well as data from evaluation from the first year of the program, which began in Fall 2021. Data indicate that goal setting with an advisor is a helpful tool for at-risk students; data also indicate that not all students need the same level of support. Moreover, we learned that there are a variety of reasons why a student may drop below good standing. We conclude by describing our next steps in enhancing and developing this program.

WIP: Identity-Based Bias in Undergraduate Peer Assessment

Miss Madison Jeffrey, University of Michigan
Dr. Robin Fowler, University of Michigan
Mark Mills, UM, Center for Academic Innovation

Peer evaluation is a commonly used practice for group work throughout higher education as it allows students to pro- vide and receive insight as well as provides additional information to faculty. When such peer evaluations may be taken into consideration for grades, it is especially important to look closer at the potential bias that may be present. Students may unconsciously perceive members of their group in biased ways because of ingrained gender or racial biases, potentially resulting in skewed feedback. In this project, we look at how student feedback varies for students with historically underrepresented identities. To accomplish this, we will use survey data from a software tool that monitors team members throughout the course of a project to provide a link between students and instructors. Part of this software allows team members to evaluate one another and provide feedback, including items such as reliability, effort, quality of work, and idea generation. Using hierarchical linear regression, we will investigate patterns of ratings based on identity characteristics such as gender and race (of both evaluator and evaluated) to investigate how these factors are related to evaluations.

WIP: Contract grading as an alternative grading structure and assessment approach for a process-oriented, first-year course

Ms. Erica J Marti, University of Nevada - Las Vegas

This Work in Progress paper will describe the application and outcomes of using contract grading in a first-year engineering seminar. Contract grading has been touted in literature for many benefits, including reducing grade anxiety, allowing students to take more ownership for their grade, and increasing motivation and commitment. In addition, contract grading is associated with building equity and inclusion.

Contract grading has been used more often in writing courses and is notably promoted by Asao Inoue. In examining existing literature, there are very few examples of contract grading in engineering courses, especially with the United States. However, contract grading is especially applicable in process-oriented courses, and it may increase student accountability since they know the requirements at the onset of the class. In addition, contract grading systems where students can repeat an assignment that falls below a threshold (i.e. mastery learning) may be advantageous for students in multiple ways. For example, repeating an assignment is one approach to reduce the grade penalty for students who come in less prepared than their peers.

This paper focuses on 1) the structure of contract grading used in a first-year engineering seminar, 2) aspects of metacognitive learning in resubmitting assignments to meet the contract requirements, 3) challenges and lessons learned from first-time implementation, and 4) student survey feedback.

The seminar course used contract grading as both a grading structure and a form of assessment. Required assessments had criteria-based rubrics indicating what was need to achieve correct/incorrect or excellent/adequate/insufficient levels. If students received incorrect or insufficient, the assignment did not count toward meeting contract requirements. However, students could revise and resubmit the assignment along with a reflection meant to increase metacognition.

As this was the first course where students experienced contract grading and the instructor's first attempt with this approach, there were challenges on both ends. Lessons learned are provided to help other instructors wishing to con- vert from a traditional grading system to contract grading. Student feedback from this Fall 2021 civil engineering lab course will be presented and discussed with focus on perception of control over one's grade, motivation, metacognition and learning outcomes.

WIP: Wrap-Around Advising: A Collaborative Effort Between Faculty Members and Student Success Professionals

Dr. Andrew Assadollahi, P.E., Christian Brothers University
Mr. Mardarius Liddell Thomas, Christian Brothers University

Wrap-around advising involves a holistic methodology that puts the student at the center of attention with support from a team of academic and advising professionals. In recent years, an increasing number of academic units at universities have employed wrap-around advising practices to increase student persistence at the university and in their chosen major. To implement a successful wrap-around student advising process, it is pertinent that the faculty members and student success professionals

embrace a collegiate and collaborative outlook and remain student-centric with regards to student academic success and well-being. Within a civil engineering program, a wrap-around advising model has been developed by a faculty member and a student success professional and implemented in a first-year civil engineering course. This wrap-around advising model involves a collaborative and intensive process of fluid communication among the faculty member, the student success professional, and the students. In this work, the authors discuss the history of development of this advising plan, some challenges, early results, and long-term goals.

WIP: Tackling DEI Issues in the Classroom Through Interactive Historical Fiction

Dr. Stephany Coffman-Wolph, Ohio Northern University
Dr. John K. Estell, Ohio Northern University

The retro 80s game, Oregon Trail, taught and inspired a generation about a significant historical event in the United States - the beginning of westward expansion. The game has achieved almost cult-like status, but this does not exclude the game from flaws concerning the lack of representation and other Diversity, Equity, and Inclusion (DEI) issues. Female representation has been and continues to be an issue within computing fields and computer gaming. Given that women are stakeholders in educational software and part of the audience, it is essential they see themselves being positively represented. Creating a version of the Oregon Trail game that presents a more realistic view of women's contribution to westward expansion could help combat some of the negative gender stereotypes in existence.

The first-year aspiring software developers (of all genders) will create a historical-based interactive fiction gamification app. Specifically, the students will create a game exploring the nature of American Western Expansion through the lens of the women who undertook the dangerous journey along the Oregon Trail in the mid-1800s. The authors' motivation is to combat negative stereotypes found in the original game and provide positive representation to current and future students. The primary goal of the project is to develop first-year programming students' ability to use storytelling in software development. Additionally, will provide students with opportunities to exam diversity issues within a familiar context, help to develop social awareness, and appreciate different perspectives. This project is a springboard for a future special topics course on storytelling with the bonus of providing the current computer science majors with more experiences with major software development.

This paper will provide background on the project, lesson plans, details of the course assignments, and results of end survey results regarding the project. This paper will supply all interested audience members with materials developed "in-house" to add in adoption efforts by others. Accordingly, a "Card" - i.e., an information repository – will be created for this paper on the Engineering Unleashed website operated by KEEN. This card provides instructional materials mentioned in this paper and can be freely downloaded, reviewed, adopted, and if desired modified, by anyone for use in their courses under the Creative Commons CC BY-NC license.

WIP: Adaptive Comparative Judgement as a Tool for Assessing First-Year Engineering Design Projects

Dr. Clodagh Reid, Technological University of the Shannon: Midlands Midwest
Mr. Gibin Raju, University of Cincinnati
Dr. Sheryl A. Sorby, University of Cincinnati
Dr. Niall Seery, Technological University of the Shannon

Design projects are an important part of engineering education and are included in many first-year programs. In assessing these projects, educators most often use rubrics where points are given for meeting specific criteria and grades determined through adding up these points which can be time consuming and restrictive. Seldom is a holistic approach taken to assessing student design projects. The desire to employ holistic assessment strategies to student work with open-ended and divergent responses has been widely noted in the literature. Holistic strategies can provide in- sight into the role of qualities, such as creativity, which are not typically incorporated into standard assessment rubrics.

Adaptive Comparative Judgement (ACJ) is an assessment approach developed to assess student performance in a holistic manner. The ACJ system is composed of three elements; a set of portfolios produced by students in response to an open-ended assignment, a set of judges which may be made up of students or experts in the area, and a pairs system. ACJ is supported by a software solution that adaptively selects pairs of portfolios and presents them to the judges, who judge the work based on professional constructs of performance and capability e.g., creativity. At any one time the judges are making comparisons between only two portfolios, and they select the one of the two that they believe is more creative (in this example). Each portfolio is judged on multiple occasions by various judges, in various pair combinations, providing a broader consensus of the creativity of the work based on multiple perspectives. The output of the judges is a rank-ordered list of the least to most creative portfolios. In studies using the ACJ system to measure various design qualities, high reliability levels have been achieved among judges (˜0.9).

Given the dynamic nature of the ACJ assessment tool, there are various benefits this approach can offer engineering educators. The demands placed on an educator to assess many portfolios may be reduced as students can act as the judges and reliably assess their peer's work. In addition, the ACJ approach can support students in gaining feedback on the standard of their own work relative to that of their peers which is a valuable experience for first-year engineering students. This paper will explore the use and benefits of ACJ for assessing first-year engineering design projects. Further, conference attendees will be provided the opportunity throughout the conference to engage with the ACJ software as judges to experience how this system can work in practice for assessing student design projects.

WIP: The Importance of Freehand Sketching and Technical Drawing

Prof. Raymond Eugene McGinnis Jr., Christian Brothers University
Dr. Andrew Assadollahi, P.E., Christian Brothers University

This Work in Progress Paper discusses the importance of freehand sketching and technical drawing skills for students studying computer aided drawing. Freehand sketching is the process of drawing without any measuring instruments and is accomplished via pencil and eraser only whereas technical drawing is drawing by use of drafting equipment including t-squared, drawing triangles, and French curves. Freehand sketching has been shown to be important because it connects students' hand movements to their mental thinking ability. In addition, freehand sketching is a quick method of communicating and idea in a graphical format. With the advancement of computer technology, many universities have deemphasized freehand sketching and technical drawing skills over computer-aided design methods. This research aims to show how freehand sketching and technical drawing techniques taught to first-year civil engineering students impacts the students' understanding of computer-aided design (CAD). The objective of this research is to determine the students' perception of the helpfulness of the freehand and technical drawing and correlate these perceptions to the understanding of CAD techniques. Current as well as former students who have completed a first- year civil engineering graphics course will be surveyed to determine the effectiveness of this process.

WIP: The Student's Perspective on CAD Software in a First-Year Civil Engineering Graphics Course

Prof. Raymond Eugene McGinnis Jr., Christian Brothers University
Dr. Andrew Assadollahi, P.E., Christian Brothers University

This research focuses on the students' perspective on computer-aided design (CAD) software in a first-year civil engineering graphics course. This paper aims to chronicle the students' experience in transitioning from MicroStation to AutoCAD during the semester and to better gauge the extent of how much of each software package should be used. The instructor of the class begins the semester teaching MicroStation due to his experience that students typically have an easier time of learning AutoCAD after learning what seems to be the more difficult MicroStation. This research discusses how the instructor transitions from one software to another and will survey current and prior students who have completed the course to gain their perspective in how well the transition was achieved. The long-term goal of the course is to provide the students with the best educational experience and best prepare them for future classes, internships, and full-time employment. The results of this research summarize the student's perceptions of each soft- ware package and their perceptions of transitioning between the software package to help determine how much of the semester should be spent on each software package.

WIP: Using CATME in Team Development of One-Semester- Long Open-Ended First-Year Engineering Student Design Projects

Dr. Rui Li, New York University
Dr. Jack Bringardner, New York University Tandon School of Engineering

Teamwork skills are widely regarded as one of the most important and transferrable skills in both academic and professional environments. The Accreditation Board for Engineering and Technology (ABET) learning outcomes for teamwork include "an ability to communicate effectively with a range of audiences" and "an ability to function effectively on a team" (ABET 2020). These criteria are intrinsically linked to the idea of multidisciplinary collaboration. Being able to work effectively in multidisciplinary teams is a highly sought-after professional skill for engineers. In engineering education, studies have shown that the integration of collaborative work into course content can enhance project-based learning outcomes by developing effective teamwork and communication skills.

Within engineering design education, it is essential to help students develop effective teamwork skills and critical engineering design abilities, such as innovation and open-mindedness. However, it can be challenging for instructors to precisely assess an individual contribution to the completion of team goals. Peer feedback allows the participants to develop and improve their teamwork skills via giving feedback on team members' competencies and receiving feedback on one's own competencies. These competencies include contribution, interaction, project, and time management, as well as task-specific skillsets. One advantage of using peer feedback is that it captures interactions when an instructor is not present. Therefore, they could provide additional support for assessing individuals on a team. The goal of this study is to apply more quantitative peer evaluation to help students establish and be aware of healthy team dynamics at the storming stage. Past literature shows a web-based tool, CATME (Comprehensive Assessment of Team Member Effectiveness), could reduce team conflicts and help assess individual contributions to a team.

In the context of an open-ended project in a large private institute, each project lasts for one semester. Three hundred first-year students participate in this group activity with a team formation of two to four members. The primary objective of the project is to build a functional prototype that can solve a real-world problem. Some of the past examples were prosthetic arms, smart water bottles, or self-watering flowerpots. The team will meet regularly and present their progress four times throughout the semester. Each team was assigned a mentor to provide guidance on the technical design of their prototype. Currently, class instructors track team performance using Google Forms with a single peer rating of 15 and comments. In contrast, CATME peer evaluation uses five dimensions of teamwork of CIKEH: Contributing to the team's work: Interacting with teammates; Keeping the team on track; Expecting quality work; Having relevant knowledge skills, and abilities.

The current team development fits the description of the four-stage model developed by Bruce Tuckman: forming, storming, norming, and performing stages. It is common for the storming stage to lead to more conflicts within the team as the team members start interacting more and more. Competing for leadership and inter-personal conflicts become the major scenes. This study aims to use CATME to improve team development. The research question is: can CATME helps to mitigate conflicts and identify leadership in a multidisciplinary team environment?

To answer the research question, CATME will be used to help with team development in a class of 13 students for a test run. The students will be split up into five groups, two experimental groups are using CATME peer evaluation, another two experimental groups are using conventional Google survey form, and the last group does not use any peer-evaluation software. Moreover, an end-of-semester survey will be used to learn about students' experience in CATME. The future plan is to implement CATME in cross-school Vertically Integrated Projects (VIP) and senior design projects.

WIP: Investigating the relationship between FYE students' reflections and academic performance across gender

Mr. Ahmed Ashraf Butt, Purdue University at West Lafayette (COE)
Dr. Saira Anwar, Texas A&M University
Dr. Muhsin Menekse, Purdue University at West Lafayette (COE)

Reflection is an important skill and is a practical learning tool to engage students in learning tasks. In the context of first-year engineering (FYE) students, studies have emphasized the importance of the reflection activities as it facilitates the students' learning process by engaging them with the learning contents, specifically with threshold and conceptually challenging concepts. Considering that the national average of male and female student population in the USA in FYE programs is disproportionate, students may experience varying impacts on their learning across gender. Consequently, this work in progress contributes to the literature by exploring the role of gender-based variations in the relationship between students' self-reflection and academic performance in FYE students. Specifically, this study is guided by a research question: Do students' self-reflections have a varying effect on the students' academic performance between gender groups? We collected the data from 120 FYE students enrolled in a required FYE course at a large Midwestern University. We focused on a first-year programming course to evaluate the impact of reflection across gender groups and students' performance for conceptually challenging concepts. We collected the data on gen- der, course reflection, and academic performance. In the data collection process, students self-reported their gender information. To collect students' reflections, we used CourseMIRROR mobile application. This application prompted students to reflect on the interesting and confusing aspects of the lecture after the end of each lecture throughout the semester. We used the reflection specificity score (i.e., the quality of the reflection) to measure students' ability to reflect, calculated by the application using NLP algorithms. Further, the instructional team provided the data on students' performance through their exam scores. To inform our study, we will conduct multiple regression for each set of reflection questions (i.e., confusing and interesting aspects of lecture), where the dependent variable is the students' exam score, and the independent variables are the average specificity score of students' submitted reflections, and their gender. The draft paper will present the preliminary results across gender groups, implications, limitations, and future directions.

Monday 11:00 AM-12:30pm Technical Session M3

Workshops M3	Facilitator	Location
Hands-On Design Activities for Introduction to Engineering Courses to Accommodate Students of Varying Backgrounds	John Krupczak	C211 Wonders
Fully Engaged: Integrating mindfulness and meditation in engineering classes	Kathryn Schulte Grahame	C213 Wonders
Helping Students Develop their Cross Cultural Communication Skills to Promote a More Diverse and Inclusive Learning Environment.	P K Imbrie	C215 Wonders

Hands-On Design Activities for Introduction to Engineering Courses to Accommodate Students of Varying Backgrounds

C211 Wonders

Dr. John Krupczak Jr, Hope College
Katharine Hopkins Polasek, Hope College

In this workshop, participants will carry out three different design projects specifically intended for introductory engineering courses that include students with a wide range of prior exposure to engineering. The design projects engage students with a tentative interest in engineering and limited prior hands-on experience, while also challenging the skills and creativity of those students already committed to an engineering career. After the workshop, participants will be provided with classroom kits of materials that they can take with them back to their home institutions. The efforts to increase diversity in engineering have resulted in a challenge for introduction to engineering classes of supporting students with a wide range of prior exposure and degree of interest in engineering. Introductory courses now include some students, possibly from groups currently underrepresented in the engineering profession, that have been success- fully recruited to consider engineering as a career. These students may have only a tentative interest in engineering and limited prior experience in hands-on activities. Simultaneously, introduction to engineering courses include students with a well-established interest in an engineering career and a considerable background in design and fabrication work. Successful introduction to engineering courses must engage and support both types of students. Design projects in these courses must meet several criteria that are challenging for the instructor. They should appeal to students' intrinsic interests; support hands-on skills development; be completed during a typical laboratory period; not require specialized equipment; be carried out in a range of physical spaces; and illustrate general engineering principles be- yond the details of the project. We have developed and tested several projects that meet these requirements including a solar-powered phone charger, an electrodynamic loudspeaker, and a suite of microcontroller-based activities with a biomedical emphasis. The series of projects include extensive scaffolding to support novices, while also containing relevant open-ended design elements to challenge the creativity of the more experienced. Students show increases in confidence and interest along with decreases in anxiety concerning engineering. Females attained par with male students in design self-confidence. This workshop will allow participants to learn about and carry out these hands-on projects for themselves. Classroom kits will be provided for those interested. This project is supported by the National Science Foundation.

Fully Engaged: Integrating mindfulness and meditation in engineering classes

C211 Wonders

Dr. Kathryn Schulte Grahame, Northeastern University

The purpose of this workshop is to actively involve participants in the practice of mindfulness and meditation while learning its principles and how to integrate them in a variety of ways into engineering classes. The workshop will look at the art and science of mindfulness and meditation interspersed with activities used to teach and practice. The format will be hands-on including participation in exercises as well as discussions and sharing of practices from a variety of perspectives. The content comes from various texts on mindfulness such as Fully Present: The Science, Art, and Practice of Mindfulness, by Susan L. Smalley. The activities will include guided practice sessions and discussions that illustrate and elucidate the content and use of meditation and mindfulness in engineering classes. Presenting and practicing a variety of ways allows participants to customize for their comfort and knowledge to grow and add on where they see the best fit.

Helping Students Develop their Cross Cultural Communication Skills to Promote a More Diverse and Inclusive Learning Environment.

Dr. P.K. Imbrie, University of Cincinnati

Scaffolding young engineers to envision pathways that will enable them to develop a long-term commitment to in- crease diversity in engineering is an organic way to promote an inclusive and equitable environment with a strong sense of belonging for all students, faculty and staff. Given the increasingly diverse and multicultural world, the question is ”how do we prepare our first-year engineering students with the knowledge, skills and abilities (KSA) necessary to ensure they are provided an opportunity to reach their potential in this regard?” The proposed workshop will engage participants in a series of novel activities, which are grounded in the literature that are developmentally appropriate to help first-year students discover their communication style and learn how said style impacts their interactions with others.

The purpose of the workshop is to share information on how a faculty and/or staff member (or team of faculty and staff members) can implement ways to engage first-year students in the broader discussion of diversity, equity, and inclusion. As various initiatives such as the ABET EAC Criterion 3, Outcome 5, ”an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives” (emphasis added), along with deeper outcomes created institutionally and specifically for first-year students, such as 1) Develop skills for cross-cultural communication; 2) Design a process to communicate technical information via written, oral and visual methods and demonstrate skills for cross-cultural communication, the curricular vehicle takes on importance. This workshop will present known curricular initiatives for incorporating experiential assignments within the first-year curriculum along with rubrics to grade assignments. These range from a cultural context inventory and communication star to a handedness exercise and identity mapping. Further, the participant will work to transfer these ideas and ideas from other participants to their particular institutional need.

Assuming a 2 hour workshop, the expected timeline will be followed:

- 15 minutes, review of DEI curricular literature and background.
- 20 minutes, small group exercise and report out discussing institution specific learning outcomes and environments.
- 15 minutes, discussion of various learning objectives, tools, and activities.
- 20 minutes, small group exercise and report out of variations and additional tools and activities gathered.
- 15 minutes, discussion of assessment and evaluation examples and alternatives.
- 20 minutes, small group exercise and report out of assessment and evaluation examples and alternatives.
- 15 minutes, summary, wrap-up, and evaluation.

Monday 2:00-3:30pm Technical Session M4

Workshops M4	Facilitator	Location
Top 5 "Soft Skills" Every First-Year Engineer Needs to Know	Danny Rubin, Rubin Education	C211 Wonders
From First Year to the Workforce: A Guide to Computational Skills for the Future	Hoda Sharifi, MathWorks	C213 Wonders
Introduction to Adaptive Comparative Judgement: A Holistic Assessment tool for Design Problems	Clodagh Reid	C215 Wonders

Top 5 "Soft Skills" Every First-Year Engineer Needs to Know

C211 Wonders

Danny Rubin, Rubin Education

Do your students write emails like text messages? You aren't alone!

In a fast-moving workshop, author and communications expert Danny Rubin will lead a session about the essential "soft skills" every first-year engineering student should possess by the end of freshman year.

Topics include email etiquette, phone etiquette, "small talk" conversation skills and much more.

Rubin works with engineering programs across the country to incorporate in-demand communication skills into curriculum. Grab your seat early and don't miss out!

From First Year to the Workforce: A Guide to Computational Skills for the Future

C213 Wonders

Dr. Hoda Sharifi, Customer Success Engineer, MathWorks
Chad Allie, Customer Success Engineer, MathWorks

Educators are challenged with having to teach skills necessary for students to be successful in the workforce. These skills can range from computational thinking to hands-on experience. To aid educators, MathWorks provides several solutions to enable the teaching and learning of these desired skills. In this 90-minute session, we will discuss how these solutions can contribute to course development, delivery workflow, student engagement and success.

We will introduce several resources including:

- Accessing MATLAB and Simulink Online for anytime, anywhere use
- Leveraging interactive content with self-paced courses, MATLAB Apps, and Live Scripts
- Virtualizing labs through simulation and/or hardware accessible at home
- Mentoring students at scale with automated assessment and feedback in MATLAB Grader
- Connecting students with the community by participating in the MATLAB user community

Workshop Requirements:

- Bring your own laptop
- Create a free MathWorks account (Effort: 3 minutes)
- Download MATLAB on your machine or sign into MATLAB Online

Optional Training to take before the workshop:

- MATLAB Onramp
- Simulink Onramp

Post-Workshop Practice:

- Teaching with MATLAB Training

Workshop: Introduction to Adaptive Comparative Judgement: A Holistic Assessment tool for Design Problems

C215 Wonders

Dr. Clodagh Reid, Technological University of the Shannon: Midlands Midwest
Dr. Sheryl A. Sorby, University of Cincinnati
Mr. Gibin Raju, University of Cincinnati
Dr. Niall Seery, Technological University of the Shannon

This workshop is an interactive session where participants will experience an exciting approach for holistically assessing design problems, Adaptive Comparative Judgement (ACJ). ACJ is an adaptive software tool that can be used by students and faculty to assess students' work holistically and reliably. This tool can be used to reduce the grading load associated with project work and reduce the time taken to grade and provide feedback to students. The goal of this workshop is to introduce participants to the ACJ approach. The process underpinning the ACJ software tool will be explored, and participants will be taken through the procedure of setting up an ACJ session and given the opportunity to experience the process of assessment using the ACJ tool. Following this hands-on experience of ACJ, participants and facilitators will discuss the possible benefits and challenges of using ACJ in a formative and summative assessment capacity with first-year engineering students. Workshop attendees will require a device that is wireless fidelity enabled.

Monday 3:45-5:00pm Technical Session M5

Time	M5A - Computer Oriented First Year Courses – C211 Wonders	Lead Author
3:45-4:00	The First-Year Computer Science Experience Project	John Cole
4:00-4:15	Full Paper: First-Year Computing Course with Multiple Computing Environments - Integrating Excel, Python and MATLAB	Srinivas Mohan Dustker
4:15-4:30	First Year Engineering Student Definitions of Systems Engineering: A Comparison Between Two Institutions	Katrina L Carlson
4:30-5:00	Group Discussion	

Time	M5B - Remote Learning and Team Building in First Year Courses - C213 Wonders	Lead Author
3:45-4:00	Evaluating Freshmen Engineering Students' Experience in a First-Year Engineering Program and Lessons Learned during Covid-19 Pandemic	Aysa Galbraith
4:00-4:15	Full Paper: An Investigation of Team Conflicts in a Large-Enrollment Introductory Engineering Course	Haritha Malladi
4:15-4:30	How Can We Make This Work? First Year Engineering Design Team Development in Virtual vs. In-Person Environments	Natalie C.T. Van Tyne
4:30-4:45	Lessons Learned from COVID That Have Been Transferred to Post-COVID Teaching and Learning	Michael Cross
4:45-5:00	Group Discussion	

Time	M5C – First Year Design Projects – C215 Wonders	Lead Author
3:45-4:00	Provision of the practical learning environment via application-based projects integrated with the undergraduate engineering curriculum	Surupa Shaw
4:00-4:15	Community-Engaged First Year Learning Community	William C. Oakes
4:15-4:30	Redesigning an Introduction to Engineering Course as an Interdisciplinary Project-Based Course	Kelly Salyards
4:30-4:45	An International Design Project for First Year Engineering Students at Multiple U.S. Institutions	Thomas J. Siller
4:45-5:00	Group Discussion	

M5A - Computer Oriented First Year Courses

C211 Wonders

The First-Year Computer Science Experience Project

Prof. John Cole, The University of Texas at Dallas

The University of Texas at Dallas, along with many other schools, requires an orientation course to introduce students to the broad discipline of computer science or engineering. At UTD, this orientation course is offered only in the fall term, and is required of all freshmen declaring CS or engineering as a major. I'm going to discuss the Computer Science version. A team project, in which students write a program or build something related to computation, should be part of any such course. However, incoming freshmen have widely varying degrees of programming expertise, from none whatsoever to the equivalent of three semesters of introductory courses. In addition, those with programming experience have typically been exposed to Java, and maybe C++ or Python. Such a project must be difficult enough to give students a sense of accomplishment but not so difficult that they give up. It must also give students a sense of what it is like to do actual computer science and software engineering. It must allow for some level of creativity without being too open-ended. Basic guidelines for such a project are:

1. Students with varying levels of experience must be able to specify, design, and implement it in four to six weeks.
2. It must involve sufficient work that the entire team must participate.
3. Projects cannot rely upon extensive programming knowledge.
4. Projects are generally done in phases that build upon each other and are graded separately.
5. Each phase stands alone as much as possible so that difficulties in an earlier phase do not insure a bad grade in a later one.

Learning objectives in assigning such a project are:

1. Learn basic software design principles such as flowcharting and pseudocode.
2. Work with a team.
3. Come up with an idea and refine it.

Instructors at UT Dallas have tried various kinds of projects, from programming to cross-discipline projects involving hardware and software, to papers, and have some data on what works well and what does not. While I do not have quantitative data to support any specific pedagogy for the project, my colleagues and I have written student feedback on various kinds of projects. In this paper I draw from my own experience of having taught multiple sections of this course for the last seven years as well as talking with and observing other instructors.

Full Paper: First-Year Computing Course with Multiple Computing Environments - Integrating Excel, Python and MATLAB

Mr. Srinivas Mohan Dustker, Purdue University at West Lafayette (COE)

Dr. Carla B. Zoltowski, Purdue University at West Lafayette (COE)

Dr. John H Cole, Purdue University

This full paper will describe the use of multiple computing environments (Excel, Python and MATLAB) integrated in a first-year computing course. Computing is an important outcome of many First-Year Engineering (FYE) programs because it prepares students for the analytical and problem solving skills required for most engineering program. Computing is growing in importance across all the engineering fields.

Close to half a century ago, scientists, engineers, and mathematicians learned programming in a specific language used broadly within their field. Additionally, programming has often been taught using syntax and through a single language. This can lead to students being embroiled in the specifics of the programming language and not under- standing the true potential of programming as a scientific and logical problem-solving tool. Given the fast pace of development in technology, and new computing language and environments being introduced at an increasing pace, faculty teaching FYE programming courses face challenge in choosing a language or environment.

The approach used across a set of courses described in this paper is from a large midwestern public university in the United States. Students participate in a foundational year that is common across all majors but has options within the first-year. This paper will describe in detail two of the four options that are open to all engineering majors and share a common

approach to introducing computing. The approach is to introduce students to computing concepts by applying these concepts in Excel, Python and MATLAB within a single semester. This paper will provide two years of assessment data showing students' performance and perception of the courses. The discussions present the affordances of this approach and methods for accommodating the large variance in students computing backgrounds. In addition, the discussion describes the confounds of the pandemic with virtual teaching and potential methods to address these confounds. This paper will interest instructors, and researchers, who teach computing to undergraduate engineering students and the methods used to achieve multiple computing related learning objectives in a short period of time.

Keywords: first-year engineering, computing course, multiple programming language

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First Year Engineering Student Definitions of Systems Engineering: A Comparison Between Two Institutions

Mrs. Katrina L Carlson, Michigan Technological University
Dr. Akua B. Oppong-Anane, Montana Technological University
Dr. Michelle E Jarvie-Eggart P.E., Michigan Technological University
Miss Amanda Marie Singer, Michigan Technological University

This full research paper builds on previous work investigating first-year engineering (FYE) students' understanding of Systems Engineering and suggests methods to increase students' knowledge of the major for increasing enrollment in the program. Systems Engineering has recently been acknowledged as a discipline in its own right by the Accreditation Board for Engineering and Technology (ABET), which began accrediting systems engineering programs in 2017-2018 (ABET, 2016). In 2021, ABET approved and accepted an updated Systems Engineering Program Criteria, cooperatively revised by INCOSE (International Council on Systems Engineering) (ABET, 2021). Systems Engineering is not available at University Y, and it is currently only offered as a minor under the Bachelor of Science in Engineering degree at University X. The primary goal of this study was to understand how first year engineering students define Systems Engineering and whether their understanding of the discipline was influenced by the availability of a Systems Engineering program at their university.

A survey was conducted of FYE students at two Universities, one with a Systems Program (University X) and one without (University Y). The students from University X, a Midwestern technical university (N=63), and University Y, a Western technical university (N=37) were also asked to define each of the engineering majors. None of the students surveyed were enrolled in a Systems Engineering program.

In the 2021-22 academic year there are 12 students enrolled in Systems Engineering at University X, a relatively new program, and less than 5 of them are female. The previous year, six students were enrolled, and at least one of them was female, a 50% increase in total enrollment. The qualitative results of this survey indicate that many students are unsure of what Systems Engineering is, and there are many answers that are very general about complex systems, including "System Engineering is engineering where you work on risk management, integration of other engineers. Basically a broad sense of most engineering branches and being able to connect them" or "understanding how systems work and how they affect each other." This is problematic because students might not select Systems Engineering as their major area of study due to lack of knowledge of the discipline. Previous survey results of University X's students will be compared to the current results across the two universities. Results of this study can help emerging Systems Engineering programs understand points of confusion about the discipline and better guide the development of educational materials about their majors.

M5B - Remote Learning and Team Building in First Year Courses

C213 Wonders

Evaluating Freshmen Engineering Students' Experience in a First-Year Engineering Program and Lessons Learned during Covid-19 Pandemic

Dr. Heath Aren Schluterman, University of Arkansas
Dr. Aysa Galbraith, University of Arkansas
Mrs. Leslie Bartsch Massey, University of Arkansas
Mr. Brandon Crisel
Dr. Candace Auburn Rainwater, University of Arkansas

This is a full paper abstract. The mission of our First-Year Engineering Program (FEP) is to help first year engineering students build a solid foundation for their education. All new students take a common set of classes, dependent upon their initial math placement, which includes an introduction to engineering class. In addition to covering fundamentals of engineering topics, this class introduces different engineering fields allowing students to make an informed choice of major. However, FEP is more than just a set of classes. It also provides orientation, peer mentoring, tutoring and supplemental instruction, academic advising, basic career advising, and academic skills development. Historically, FEP has provided social opportunities for students to encourage building peer relationships from the start.

Our university pivoted to online learning during spring 2020 due to the Covid-19 pandemic. FEP returned in fall 2020 with hybrid class models in Introduction to Engineering courses where students could choose to attend in-person or remotely. Classrooms returned to fully in-person learning in fall 2021. The goal of this paper is to explain the adjustments in Introduction to Engineering courses and explore the differences in student performance in these courses before, during, and after Covid-19 related adjustments. We will examine the students' grade distributions with a specific interest in any changes in the DFW (grades of D, F, and withdrawal) rates. We will also compare course and instructor ratings for the courses before, during and after pandemic-related course adjustments.

While we suspect that the student learning and performance suffered during 2020-2021 academic year due to on- line and hybrid delivery methods, we also have observed a shift in student attitudes and expectations after returning to our normal, in-person delivery method in 2021-2022 academic year. We anticipate that this shift requires us to adjust our course content and course delivery in future semesters. We will examine positive learning experiences that resulted from changes in the course mandated by the pandemic and look for opportunities to marry historical elements of the program with newer, well-received practices to create the most suitable learning experience for our students.

An Investigation of Team Conflicts in a Large-Enrollment Introductory Engineering Course

Dr. Haritha Malladi, University of Delaware
Prof. Jenni Buckley, University of Delaware

Team-based projects are widely used in introductory engineering courses to support the development of collaboration and communication skills and to engage novice engineers in higher levels of thinking. While the details of team- based design projects may vary across institutes, they generally involve small teams of students tasked with solving a substantive, open-ended design challenge that requires the application of engineering principles to create physical prototypes or computational models. Team-based design projects are employed at all levels of engineering training culminating in senior capstone experiences. A typical engineering student will engage in at least one semester-long, team-based project per academic year. Team-based projects in introductory engineering courses play an important role in inculcating good collaborative practices among students.

Conflicts within student teams are common, especially in the first year, when students may have had limited experience working on substantial projects that require contribution from all team members. Consistent with our experience, social loafing has been identified as the most prevalent problem within student teams, particularly in early undergraduate years. Social loafing is defined as reduced motivation, effort, or performance from individual team member(s). The incidence of social loafing can be reduced by assigning compelling, complex projects to smaller teams of stu- dents and routinely using peer evaluations. Ohland et al. have developed a robust peer evaluation system (CATME by Purdue University) that is widely used in engineering programs—including our institution—to collect quantitative and qualitative information that can be used to individuate student performance within teams. To effectively address interpersonal issues in teams, it is important to detect the incidence and root cause of team conflicts.

This paper presents an investigation into the prevalence of team conflicts in a large-enrollment introductory engineering course (ca. 650 students) in a mid-sized, research-intensive state university in the US. We have identified three potential root causes that may explain perceived social loafing by team members: 1) logistical barriers, 2) marginalization, and 3) genuine disinterest. An example of the first type, logistical barriers, is when a student has difficulty contributing to a team based on the location and timing of team meetings. The second root cause is when a student feels marginalized by the group, thus contributing to reduced participation. The third, genuine disinterest, includes instances in which a student has decided to change majors and is not interested in performing well in the course. Using weekly CATME peer evaluation data and an end-of-semester student survey, this study categorizes the incidence of social loafing based on its root cause. Other potential causes of team conflicts are also identified. Results from this study will be used to guide instructors on how to coach individuals and teams towards more effective team behaviors and address social loafing when it occurs.

How Can We Make This Work? First Year Engineering Design Team Development in Virtual vs. In-Person Environments

Dr. Natalie C.T. Van Tyne, Virginia Polytechnic Institute and State University

Dr. Juan David Ortega-Alvarez, Virginia Polytechnic Institute and State University / Universidad EAFIT

This Evidence-Based Practice paper contains a study about the similarities and differences in team development among first-year engineering students during an introductory design course at a major university in the eastern United States. The study contained one group of teams that operated in a totally online environment in Spring 2021, due to COVID- 19 restrictions, and another group of teams who were able to operate in Spring 2022 in person. All teams consisted of students in their second semester of college. Effective teamwork is important in both academic and industrial settings, but it can be adversely affected by the inability to meet in person, particularly at the first-year level.

Students have been dealing with the uncertainties caused by the COVID-19 pandemic and its implications for their physical, mental and emotional health. As a result of these uncertainties and the resulting changes in course content and delivery methods, it was reasonable to wonder if design teams at this age level were able to operate as constructively in an online environment as they would be expected to in person.

This research question was explored through this comparative study:

- How does first-year design team development vary between virtual and in-person operation?

A team development survey was administered to all teams during Week 11 of 15, with each team's results reported and interpreted by the team as part of a third quarter status report in Week 12. The survey was based on Tuckman's model for team development, which consists of the following stages: Forming, Storming, Norming, and Performing.

Five- and six-member teams were originally assigned on the basis of two skills and personality assessments, one of which was the CATME team formation survey. In addition to the data from these assessments and the Tuckman- based team development survey, CATME peer evaluations of team member performance were also available, and were used to inform the survey results, along with team contracts and the Week 12 project and team status report.

Preliminary survey results indicated that most team members considered their team to be in either the Performing stage or in a transition between the Norming and Performing stages. However, response bias was possible, such as a lack of well-considered responses to survey questions, collaboration between or among team members in survey responses, and different interpretations of particular questions. In addition, the fact that all teams provided a summary of their team's survey results as part of a graded assignment may have caused them to emphasize only positive results and omit negative ones. However, the fact that both groups of teams showed a tendency toward the same stages of development indicates that perhaps online team operation is not as disadvantageous as originally thought.

Lessons Learned from COVID That Have Been Transferred to Post-COVID Teaching and Learning

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Dr. David M. Feinauer P.E., Virginia Military Institute
Dr. Roger J Marino P.E., Drexel University
James R McCusker PhD, Wentworth Institute of Technology
Prof. Johanna P Casale, Drexel University

The COVID-19 pandemic required a rapid shift in course content delivery. Educators were faced with the challenge of providing some sort of continuity to student learning. Several content delivery modalities were used, including asynchronous, synchronous, and hybrid. The term HyFlex gained popularity, representing simultaneous offering of courses in-person, asynchronously online, and synchronously online, with students given the flexibility to engage through any of the modalities. New and innovative approaches to interactive learning were developed and implemented. Addition- ally, a transition to the online performance of laboratory experiments was required. Some of these new methods have carried over as we have moved back into more traditional education operations.

In this paper, faculty from multiple institutions will share success stories from techniques developed during the transition to online learning that have been transferred to or refined for the post-COVID in-person learning environment. For example, deep integration of tablets into courses for lecture presentations (with screen recording), notetaking, problem-solving, and exam administration aided in remote instruction and has been continued. The use of online simulation tools (such as TinkerCAD) to perform traditional hands-on experiments in simulation has been continued as pre-lab assignments or to compare data collected in the laboratory to expected/theoretical results. It was also discovered that remote/online tasks administered through a learning management system (LMS) can be effective at building community. Starting with ”introduce yourself” videos or discussion forum tasks can help students build community for the in-person classroom as well. Video presentations of assignments provide a way to preserve in-class time for problem-solving sessions (flipped-classroom model). The submission of student-narrated video explanations of their homework problem solutions or lab exercise results helps to promote student understanding of the subject matter. The opportunity to have guest speakers virtually in the classroom from anywhere in the world became easier, more prevalent, and more comfortable — and the use of virtual visitors has been maintained. The perceived effectiveness of different delivery methods: in-person (both students and presenter in the classroom) vs. live - virtually (students in the classroom, presenter virtually) vs. pre-recorded video (either in or out of the classroom) will also be discussed.

M5C - First Year Design Projects
C215 Wonders

Provision of the practical learning environment via application-based projects integrated with the undergraduate engineering curriculum.

Dr. Surupa Shaw, Texas A&M University

The integration of real-world application-based projects in the undergraduate engineering curriculum is becoming popular with many educational institutions. The incorporation of learning via real-world projects provides the students with the much-needed confidence as problem solvers for the community. The need for finding a project to apply the engineering principles learnt as course content, makes the learning process relevant and motivating. The students automatically become responsible for discovering new optimal solutions through their engineering expertise, while simultaneously developing an appreciation for selecting the precise problem area that needs immediate assistance. This paper focuses on the significance of providing a professional experience to the undergraduates through application-based projects, that allows them to utilize their engineering skill-sets for functioning as technically versa- tile engineers, after graduation. The application-based projects also highlight the creative engineering element among undergraduates, in the form of obtaining long-term sustainable solutions. This paper explores the effectiveness of the project-based learning over the traditional lecture-based learning methods. It is showcased in this paper that project-based learning methodologies certainly leads to better retention of the course content while developing our undergraduates into versatile engineers. A good engineer should not only be equipped with the thorough knowledge of engineering principles, but should also be creative, resourceful, team-worker and capable of adapting ethically to the given circumstances, that they can undoubtedly attain via application-based projects. It might be a little demanding to find the appropriate project, as per the engineering curriculum guidelines, but it is worth the positive and valuable experiences of the undergraduate students. Active participation in project-based learning supports the development of engineering student's professional and technical skills. Application-based projects not only add value to the learning process, but also provides the priceless perspective to the undergraduate students for understanding and evaluating the engineering curriculum, while allowing their professors to better support their development.

Keywords—Alternate learning strategies, Application-based projects, Active Learning.

Community-Engaged First Year Learning Community

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Community Engaged Learning is a pedagogy that integrates academic learning with service activities and partnerships with local or global communities. The approach has shown many benefits to learning and student motivation. Within engineering it has shown benefits that include broadening the view of engineering which has been linked to efforts to increase diversity within engineering. Building cohorts of first-year students has also been linked to increases in persistence through learning communities and interest groups. This paper will provide a description of a first-year engineering learning community that uses a community-based design experience as an alternative to the traditional first-year introductory engineering courses. Students are given the option to live together and take a cohort of 2-3 classes together. Outside of class activities are done to connect students and instructors outside of the traditional class- rooms. The learning community has grown to over 300 students per year. The classes and processes are explained and data shared that illustrates the positive impact of the approach. Female students are drawn to this option at 160% the rate of the overall first-year program. Data shows that they choose this option to gain engineering experience that connects with issues that matter to others.

Redesigning an Introduction to Engineering Course as an Interdisciplinary Project-Based Course

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Dr. Benjamin B Wheatley, Bucknell University
Prof. Katsuyuki Wakabayashi, Bucknell University

All first-year engineering students at Bucknell University are introduced to Engineering through a first-semester, re- quired course taught by faculty members representing six departments and ten degree programs. In 2021, this cornerstone course was re-envisioned with modern and emerging pedagogical approaches and greater consistency across course sections. The new version also focuses on transferable skills for all curricula and programs within the College. The course was redesigned to

focus on learning and applying the engineering design process through a variety of projects with a common theme of sustainability. While the engineering design process is key, the redesign integrated concepts and activities to address teamwork, written and oral communication, information literacy, engineering ethics, local and global sustainability, and inclusion into the projects. The redesigned course enables each student to apply the engineering design process to two projects with different teams and different engineering instructors over the fourteen week semester. While each instructor has academic freedom to deliver their section in their own style, consistency across all sections and instructors was improved through common learning objectives and storyboards, which pro- vided sample classroom activities and points of discussion. Consistency across each project was achieved through three common benchmark assignments and a culminating Design Expo. This paper describes the redesign process and the intentions behind the redesign itself, the common theme of sustainability integrated through all projects, and the scaffolding structure that was established across all sections. The challenges and opportunities that arose in the first iteration of the redesign course are highlighted along with the next phase of continuous improvement.

An International Design Project for First Year Engineering Students at Multiple U.S. Institutions

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Ms. Erica J Marti, University of Nevada - Las Vegas Cory Budischak, Temple University

Dr. Matt Gordon P.E., University of Denver

Dr. Carlo Salvinelli, University of Colorado Boulder

Multiple U.S. institutions of higher education are participating in an international design challenge aimed at first- and second-year engineering students. This challenge has been operating for many years through Engineers Without Borders (EWB) organizations in Australia and the United Kingdom (UK). Beginning in 2019, EWB organizations in South Africa, the UK and USA partnered to develop a design challenge and run the associated competition in each of the nations. In the 2020-2021 academic year, five U.S. universities participated in the program and EWB-USA competition. During the 2021-2022 academic year, a total of five schools were involved. In this paper, we give an overview of the program and describe how the schools implemented this design challenge. Several different approaches for the design challenge are described as each school integrated the program into their existing curriculum. In addition, each school describes the motivation for participating in the program and how it fits into their curriculum.

The program, Engineering for People Design Challenge, comprises a collaboration between a community, a local non-governmental organization (NGO), and EWB-UK, EWB-South Africa. Collaboratively, a team develops an extensive design brief that includes a project description—identifying 8 design areas focused on local community needs—along with cultural background on the community. Additional resources provide guidance for instructors and students on how to proceed with the design process and how marking criteria are used to assess the projects. Each participating school is then allowed to submit five top projects to the international competition. An international panel of judges then chooses the top schools to participate in each nation's Grand Finals based on the project submissions, which can take the form of a design report or video and poster. The top ten teams are selected for the Grand Finals and showcase their project through an idea pitch in front of judges.

The Engineering for People Design Challenge was devised to provide engineering students with an opportunity to practice their skills and address global issues as a means to developing globally responsible engineers. The benefits of this program to our first-year engineering programs are described in this paper. These include meeting accreditation requirements, motivating engineering students—especially women—who seek help- or social-oriented careers, and increasing engineering self-identity. The primary goal of the paper is to inform more faculty about this program, and encourage widespread participation in the U.S.

Tuesday 8:30-9:45 AM Technical Session T1

Time	T1A – Innovative First Year Curriculum Kellogg 103AB	Lead Author
8:30-8:45	Improving Inclusion and Growth Mindset in First Year Engineering, Science and Mathematics Courses	Jared Oluoch
8:45-9:00	Data And Stakeholder Driven Redesign of a First-Year Engineering Curriculum	James R McCusker
9:00-9:15	Student Perceptions of Involvement, Identity, and Success in an NSF-funded STEM Access Program at Baylor University	Jessica Martin
9:15-9:30	Towards the Use of the MUSIC Inventory for Measuring Engineering Student Engagement	Jon Sticklen
9:30-9:45	Group Discussion	

Time	T1B – Writing and Reflections in First Year Engineering Kellogg 104AB	Lead Author
8:30-8:45	Goal-Setting Reflections for First-Year Students	Charles E. Pierce
8:45-9:00	Student and Instructor Reflections on Integrating Short Mindfulness-Based Meditation Practices into a First-Year Engineering Design Course	Hannah Nolte
9:00-9:15	Familial Influence on the Choice to Study Engineering: Insights from a Cross-University Study	Amanda Marie Singer
9:15-9:30	Student Reflections on Team Experiences in a First-Year Engineering Course	Jenahvive K. Morgan
9:30-9:45	Group Discussion	

T1A – Innovative First Year Curriculum

Kellogg 103AB

Improving Inclusion and Growth Mindset in First Year Engineering, Science and Mathematics Courses

Dr. Jared Oluoch, The University of Toledo Dr. Lesley M Berhan, The University of Toledo
Prof. G. Glenn Lipscomb II, The University of Toledo Melissa Oddo, The University of Toledo

The Equity Champions program at the University of Toledo (UToledo) is a semester-long community of practice for faculty that was started in Summer 2020 as part of our university's participation in the Association of Public and Land Grant Universities' (APLU) Student Experience Project (SEP). The mission of the SEP is to "transform the college student experience and create equitable learning environments through innovative, evidence-based practices that increase degree attainment." As Equity Champions, faculty learn ways to implement evidence-based changes ('change ideas') in their classrooms to improve the student experience in their classrooms. The change ideas are anchored in six main themes: trust and fairness, self-efficacy, institutional growth mindset, identity safety, social belonging, and social connectedness. Examples of change ideas include revising their syllabi to include student attuned-language, creating welcome letters and videos, and sharing their personal stories of belonging. The Equity Champions assess the impact of changes the Equity Champions implement in their classrooms at various points during the semester using the innovative new tool Copilot-Ascend that was developed for the SEP. Over the course of their semester in the program, the Equity Champions build a community in which they support each other by sharing ideas and developing resources together. The Equity Champions program was initially limited to STEM faculty teaching first-year and gate- way courses; however due to the success of the program it has since been expanded to include interested faculty from all colleges at the university. In this paper we will present empirical evidence of the effects of the Equity Champions project on students' performance and overall experience in the Fall 2020 and Spring 2021 semesters. Results show that the project made gains in almost every one of the six area assessed.

Data And Stakeholder Driven Redesign of a First-Year Engineering Curriculum

James R McCusker PhD, Wentworth Institute of Technology
Prof. Christopher John Brigham, Wentworth Institute of Technology
Dr. Afsaneh Ghanavati, Wentworth Institute of Technology

The first-year engineering experience has significant implications on both retention and overall student success. As institutions adjust first-year engineering programs to meet the needs of changing demographics and student expectations, various challenges arise to meet the needs of all stakeholder groups while providing a meaningful and high-value student experience. At the authors' institution, a comprehensive redesign of a first-year engineering curricula, for 7 engineering programs, was developed over a 9-month period. The Task-force charged with the redesign drew on 5- years of institute data, stakeholder feedback, and an extensive literature review.

Through this work, the author identified various challenges that were caused by the original common first-year curricula. Institute data illustrated the impact of these challenges through their effect on program persistence and student success in subsequent years. In addition, the authors collected data from the following stakeholder groups: students, program faculty, laboratory technicians, admissions office, and administration. Stakeholder feedback indicated that there were both common and conflicting opinions on both the existing first-year program and desires for the redesign. This feedback provided additional challenges in the framing of the redesign since a priority was placed on gaining approval from all groups prior to implementing a new first-year engineering program.

In this paper, the authors present the first year of a multi-year study on the redesign of the first-year engineering program at the authors institution. In this initial work, the authors focus on the insight drawn from the institute data, stakeholder feedback, and literature review to frame the redesign of the first-year engineering program. Other institutions should benefit from the presentation of challenges caused by the original common first-year and from the impact of stakeholder feedback on framing the redesign.

Student Perceptions of Involvement, Identity, and Success in an NSF-funded STEM Access Program at Baylor University

Jessica Martin, Baylor University
Jana Roste, Baylor University
Mr. Austin T. Smith, Baylor University
Mr. Shane Michael Meyer, Baylor University
Miss Emma G Cartisano, Baylor University
Emily Sandvall, Baylor University
Ms. Andrea Pouso Morales, Baylor University

In the United States, attrition in STEM fields has been a point of growing concern. The National Science Foundation (NSF) funded a variety of programs aimed at bolstering access and success for STEM students (National Academy of Sciences, 2011; Olson & Riordan, 2012). Though few access programs evaluate involvement, student success literature evidences a clear relationship between involvement and success (Astin, 1999; Mayhew et al., 2016). Accordingly, our phenomenological study explored how high-achieving, low-income STEM students in an NSF funded STEM Access Program at Baylor University perceive and experience involvement and success in light of their multiple identities. Baylor University's ECS Scholars Program currently supports two cohorts of 11 students pursuing degrees in the School of Engineering and Computer Science. As a part of the program, Scholars are engaged in student and faculty mentoring which allows them to meaningfully connect with a support network. In addition, students attend monthly seminars designed to help support their success in and outside of the classroom. These students' experiences were explored via 60 to 90-minute in-depth, semi-structured interviews. Interviews were transcribed, coded, and themed by the research team. Alternate data collection methods—including campus mapping, photo elicitation, and identity wheel construction exercises—complemented interview data and added additional depth and insight to student statements. Our collective analysis revealed that, in essence, involvement is an arena in which high-achieving, low-income STEM students prioritize and live out salient identities in alignment with their understandings of success. Such findings inform recommendations concerning how faculty and staff may broaden and reframe understandings of involvement to more effectively support the success of STEM students in similar access programs.

Towards the Use of the MUSIC Inventory for Measuring Engineering Student Engagement

Dr. Susan L. Amato-Henderson, Michigan Technological University
Dr. Jon Sticklen, Michigan Technological University

One of the ”Grand Challenges in Engineering Education” is to engage students in their own learning. According to Vest (Vest, 2008), then president of the National Academy of Engineering, engineering education must focus on the environment in which students learn. While the content is changing at an amazing pace, facilitating a learning environment that fosters student ideas, inspiration, and empowerment will be critical in the 21st century. ”Students are driven by passion, curiosity, engagement, and dreams.” (Vest, page 236). We need students who are technically and creatively able to solve the challenges of tomorrow. The MUSIC model of Academic Motivation was developed to help instructors apply motivation research to the design of instruction by providing an organizational framework of current motivation principles. There is strong evidence linking student motivation to student engagement. (Nayir, 2017) But what constitutes ”student engagement”? The MUSIC model of academic motivation was developed as a means to pull together a plethora of literature focused on human motivation in a manner that would make core results from the literature on student motivation accessible to educational researchers at large through a validated instrument for the construct of student engagement. (Jones, 2009; Jones & Skaggs, 2012). The MUSIC model was implemented by developing a survey instrument (The MUSIC Inventory), now validated fairly extensively, containing five subscales: eMpowerment, Usefulness, Success, Interest, Caring. In Fall Semester, 2021, we gave the MUSIC Inventory to 220 first-year engineering students at as a first step towards utilizing the MUSIC Inventory as an assessment tool for ”student engagement”. The results from our first use is described in a Frontiers in Education 2022 conference and is now in the draft paper stage, the abstract having been accepted. One unexpected result was that we found the five subscales of the MUSIC Inventory collapsed to four subscales when subjected to re-factor analysis. There are a number of possible causes for this variation: our population was engineering students, our university is somehow different in some way affecting the results, or perhaps the students in our study were made up of post-COVID students (students whose high school years were distinctly different because of COVID). In this report to the FYEE community we discuss our second use of the MUSIC Inventory in Spring, 2022. In this deployment of the MUSIC Inventory, we configured our study to include pre- and post- data to help to better understand the collapse of the five sub-scale version of the MUSIC Inventory to a four sub-scale result when refactored in our initial study. We note that there is a small but growing literature that supports the fact-based differences of the post-COVID students versus the pre-COVID students. Most of the MUSIC Inventory validation studies (all to our knowledge) were conducted on pre-COVID students. Engagement is a key factor in student success. The Engineering Education community needs a trusted instrument to objectify student motivation-fired engagement. We are on that path, as will be reported in this paper.

T1B – Innovative First Year Curriculum

Kellogg 104AB

Goal-Setting Reflections for First-Year Students

Dr. Charles E. Pierce, University of South Carolina

The transition from high school to college is challenging for most students. There is a lot happening during the first semester that make it difficult for them to spend time thinking about and reflecting on their new academic experiences. Yet, this is a critical time for students to learn how to be a good engineering student. In our Introduction to Civil Engineering course, we use a series of journal assignments to provide students with an authentic space for their personal thoughts. The journal is designed on the belief that students need to (1) consider their own expectations for personal learning in their courses; (2) practice establishing and monitoring academic, personal, and/or professional goals; and
(3) engage in real and honest self-reflection.

This paper describes and discusses what we have learned from student responses to goal-setting reflection prompts in this course. The assignments represent a small but important piece of the course. Students are expected to complete four reflection responses for 5% of their course grade. Since our institutional LMS is Blackboard, we use its journal function for online submissions. Each response is assessed for completeness in answering all parts of the prompt. We emphasize that there is no right or wrong answer; rather, each response should be unique to each student. The course instructor, not a teaching assistant, reads and grades each submission. Written feedback is included to let students know that their responses have, indeed, been read.

The wording of each prompt is important and has evolved over time. The first prompt focuses on what students know that is relevant to the course, which is designed to learn more about each person's prior knowledge of and/or experience with engineering. The second prompt asks them to set three specific goals for the course. To that end, we introduce and practice the SMART (Specific, Measurable, Achievable, Relevant, and Time-Bound) model for setting goals. These two assignments are given in the first two weeks of class. The third journal assignment is a progress check on their goals, which occurs at mid-semester. In the final assignment at the end of the semester, students complete a self-evaluation of achievements, or lack thereof, associated with their goals.

Student and Instructor Reflections on Integrating Short Mindfulness-Based Meditation Practices into a First-Year Engineering Design Course

Dr. Hannah Nolte, The Pennsylvania State University

Dr. Elizabeth Marie Starkey, Pennsylvania State University

Dr. Christopher McComb, Carnegie Mellon University

Dr. Nicolas F Soria Zurita, The Pennsylvania State University & Universidad San Francisco de Quito

Engineering students in the United States are experiencing substantial stress and threats to their well-being. Mindfulness- based meditation practice may help students to better manage these challenges as mindfulness-based interventions have been found to improve college students' well-being and critical competencies. However, only limited mindfulness- based research has been conducted with the engineering student population. Nonetheless, this research indicates that engineering students are receptive to mindfulness-based interventions and perceive benefits from participating in these practices.

This work integrated mindfulness-based meditations into a first-year engineering design course to explore how these practices affect engineering students. All practices were formatted as five-minute guided seated meditations. These practices were implemented as part of two larger studies. During the first study, the course was taught online and during the second study, it was taught in person. To understand students' perceptions of these practices, written re- flections were collected in the first study and follow-up interviews were conducted with students in the second study. Generally, students perceived these in-class practices positively and described improved stress management, being more self-aware, and improvements in learning and coursework. Students also detailed some drawbacks to completing these practices and provided recommended changes for improving the integration of these practices into the course.

Additionally, the authors share their insights on implementing these practices into their courses. We highlight the differences between implementing these practices within an online and in-person course. We also discuss challenges associated with engagement, the timing of the practices, and logistical issues. Lastly, considerations and suggestions are provided for implementing these practices into a first-year engineering course.

Overall, the results of this work encourage the integration of mindfulness-based practices into introductory engineering courses as students perceive many benefits. However, at the same time, it is necessary to recognize that implementing these practices can be challenging for instructors. The integration of mindfulness-based meditation practices into engineering courses could contribute to an improved student experience and the development of holistically sound engineers. Future research should investigate the effects of implementing these practices in other types of engineering courses like a first-year seminar course.

Familial Influence on the Choice to Study Engineering: Insights from a Cross-University Study

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Dr. Akua B. Oppong-Anane, Montana Technological University
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Dr. Sarah Tan, Michigan Technological University

This complete research paper investigates familial influence on student engineering major choice. Within the engineering education literature body, motivation to study engineering has been linked to a variety of factors including interest in the field, competence in math and science, strong problem-solving skills, and the promise of career security. Familial influence, specifically that of parents and siblings, has also been tied to the choice to study engineering within student reflections in the literature. Occupational inheritance of careers is well documented, where parents influence their children's career choice, resulting in parents and children in the same career field. Previous work [BLINDED] at a single Midwestern STEM-focused university indicated that the presence of engineers within a students' family may influence career choice, especially within daughters of female engineers. This study seeks to expand that work by gathering data across two universities to further explore the influence of familial engineers on the career choice of engineering students.

At the conclusion of the Fall 2020 semester, 94 students enrolled in the First Year Engineering Program at [BLINDED] university and [BLINDED] university were administered a survey. This survey, adapted from the authors' previous work, aimed to understand what factors influence students' choice to pursue engineering. Students were asked to respond to a series of multiple choice questions regarding familial occupations and links to engineering or other STEM fields. To add richness to the results of the multiple choice questions, open-ended, reflection-style prompts asking students to describe what motivated them to study engineering were added to the survey. Through methods of analytic induction, student reflections to these prompts were analyzed using coding techniques to identify emergent themes. The resulting themes were aggregated into overarching categories and are presented below.

Amongst student reflections, the most prevalent factor in motivating students to study engineering was previous experience in STEM (science, technology, engineering, and mathematics.) Students' reflections also highlight interest in the field of engineering, strong "engineering" skills (problem solving, designing, building), and the promise of career stability as being key factors influencing their decision. Less prevalent within the open-ended student responses is the influence of family, mentors, and institutions. Few student responses reflect familial influence as a factor contributing to their motivation to study STEM. However, when considered in context with student responses to the multiple-choice questions, an interesting picture arises. Of the 94 students surveyed across both institutions, 27 (29%) students reported at least one family member or mentor in engineering and 62 (67%) reported at least one in either engineering or another STEM field. This paper presents an investigation into these relationships, presenting implications for future work to understand how and whether students recognize influences of familial engineers on their motivation to major in engineering.

Student Reflections on Team Experiences in a First-Year Engineering Course

Dr. Jenahvive K. Morgan, Michigan State University

The team experiences of students in a first-year engineering course were examined. Lecture material discussing emotional intelligence was presented to the students as part of the course materials used to assist them through their team experiences, and students completed design projects in inter-disciplinary teams as part of the laboratory portion of this course. This introduction to engineering design course focuses on teaching students the fundamentals of solving open-ended design problems in teams, while learning more about the engineering profession and report writing, in both a lecture and a lab. The design projects are completed in an in-person laboratory environment that allowed teams to work on their project of choice based on multiple project options ranging from designing a miniature solar car to creating a cell phone application. Student team experiences were evaluated using a series of questions and a collection of student comments. Nine questions received responses from 432 students in the course.

The discussion of emotional intelligence was based on students examining their ability to evaluate their emotions, and the emotions of others, while working in these project-based teams. Students reflected on the lecture discussion of emotional intelligence and how it may have assisted in reflecting on their own emotional intelligence, and the emotional intelligence of others, and whether it improved their team interactions. In addition, students also reflected on their passion for the engineering field and provided suggestions for improving the team experiences in the course. Overall, students found the emotional intelligence discussion to assist them in their team experiences in this first-year engineering course.

Tuesday 10:15-11:30 AM Technical Session T2: GIFTS (Lincoln Room)

GIFTS: The secret is in the details. Improving oral presentation skills with a peer and self-assessed feedback module.

Ms. Sarah Lynn Benson, Northeastern University
Dr. Leila Keyvani Someh, Northeastern University

First-Year Engineering Students entering the Cornerstone of Engineering course at XXX University have different levels of Engineering Communication knowledge, often notably weak in oral presentation as a form of communication. Previous methods to teach oral communication included a lecture on how to format and deliver oral communication. This structure provided reference material for the students but had several weaknesses including a lack of peer feed- back and self-reflection, in addition to a delay in detail-specific feedback until their skills were called upon later in the course. To remedy this, an oral communication module was created to accompany the lecture. This module had several components: an assignment, an example professional presentation, a best practices handout, peer assessment, self-reflection, and instructor feedback. An emphasis of this module was to have students reflect on the strengths and weaknesses of their skills. Through the use of recordings, students were asked to self-evaluate their presentations based on our provided rubric. Of 22 students sampled, the overwhelming majority agreed there is value in teaching oral communication skills. Students also reported that their ability to give presentations and identify small details in their own and others' presentations improved as well. Finally, many reported that through rewatching and reflecting on their presentation, they were able to identify points of improvement they would not have noticed otherwise. Through the development of these skills in their first year, students will be able to effectively communicate their ideas through- out their academic and professional careers.

GIFTS: Introducing Quad Chart to Reinforce Technical Communication Skills

Ms. Debjani Sarkar, Michigan State University
Mr. Timothy J Hinds, Michigan State University

Abstract: Our first-year engineering students write and present technical reports, lab reports, capstone projects, formal emails, posters, elevator pitches and more, to communicate their technical knowledge globally to a wide variety of audiences. They are required to present information as objectively as possible. Although the importance of communication may seem self-evident, engineering students do not conceive themselves as writers, and so, do not work to improve their writing skills, or do not know how to communicate results or technical information concisely, clearly, accurately, and logically. Communication is a skill that can be learned and developed. A quick and efficient way of communicating complex technical ideas in a simple and easily understandable way is through the creation and use of a quad chart. This comprises a single page divided into four quadrants laid on a landscape perspective. A quad chart is a universal tool, and our engineering students can use it in

multiple ways - for a quick introduction of their professional and academic activities, short briefings, an initial research proposal, lab report, or the summary of a re- search effort. Each quadrant may represent one main topic, be it an engineering problem being addressed, research question, a resume, a statement of purpose, or even an elevator pitch focused on introducing themselves. For instance, in presenting a lab report, the first quadrant can focus on Introduction of the goal or motivation of their work, the second on a succinct, bulleted Methodology or project design – where students can discuss the data collected and the process, variables tested, and control group. The third quadrant could primarily be a graphic representation of relevant data and Results. The fourth quadrant could focus on Interpretation and Conclusion of the results. It could address how the results support their hypothesis, applications for future work, and acknowledgment of limitations in their current work. They can briefly describe the content and objective of each quadrant through writing, illustrating, or through images and tables. Each quadrant can represent a single topic with its own heading and a visual that is easy to see, visualize, and comprehend. The four quadrants can be summarized to tell a visually appealing digital story or provide a quick overview of the project. A quad chart is intended to be more visual than detailed and enables to quickly introduce the project, their contribution and its significance and impact. Our first-year students can efficiently and effectively develop the skill of writing, communicating, and presenting information, their skills and expertise, and various technical documents, through a simple, visually appealing, and user-friendly single-page document like a quad chart. This idea has been implemented and practiced with graduate engineering students, but not with undergraduates. The author plans to introduce this to first-year engineering students.

Key words: quad chart, technical information, presentation, communication, graphic representation

GIFTS: Engaging First-Year Mechanical Engineering Students in Spreadsheets and Programming

Dr. Allison L. Kinney, University of Dayton

Dr. Vinayak Vijayan, University of Dayton Yucheng Li, University of Dayton

Shanpu Fang, University of Dayton

In a course focused on introducing first-year mechanical engineering students to spreadsheets and programming, there are many challenges to engaging students in the material. This paper focuses on the MEE 114L Introduction to Programming course at the University of Dayton and changes to the course structure designed to improve student engagement and learning. The Introduction to Programming course provides students with an introduction to the application and use of computer programs for mechanical engineers. The 1 credit hour course focuses on building foundational skills in use of spreadsheets, plotting, data manipulation, and basic programming through two software tools: Microsoft Excel and MATLAB. The course is taught in a flipped classroom format with students learning new concepts outside of the classroom through an interactive online textbook and class sessions devoted to time for students to work on problems in the online textbook and software-based projects with assistance from peers and instructors. In the initial implementation of this course, students spent most weeks in the semester working solely in the online textbook and completed software-based projects during 4 dedicated project weeks during the semester. Both the instructors and students observed challenges with this structure that were related to limited direct exposure with the software tools. In the Spring 2022 semester, changes were made to address these challenges by reorganizing the course structure to engage the students with the software tools each week of the semester through weekly software-based project activities. While the course is currently underway, the instructors have observed that student programming skills have improved in comparison to previous semesters and that the reorganized course structure is beneficial for both student engagement and learning.

GIFTS: Engineers in gear: Building a student support model to transcend the COVID era

Dr. Sheldon Levias, University of Washington

Dr. Lynne Spencer Ph.D., College of Engineering, University of Washington

Mr. Kelsey F Gabel, University of Washington Engineering Academic Center

The COVID-19 virus pandemic spanning the last two years has profoundly affected all aspects of life, particularly for students and educators. Technology has mitigated some of the effects of shifting formal, in-person schooling to a virtual context. The University of Washington's College of Engineering (UW CoE) instructors and students have experienced this learning environment tectonic shift in myriad ways. As a team within the broader UW CoE, the Engineering Academic Center (EAC) staff learned to adapt to this changing landscape. The EAC team had to be creative and adapt its practices in order to maintain a reasonable approximation of the support systems it's been utilizing over the last four decades to support students furthest from educational equity to earn engineering degrees. After our university shifted to all remote instruction and interaction, we did not have the physical space where so much of our community building happens. Utilizing data analysis, multimedia tools, and innovative strategies, the EAC team persisted. The adaptation that we are highlighting for this FYEE conference is for our Engineers in Gear, or EIGs, 2-hour study sessions the week prior to exams to prepare students for the types of questions that could be asked on their up- coming assessments. EIGs are done for engineering prerequisite courses in math, physics,

chemistry, and engineering fundamentals. With the move to a virtual environment, the EIG model that we had used successfully in-person was adapted to allow for remote participation. We will address how we orchestrated technological tools such as Google Forms, Zoom, Zoom whiteboards and XP-pens to emulate many of the features of in-person EIGs. We will discuss how this adaptation, taken up through necessity, has turned out to be beneficial even with the gradual move back to in-person instruction, and is now a model included in our toolkit of support as we begin to consider transcending the COVID era.

GIFTS: Retention Improvement Efforts in the Undergraduate Living and Learning Community at the University of South Carolina

Prof. Edward P Gatzke, University of South Carolina

The University of South Carolina Engineering and Computing Living and Learning Community is focused on helping students succeed in their academic careers. For many years, program activities include a one-hour professional development course, linked coursework for mathematics and chemistry courses, and residence hall tutoring availability. Recent new supports for student retention will be discussed. These efforts include:

1. Early Move-In Boot camp - A short optional course helps students adjust to campus and form social networks while providing mathematics review and professional development information.

2. More linked courses - In addition to mathematics and chemistry, the living and learning community now has implemented linked humanities coursework in the spring so that students living together can take more courses with other residents.

3. Spring activities - Traditionally, most retention efforts have focused on acclimation in the Fall semester. New efforts help support students throughout their entire first year so that they have help in taking corrective actions.

GIFTS: Assumptions, Approximations, and Dimensional Analyses, Oh My!

Dr. Charles E. Pierce, University of South Carolina

It is critical that first-year engineering students understand the value of and the process required for solving open-ended problems. The content and context for our Introduction to Civil Engineering course is built around a famous quote from a well-known structural engineer, Sir Ove Arup. He stated that: "Engineering problems are under-defined; there are many solutions, good, bad and indifferent. The art is to arrive at a good solution. This is a creative activity, in- volving imagination, intuition and deliberate choice." In this course, we challenge students to construct and document potential solutions for under-defined problems that do not have a singular right answer. We use a structured approach for problem-based learning that is collaborative and supportive. The GIFT focuses on the first step in that structured approach.

To start the open-ended solution process one must make a reasonable first estimate. Making estimates is much different from the closed-form solutions that most students are comfortable with. Choices must be made, often with limited information and knowledge. We demonstrate that with finding answers to Fermi questions. Students learn how to make assumptions and approximations while understanding how to differentiate one from the other. Assumptions and approximations are often correlated and students practice making those connections. The process of making approximations reinforces the importance of being careful and intentional about selecting units of measure. A numerical answer to the Fermi question is then calculated by setting up and performing a series of dimensional analyses, most commonly in the form of unit conversions. The GIFT will further define these three components and describe how we guide students to use them in making first estimates for open-ended problems.

GIFTS: Incorporating Patent Review into First-Year Student Design Projects to Support Ideation, Concept Selection, and Commercialization

Dr. Lee Kemp Rynearson, Campbell University

[Institution Name] requires every engineering student to take a rigorous 3-credit semester-length design course, typically in their second semester. Student teams of 3-5 pursue a design problem of their selection from problem finding through prototyping and the presentation of prototypes and the results of testing to engineers from local industry. Integration of patent review into the course presented the opportunity to enhance design instruction and project out- comes by providing students with 1) an additional source of potentially relevant mechanisms and design inspiration,
2) additional direction in concept selection to avoid active patents and 3) a strong entry point for follow-up efforts in technology licensing and commercialization for teams who have developed suitable IP.

To assist in the implementation of patent review instruction, free materials aimed at undergraduate patent review instruction were sought in collaboration with campus STEM librarians. Despite extensive searches and inquiries with STEM librarians across the country, limited results were found, none of which had the scope and detail desired. There- fore, [Institution name] STEM librarians and faculty collaborated to produce 1) templates and assignments suitable for basic patent review by undergraduate students, and 2) detailed instructional videos totaling about 45 minutes in length that walk student teams through the process. These materials and some other resources such as links to other video tutorials found and the recommended patent databases were incorporated into a publicly available webpage of the [Institutional Library Name].

These materials have been used for several first-year design course offerings, with the patent materials typically co- taught by both the course faculty and STEM librarians. Course faculty focus on the connection and utility of the information to the design process, and grade student work. The STEM librarians introduce the material and provide support to student teams performing the patent reviews. The patent materials have been introduced at different points in the course over time and are currently used in an initial review during brainstorming and ideation followed by a second review coinciding with concept selection to better orient the student teams to the different uses of the patent review findings. Several teams have elected to build on the patent review materials by completing the University's IP disclosure forms for a later contract-graded portion of the course.

Overall, the integration of patent review into the first-year design course has been smooth, with student teams of- ten conducting rigorous reviews and meaningful analyses of their findings. These materials and assignments are seen as potentially helpful to engineering design classes across the undergraduate curriculum, including first-year design, for which these materials were originally prepared, along with other classes or extracurricular activities where under- graduate students might engage with the patent review process.

GIFTS: Introducing First Year Students to The Running Track Analogy of an Electric Circuit

Dr. Christopher Horne P.E., North Carolina Agricultural and Technical State University

This work-in-progress describes a unique teaching method used for introducing the series electric circuit to under- represented minority engineering students. It is unique because of its teaching method for mathematics and historically is not used in FYEE programs. First Year Engineering Student (FYES) retention and overall success is predicated on their recent academic success in high school. Too often a struggling first semester student has limited knowledge of how a simple series electric circuit relates to a real-world event or physical concept. Student-centered active learning, in which students are asked to "do" something beyond listening and note taking, as this teaching idea suggests, should be used in STEM courses.

What is effective teaching to engage students whether in hybrid mode or in person? How can STEM activities re- main fun and interactive? Whether in-person, hybrid, or remote learning environment, STEM teachers have likely grappled with one or more of these questions. Freshmen often do not make the 'link' between an equation and a physical system despite attempts at the water flow analogy for electric circuits. One such equation that is pervasive in many branches of the engineering profession is Ohm's Law which describes a linear relationship between voltage on the left-hand side of the equal sign and current multiplied by resistance on the right side. The ability to understand and apply this equation to an electric circuit is common and useful in electrical, computer, biological and even mechanical engineering projects.

The teaching method used for explaining the series circuit uses a low-cost electric circuit kit that the students build and test; the water flow in a pipe kit is not practical in the classroom. They also learn how to model the circuit using MATLAB Simulink and engage in practical lectures on the running event called the hurdles and its physical relation- ship to circuit experiments.

Course modules are taught in the Problem Solving for Engineers course for freshman in 2021 and Spring 2022. The Problem Solving for Engineers course teaches students how to apply mathematics to the real-world including problems encountered in everyday life. The freshman class, consisting of 55 students was taught virtually while the class of 149 students is taught mask-to-mask. Most of the students are considered underrepresented and most all engineering majors are included.

Additional concepts in the simple series circuit including the voltage and resistance are explained and compared to this real-world event. The series electric circuit was conceptualized in terms of a hurdle event where runners are analogous to electric charges, hurdles represent electrical resistance, and the Gatorade station is explained in terms of the source voltage. Students are surveyed on their understanding of the running hurdles event in terms of analogies, for example, the movement electrical charges in a circuit is analogous to a runner moving along a track. Preliminary survey results are overall a positive response. Through practical lecture material on hurdle running and hands-on experimentation, freshmen student learning is enhanced. Additional data will be collected on student learning through polls, quizzes, student presentations and surveys.

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