ASEE
AMERICAN SOCIETY FOR ENGINEERING EDUCATION

MIDDLE ATLANTIC SECTION

2022 Fall Conference

Hosted by:

PennState Harrisburg

November 11-12, 2022

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Welcome from the Conference Chairs

Rajarajan Subramanian, Ph.D. (Roger) (Logistics)

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We are very happy to welcome you to the American Society for Engineering Education (ASEE) Middle Atlantic Section Fall 2022 Conference at Penn State, Harrisburg! We are sure that all of you, just like us, are excited to participate in this face-to-face conference with our engineering education professional circle. This conference features a wide variety of papers and presentations that will enrich our knowledge of teaching and learning. We believe this conference will bring the new and innovative technologies used for teaching and the current techniques practiced in various classrooms across the region to you.

The theme of this conference is “Making Engineering Education Accessible and Inclusive”, and we are very grateful to the participants that present their work at the conference.

Conference Organizing Committee

Dr. Roger Subramanian
Dr. Sadan Kulturel-Konak
Dr. Shashi Marikunte
Dr. Saravanan Gurupackiam
Dr. Esfakur Rahman

Conference Organizing Committee is thankful to –
Dr. John Mason, Chancellor, Penn State at Harrisburg
Dr. Omid Ansary Senior Associate Dean, Penn State Harrisburg
Dr. Vahid Motevalli, Director, SSET, Penn State Harrisburg.
The ASEE MAS conference is made possible by the dedication of many volunteers. Most notably-
Staff Volunteers: Ms. Heather Lookenbill and Ms. Tami Hile
IT Staff: Christopher Weaver and Ilhan Kucukaydin
ASEE Mid Atlantic Section Liaisons
Dr. Maxine Fontaine, Stevens Institute of Technology, Chair (ASEE Mid Atlantic Section)
Dr. Pritpal (Pali) Singh, Villanova University, Meetings Chair

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Conference in Short

Times reflect Eastern Daylight Time (EDT)

Fri, Nov. 11	Event	Lead Author	Location (Olmsted Bldg.)
2:00 - 7:00 PM	**Registration and Help Desk**		Atrium
2:45 - 3:45 PM	Workshop: "Mastery-Based Engineering Pedagogy "	Sara Atwood & Kurt DeGoede	W-107
4:00 - 5:00 PM	Workshop: "Effectively Engaging Students in Group Problem Solving"	Sadan Kulturel-Konak & Abdullah Konak	W-107
5:00 - 5:45 PM	Campus Tour		Tour starts from W-107
5:00 - 5:45 PM	Executive Board Meeting		W-138
6:00 - 7:30 PM	Dean's Reception & Dinner (Dean's Address by **Dr. Vahid Motevalli, Director, School of Science, Engineering, and Technology, Penn State Harrisburg**)		W-107

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Sat, Nov. 12	Event	Lead Author	Location (Olmsted Bldg.)
8:00 AM - 2:00 PM	**Registration and Help Desk**		Atrium (Lobby)
8:00-8:30 AM	**Breakfast**		W-107 (Gallery Lounge)
8:30-9:15 AM	**Welcome Address by Dr. John Mason, Chancellor of Penn State at Harrisburg & Keynote by Kemi Ladeji-Osias, Ph.D. Program Director, Engineering Education, Division of Engineering Education and Centers, Directorate for Engineering NSF**		W-107 (Gallery Lounge)
Technical Session-1 **9:30–10:30 AM**	Diversity, Ethics, and Inclusiveness *Moderators: Douglas Yung and Gary Halada*		
	Designing the Department of Engineering Studiesâ€™ Sub-baccalaureate Programs for Future Deaf Students at (School 1): A SWOT Analysis	Dino J Laury & James Fugate	**W-117**
	First-Year Catapult Design Experience for the Deaf and Hard-of-Hearing Engineering Technology Studentsâ€™ Incidental Learning at NTID	Dino J Laury	
	Bridging the Social Capital Gap in Historically Marginalized Populations	Sara A. Atwood	
	The Role of Mentors in Student Innovation Competitions and Programs	Alexa Prince	
	All the posters that will be displayed between 10 AM to 2 PM can be found on the last page of this schedule		
Break 10:30-10:45 AM			
Technical Session-1 **10:45–11:45 AM**	Measurements Of Adaptive Expertise Among Low-Income STEM Students	Alexander John De Rosa	
	Diversity, Ethics, and Inclusivity: Learning from Engineering Failure	Gary P. Halada	
	Promoting Inclusion and Equity in a Biomedical Engineering Capstone Design Course	Douglas Yung	
	On Improving Cognitive Learning with Effective and Interactive PowerPoint Presentations	Felix F. Udo-Eyo	
Technical Session-2 **9:30–10:30 AM**	Interactive Learning and Research Learning *Moderators: Bala Maheswaran and Nadir Yilmaz*		
	Soft skills enhanced project-based pedagogy in the community college reflecting apprenticeship and industry need	Dugwon Seo	**W-138**
	Undergraduate Research in Sustainable Aviation	Nadir Yilmaz	
	Accelerated Experiential and Interactive Learning in Entrepreneurship Program	Bala Maheswaran	
	Universal Design Learning Approach: Its Paradigm and Application in Engineering Education	Felix F. Udo-Eyo	
Break 10:30-10:45 AM			
Technical Session-2 **10:45–11:45 AM**	Taking the Mystery out of the Trigonometric Functions	Daniel Blessner	
	Accident Occurrences and Safety Issues Reported by Mid-Atlantic P-12 Engineering Education Programs	Tyler S. Love	
	Building/Testing Novel Sensor Technology in Summer Research & Independent Study	Luka Baramidze	
	Political Bodies: Introducing Political Disability Identity for Research and Education	Liam McDermott	

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Sat, Nov. 12	Event	Lead Author	Location (Olmsted Bldg.)
11:45 to 1:00 PM	**Lunch & Business Meeting**		**W-107**
Technical Session - 3 **1:00–2:00 PM**	Technology and Software *Moderators: Brett Rocha and Felix Udoeyo*		
	Software Simulation to Reinforce Learning in a Power Systems Analysis Course	Rafic Bachnak	**W-117**
	Mechanics Escape Room: Escaping the Monotony of Solving Problems	Brett Rocha	
	Engineering Art: Democratizing creative expression using normative rules	Thomas E Ask	
	Co-ops: Not just for the experience but increase your probability of full-time employment	Paul John Ackerman	
Break 2:00-2:15 PM			
Technical Session - 3 **2:15–3:00 PM**	A Feasibility Study on Building a Stand-Alone Community Microgrid in the United States	Salma Alami Yadri	
	Factors Influencing High School Engineering Course Enrollment: A Comparison by Gender	Grace Mary LoPiccolo	
	All the posters that will be displayed between 10 AM to 2 PM can be found on the last page of this schedule		
Technical Session - 4 **1:00–2:00 PM**	Outreach and Capstone Design Projects *Moderators: Tracey Carbonetto and Thomas Ask*		
	Power Systems Relay Coordination using Hardware-in-the-loop	Oluwadamilola Ajayi	**W-138**
	Motion Capture System Used for Joint Angle Measurements as an Undergraduate Project	Suzanne Keilson	
	Enhancing Student Learning through Inter-Disciplinary Capstone Design Project	Shashi S. Marikunte	
	A STEM Outreach Project for High School Students: Optimization of the Design Parameters for the Antibiotic Manufacturing Process Using R	Zuyi Huang	
Break 2:00-2:15 PM			
Technical Session - 4 **2:15–3:00 PM**	Deriving Closed Formula Design Restrictions in Electronics Labs	Nashwa Elaraby	
	Promoting Careers in the Water/Wastewater Utilities to K-12 Students and Educators	Kauser Jahan	
	Coding a Simple Construction Activity in a First-Year Engineering Course	Tracey Carbonetto	

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Sat, Nov. 12	Event	Lead Author	Location (Olmsted Bldg.)
Posters **10 AM - 2 PM**	Posters *Moderators: Sadan Kulturel-Konak and Suzanne Keilson*		
	Low-Cost, Biomimetic, Vibrotactile Stimulation for Non-Invasive Sensory Feedback	Joseph Kutteh	**Atrium (Lobby)**
	Correcting Low-Light Imperfections on Images when Submitting Online Work Using HSV	Aldo Morales	
	A Virtual Clinical Immersion for Biomedical Engineering	Douglas Yung	
	Creating Sustainable Resources for Our Cities Via Collaborative Community Engineering Projects: Using Problem Based Learning to Empower Future Engineers and Society	Sayid Achilov	
	Long-Term Effectiveness of Multiple Restoration Projects in Streams of the Lititz Run Watershed	Elizabeth Raifsnider	
	Modeling the Impacts of Storm Intensities and Rainfall Time Increments on Flooding	Jonathan Fischer	
	Mastery-Based-Learning to Study Anxiety and Belonging in a Circuit Analysis Course	Meghan Williams	
	Reliability Based Design Optimization of Foundation Systems using A First Order Reliability Method and a Parametric Study	Nicholas Balzano	
	Data Analytics for Decision-Making at Academic Departments	Ashwin Satyanarayana	
	Salt Transport in a Bioretention Basin after Roadway Deicing Applications	Carrie Fischer	

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Penn State Wi-Fi Connection:

Visitor Networks

Penn State provides the following wireless networks for campus visitors.

psu-guest:
This unauthenticated network is free for Penn State guests to use wherever it is available. Click on “psu-guest” among your available networks to connect. If the psu-guest web page doesn't open automatically, open a browser and go to https://psu-guest.psu.edu

Maps & Directions

Please see the **Map below**. All the events are taking place in "Olmsted Building". It is divided into East and West wings. Our events are taking place on the West side of the Olmsted (Rooms W-107, W-117 & W-138). Poster displays and Registration are taking place in the central portion of the building called as Atrium or simply Lobby. For directions, when you put it in google maps, use "Olmsted Building, Middletown, PA 17057". **Parking is free** for both days.

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Conference Sponsors:

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Keynote Speaker

Dr. J. 'Kemi Ladeji-Osias

Program Director for Engineering Education, Engineering Education and Centers Division Engineering Directorate
National Science Foundation

Dr. J. 'Kemi Ladeji-Osias is the Program Director for Engineering Education in the Engineering Education and Centers Division of the Engineering Directorate at the National Science Foundation where she oversees programs focused on the professional formation of engineers. The EEC Engineering Education portfolio includes Revolutionizing Engineering Departments (IUS/PFE: RED), Research in the Formation of Engineers (RFE), and the Research Initiation in Engineering Formation (PFE: RIEF) programs. She is on temporary assignment from her position as Professor of Electrical Engineering and Associate Dean for Undergraduate Studies in the School of Engineering at Morgan State University in Baltimore. Dr. Ladeji-Osias earned a B.S. in electrical engineering from the University of Maryland, College Park, and a joint Ph.D. in biomedical engineering from Rutgers University and UMDNJ. Dr. Ladeji-Osias' involvement in engineering curricular innovations includes adapting portable laboratory instrumentation into experiments from multiple STEM disciplines. She enjoys observing the intellectual and professional growth in students as they prepare for engineering careers.

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Workshop I: Friday November 11, 2:45 - 3:45 PM	Location
Mastery-Based Engineering Pedagogy **(Sara Atwood & Kurt DeGoede)** Take control of your grading and your curriculum – What do your students NEED to be able to do to be successful, in the rest of this course, in the next course, professionally? Your best students will master all outcomes of your course in either model, but what do your C students take from the course? If you would rather have your C students achieve A-level work on 5 outcomes rather than C-level work on 12, Mastery-Based Learning (MBL) may be perfect for your course. In our MBL courses we see students taking ownership of their learning far beyond traditional courses: they understand what they know and what they need to work on, and they learn how to master skills. This workshop will allow you to explore the possibilities of transitioning a course to MBL.	**W-107**
Workshop II: Friday November 12, 4:00 – 5:00 PM	**Location**
Effectively Engaging Students in Group Problem Solving **(Abdullah Konak & Sadan Kulturel-Konak)** Innovation means coming up with new products, services, solutions, and ideas that improve the status quo. Although creativity is one of the most basic human traits, it sometimes seems challenging to innovate. Solution design teams, especially in larger, established organizations, frequently fail to develop innovative solutions. Research shows that a structured approach to innovation can improve the productivity and creativity of innovation teams. This hands-on workshop introduces several techniques that can help innovation teams in finding (a) facts, (b) new ideas, and (c) creative solutions in classroom settings. This workshop will introduce several collaborative innovation and problem-solving methods and how to apply them to better engage all students in group work.	**W-107**

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Abstracts

Software Simulation to Reinforce Learning in a Power Systems Analysis Course

Dr. Rafic "Ray" Bachnak P.E., Pennsylvania State University, Harrisburg, Capital College
Dr. Peter Idowu P.E., Pennsylvania State University, Harrisburg, Capital College

Software simulation has become an integral component of a comprehensive learning experience in engineering and technology programs. Popular software packages include PSpice, LabVIEW, MATLAB/Simulink, and Multisim. This paper describes the use of software packages for developing several laboratory exercises that reinforce learning in a power systems analysis course. The main purpose of these exercises was to supplement the classroom lectures with laboratory materials that correspond to the topics covered in the textbook. These topics include three phase power, transformers, transmission lines, power flows, faults, and system protection.

During the semester, students completed a total of nine exercises and worked on a final project that included an oral presentation. The exercises ranged from writing simple MATLAB code that perform computations and graph results to more complex and practical applications such as simulation of three-phase power circuits and synchronous generators using Simulink. Simulink is a graphical programming environment that offers easy integration with the MATLAB environment to model, simulate, and analyze real-world systems and has been used to help in the design and simulation of power systems. Students also completed three simulation exercises using ETAP, an electrical anal- ysis software package that is suitable for monitoring, control, operator training, optimizing, and automating power systems. The overall goal is to enhance the students' critical thinking and problem-solving skills and train them to apply effective solutions by identifying alternative approaches, testing systems, and comparing results. Students pre- pared written reports that included a one to two-page conclusion where they described their designs, explained the operation of the systems, discussed results, mentioned problems they faced, stated what they have learned, and suggested ways to improve the laboratory assignments.

The paper will briefly describe the laboratory activities, show how students were exposed to a wide range of ap- plications, and provide details about the Simulink and ETAP exercises, including schematic diagrams.

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Bridging the Social Capital Gap in Historically Marginalized Populations

Stephanie Zegers, Elizabethtown College
Dr. Sara A. Atwood, Elizabethtown College

First-generation college (FGC), historically marginalized populations (HMP), and female engineering students often have social capital deficits that impede their transition from college to industry, despite social capital underpinning a successful career in engineering. ASEE's 2020 Survey for Skills Gaps in Recent Engineering Graduates identified communication as acritical professional skills for recent graduates. Providing students with explicit instruction on professional skills that support building social capital can be a way to address this deficit. This paper investigates student-perceived growth on specific skills within the communication purview related to building social capital: the ability to build relationships online, the ability to build professional relationships in-person, the ability to interview, and the ability to negotiate. These skills were targeted based on their contribution to developing social capital in the early years as a professional. First is the ability to build relationships both online and in-person. The adage "It's not what you know, but who you know" is often true when searching for an internship or professional position. The US Bureau of Labor and Statistics concludes that 85% of jobs are filled by networking. Secondly, the employment interview is often the deciding factor in hiring one candidate over another. Lastly, the ability to negotiate salary is often noted as a reason for inequalities in salary/wage across populations. We piloted a professional skills seminar that provides explicit instruction in these communication skills. We measured the student's perceived skill level with a Likert scale at the beginning and conclusion of the course. The instructor facilitated intentional activities to build these professional skills in the students throughout the semester. We then analyzed the pre-& post-assessment scores for individual growth in marginalized subgroups: FGC, HMP, and female-identifying, compared to counterpart subgroups: Continuing-generation, historically privileged populations, and male-identifying. The results showed positive trends of growth in each professional skill for all students and in sub-groups including first-generation, historically marginalized populations, and women.

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The Role of Mentors in Student Innovation Competitions and Programs

Miss Alexa Joelle Prince, Penn State Berks
Dr. Sadan Kulturel-Konak, Pennsylvania State University, Berks Campus
Dr. Abdullah Konak, Pennsylvania State University, Berks Campus
Prof. David Robert Schneider, Cornell University Systems
Engineering Prof. Khanjan Mehta, Lehigh University

Many students in Science, Technology, Engineering, and Mathematics (STEM) fields seek to expand their technical knowledge, develop an innovative mindset, and build teamwork and communication skills. To respond to this need, many higher education institutions and foundations have broadened their co-curricular program offerings to include design challenges, hackathons, startup competitions, customer discovery labs, and pitch competitions that are designed to support and benefit student innovators. Faculty mentors are responsible for being available to students to answer questions, guide student thinking, and advise student teams to facilitate learning. For these students to gain crucial knowledge and at least be educationally successful in these programs, a mentor possessing key traits and using certain strategies is proven to be highly influential. While much research supports the importance and benefit of STEM students' participation in these programs, literature discussing the effective strategies for mentoring students participating in these programs remains limited. Exploring the best mentoring practices will provide insight into how to support and prepare students for innovation competitions and their upcoming careers as well as catalyze their entrepreneurial minds for future success. Based on a series of interviews with experienced mentors of innovation competitions and programs, this paper presents a set of best practices for mentoring student innovation teams.

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Soft skills enhanced project-based pedagogy in the community college reflecting apprenticeship and industry need

Dr. Raymond K.F. Lam, The City University of New York, Queensborough Community College
Dr. Dugwon Seo, Queensborough Community College
Dr. Merlinda Drini
Dr. Guozhen An, CUNY Queensborough Community College

Apprenticeship is a way of learning that combines traditional classroom learning and on-the-job training experience. New York City Jobs CEO Council (https://nyjobsceocouncil.org/) provides an apprenticeship program to community colleges in the City University of New York by incorporating businesses and education leaders to establish a bridge between employers' needs and practical job training for community college students. The authors of this paper have participated in the NYC Job CEO Council's Educator Program which provides opportunities to interconnect community college faculty and various employers directly to fill the gap between employers' demands and college teaching. The employers pointed out that new college graduates lack of soft skills including oral and written communication, digital fluency, problem-solving, critical thinking, time management, leadership, and teamwork. These soft skills are also required for students who participate in the apprenticeship program. However, teaching technical knowledge is the general and primary focus of the conventional methods in engineering technology colleges, and teaching soft skills is mostly not included in the curriculum and assessment. Therefore, preparing engineering technology students for apprenticeship and their future career start is essential. The authors learned that project-based pedagogy is an avenue for teaching soft skills to students. Thus, we designed and implemented the project-based pedagogy including soft skill training. In this paper, multiple project-based projects in different disciplines of engineering technology for both in-person and virtual classroom settings are presented including methodologies of teaching soft skills, pedagogical limitations in a community college setting, assessment, and learning outcomes.

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Measurements Of Adaptive Expertise Among Low-Income STEM Students

Dr. Alexander John De Rosa
Dr. Maxine Fontaine, Stevens Institute of Technology (School of Engineering and Science)
Dr. Frank T Fisher, Stevens Institute of Technology (School of Engineering and Science)
Dr. Ashley Lytle

One of the goals of undergraduate education is to prepare students to adapt to a challenging career that requires continual learning and application of knowledge. Working professionals should have deep conceptual knowledge that they can apply in a range of contexts and possess the attitudes and skills of lifelong learners. Literature suggests the concept of Adaptive Expertise (AE), which describes the ability to apply and extend knowledge and skills to new situations, addresses some of these characteristics. Survey data concerning the level of AE displayed by various populations is extremely limited in most contexts, be it education or working professionals. As such, data concerning the level of adaptiveness displayed among various groups needs to be measured if activities designed to promote the development of AE are to be created and then tested in terms of their efficacy. This investigation provides this critical baseline data for future studies as we track the AE development of individual students through their studies and into their
professional careers.

In this study, an existing survey instrument designed to measure adaptive expertise was disseminated to a large number of incoming first-year STEM students in the fall of 2021 (n=711). In spring of 2022 this survey was followed up with another data collection effort targeting low-income students in particular. A total of n=208 low-income students from all four years of an undergraduate STEM education completed the AE survey. Targeted interviews were then conducted with 24 of these students (6 per year, 3 male, 3 female) to examine the differences displayed by low and high AE students.

Results of the AE survey indicated no statistically-significant differences between low-income and non-low-income first-year students in terms of their level of adaptiveness. In addition, the level of AE displayed by low-income students increased through the program in a manner similar to non-low-income STEM students. Several themes emerged from the interview responses including: a general understanding among students of the likelihood of needing to continually learn new concepts throughout their careers, and students expressed growth in understanding the acceptance of reaching out for assistance from other students and faculty after exploring information on their own. Two dominant and divergent metacognitive processes were also observed: teaching/explaining concepts to others (highly adaptive) or primarily relying on exam/course grades for feedback (low adaptiveness). The data gathered here will allow the research team to develop activities to promote AE and to measure their effectiveness. Data gathered from interviews for example demonstrates the need for a greater emphasis on metacognitive practice to promote various aspects of AE.

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Building/Testing Novel Sensor Technology in Summer Research & Independent Study

Mr. Luka Baramidze, Bucknell University
Dr. Peter Mark Jansson PE, Bucknell University

Practical learning is an inherent part of the engineering curriculum. Engineering students best learn the course mate- rial through intensive hands-on experiences. Research and independent study opportunities allow students to directly apply their engineering knowledge to real-world problems as a continuation of their in-class learning. The research and independent study opportunities under the guidance of an ECE professor described in this paper have provided students with unique experiences to augment their coursework with diverse applications as well as increasing agency in their developing engineering careers. Agency in education allows students to create rather than seek out learning opportunities. The students can also get practice with innovative problem-solving — promoting innovative thinking is crucial to develop as an adaptive expert. One proposed adaptive expertise framework differentiates two dimensions a learner may develop: efficiency and innovation. Undergraduate education focuses on widening the breadth of the content a student is exposed to – an expert, in a classical sense, is defined as being efficient when solving routine problems. On the other hand, an adaptive expert can innovate when faced with problems that are not routine. The latter is the product of incorporating student-centric learning into the undergraduate curriculum – providing future experts with the innovative space to foster their professional and personal skills to become better practicing engineers. The learners are challenged through open-ended design problems as the work is often student-led. These experiences provide practical skills, but they are essential as well in building professional skills such as teamwork, leadership, troubleshooting, and best design practices. This paper describes our recent efforts to provide more adaptive learning experiences via building and testing a novel Mach effect sensor technology over the past few years in summer research and independent study opportunities at _University in the College of Engineering. This work should be of interest to engineering faculty and students as it demonstrates the critical role independent study and summer research can play in enhancing and deepening engineering education.

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Engineering Art: Democratizing creative expression using normative rules

Dr. Thomas E Ask P.E., Pennsylvania College of Technology

This paper offers a presentation on the use of normative rules to create works of art and music as well the use of this approach in encouraging creative expression in engineering and design students.

Identifying patterns found in art and music allow untrained people to employ these rules, thereby broadening access to creative expressions. The democratizing implications of technology is already apparent in applications such as additive manufacturing and digital manipulation of imagery. These applications of technology allow people without artisanal skills of a sculpture or painter to move their mental conjuring into physical embodiments. Identifying normative rules that undergird many artistic and musical expressions allow their prescriptive usage by less trained individuals to create art and music, which represent rich expression of creativity. Relying upon heuristics to move ideas forward into tangible expressions embolden students to use their abilities to create designs and solve engineering challenges.

This paper identifies normative rules used in some forms of art and music, then uses these rules to produce alluring works. Use of AI generated art from DALL-E is compared with the author's artwork as a foundation for a presentation of individual style and the intersection of AI and human creativity. This paper also shares experiences with artistic exercises in an introductory mechanical engineering class.

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Motion Capture System Used for Joint Angle Measurements as an Undergraduate Project

Dr. Suzanne Keilson, Loyola University Maryland

This paper was part of an undergraduate research project in assistive technologies. It presents an analysis of the Leap Motion as an occupational therapy tool. The Leap Motion's speed, ease of use, accuracy and price make it a competitive alternative to the goniometer, a commonly used tool for angle measurement. The Leap Motion, a hand gesture tracking system was analyzed with respect to its angle measuring capabilities. Existing software, BREKEL Pro Hands was used in conjunction with the Leap Motion to generate an Excel worksheet of hand data. These data were analyzed utilizing MATLAB to calculate joint angles. The joint angle measurements were then compared with corresponding angles measured with a goniometer. In addition to a presentation of the student's technical work and analysis, some comments and conclusions will be drawn about the impact these kinds of projects can have on the undergraduate educational experience and how they may become more infused in the curriculum.

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Enhancing Student Learning through Inter-Disciplinary Capstone Design Project

Dr. Shashi S. Marikunte, Pennsylvania State University, Harrisburg, Capital College
Dr. Saravanan Gurupackiam, Pennsylvania State University, Harrisburg, Capital College

In many universities, capstone project is associated with an advanced course, which focus on the expertise in one concentration area. This limits student learning of interdependency of other disciplines within the major for problem solving. At our program, we formulated a creative way to use the traditional course offering yet provide an opportu- nity for students to work on an inter-disciplinary project in civil engineering. Students from three concentration areas within civil engineering (structures, construction, and transportation) were offered an opportunity to work together in small groups on an active or proposed project that included components from all three concentration areas. Student groups were provided with drawings and specifications of an actual project that was in the process of being built or recently completed and were required to propose alternate approaches to design and other components of the project. All groups diligently worked on this project in true competition style, to incorporate changes through value engineering, sustainability, energy efficiency, and other modern tools to improve the functionality, or other aspects of the project. Students had opportunity to review actual construction drawings and work in inter-disciplinary teams to incorporate changes. Confidential peer-reviews were used to assess the performance and contribution of each member, and their interaction with other members of the group. Students presented their final project in front of mixed audience that included family members as well as experts in the area during the Capstone Design Conference. Team consisting of faculty and industrial advisory board members evaluated communication skills and technical skills of students during this conference. In addition to enhancing student learning, this approach was also valuable to assess ABET student outcomes that are difficult to assess in the traditional class setting. This paper presents the beneficial effects of such approach to assess ABET student outcomes, and their effectiveness. The success of this approach has encouraged us to broaden the project to include all concentration areas in civil engineering going forward.

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Undergraduate Research in Data Science and Sustainable Aviation

Mr. Kayode D Dunkel Vance, Howard University, USRA NAMS Student R&D Program
Dr. Nadir Yilmaz, Howard University

The aim of this study was to process large data sets obtained from NASA and to estimate the emissions for traditional jet fuel through calculating the path lengths of aircrafts. Computational analyses were performed, in collaboration with NASA and Universities Space Research Association, as part of a summer research program for undergraduate students. A program using Python was developed to process the NASA Sherlock data to obtain aircraft details and flight paths. Altitude independent emissions were then estimated for traditional jet fuel. The paper also describes future research plans for altitude dependent emissions, implementation of an approach for sustainable aviation fuels, and high performance computing capabilities.

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Co-ops: Not just for the experience but increase your probability of full time employment

Dr. Paul John Ackerman Jr P.E., York College of Pennsylvania

This paper will discuss the results of an engineering cooperative program over a seven year period for a college civil engineering program. For College X, students are required to pursue three co-op opportunities over the course of their four-year academic schedule. Many faculty and industry personnel are familiar with the benefits that engineering co- operatives (co-ops) provide to both students and employers. One of the most significant benefits for the students is the opportunity to gain hands-on engineering work experience. On the other hand, one of the most significant benefits for employers is utilizing co-op as a recruitment tool to hire entry level engineers. Increasing the probability of full time employment is mutually beneficial but especially for employers in this current time. After tracking co-op and full time hiring opportunities for students over a seven year period, data shows that co-ops do increase a student's probability of receiving a full time employment offer from their co-op employer. Although this conclusion, more opportunities increase probability, may seem obvious there is very little quantifiable data available to reinforce this perception. The results in this paper will quantify the benefit of a co-op experience and provide results showing how many students accepted full time employment with companies they completed a co-op experience with versus students who accepted an offer from a company they did not complete a co-op with. In addition, results will also quantify the amount of work experience, measured in time only, students were able to obtain through the co-op program. The paper will also discuss the findings in analyzing student preference in co-op location, whether students prefer to pursue opportunities close to home or close to school. In addition, the effect CoVid-19 lockdowns had on the co-op program will also be discussed. Lastly, nationwide trends in training and recruitment costs and the effects co-op programs have on these costs will be discussed.

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Taking the Mystery out of the Trigonometric Functions

Mr. Daniel Blessner, Pennsylvania State University, Wilkes-Barre Campus
Dr. Dimitrios Bolkas, Pennsylvania State University, Wilkes-Barre Campus

Making engineering education accessible to under prepared students entering college from high school and students transitioning from the community college level is sometimes difficult due to the demanding mathematical requirements the major demands. One specific area of great difficulty for under prepared students is understanding the trigonometric functions. Part of the problem is that the trigonometric functions seem mysterious to them because they are only seen as buttons on a calculator. The trigonometric functions are classified as transcendental functions. A transcendental function cannot be written as a finite combination of algebraic expressions. The key word is FINITE. This fact in most cases eliminates the equation form from ever being seen by students. Students know them as only a word sine, cosine, and tangent that is somehow related to the sides of a right triangle. Below are the Power Series Expansion formulas for sine, cosine, and tangent functions. For simplicity in computation purposes only the first three terms in the series will be used. Using theses formulas will give incoming engineering students the hands on feel of working with familiar functions such as linear lines and parabolas. They are familiar with the independent variable x and the dependent variable y. This paper is not intended to be another trigonometric chapter. It is only intended to help students become better familiarized with the notation used and to present the trigonometric functions as ”Real Functions” with an actual x as the independent variable on the right-hand side of the equation. Most students don’t even realize that the familiar f in f(x) is being replaced by sin, cos, and tan. This approach can also help students understand another difficult transcendental function ”Logarithms” which is also just another button on a calculator.

b/c = f(x) = sin(x) = x – x3/6 + x5/120 b/a = f(x) = tan(x) =x + x3/3 + 2x5/15 a/c = f(x) = cos(x) = 1 – x2/2

+ x4/24 c2 = 2 + b2

In addition, this paper is not written from a research perspective. There was no collected student data from surveys as to the effectiveness of this supplemental chapter. This paper will contain the full written abbreviated chapter needed to be included in any first semester trigonometry course. Formula derivations will not be included, and knowledge of radian measure will be assumed. It will contain the appropriate number of fully worked example problems. The problems will contain the use of the above functions where students only use a calculator to calculate the first three terms of the Power Series Expansion. It is intended only as a learning resource and can be used by anyone including math and engineering educators.

A secondary benefit from this supplemental chapter, will be to reinforce incoming engineering students that a di- mensionless ratio of 2 lengths from a given right triangle is a function of the given angle x which is measured in radians. This paper will hopefully reinforce the idea that the trigonometric functions require a real number input into a formula. These real number angles measured in radians will also be related to angles measured in degrees.

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Political Bodies: Introducing Political Disability Identity for Research and Education

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Disabled students are significantly underrepresented in engineering. Approximately 17.6% of engineering undergraduates are disabled (NSF, 2021), compared to the 26% of the U.S. population being disabled (CDC 2020). Additionally, disabled scientists and engineers are more than twice as likely to be unemployed or not in the workforce as their nondisabled counterparts (NSF, 2017). Yet despite these systemic issues, disability as an identity is woefully under- studied in engineering education. When it is studied, very little attention is paid to how a political space such as the classroom affects disability identity formation. The political choices we make in our classrooms as educators can have long standing effects on our students, especially our students who belong to marginalized groups such as the disabled community. By doing research and designing curricula using frameworks that focus attention on the experiences viewpoints of disabled students, we can create a space where disabled engineers feel welcome, seen, and accepted. Already beginning to be used in physics education, Political Disability Identity is a framework that allows educators understand disability identity in a classroom setting and guide accessible classroom practices. Developed by Michelle Putnam (2005), Political Disability Identity is an ideal framework for use in discipline based education both in classroom design, and in research. This presentation will serve to develop the idea of the classroom as a political space, introduce a Political Disability Identity framework to engineering educators and education researchers, explore what Political Disability Identity means for engineering students in physics as an example, and provide suggestions for praxis in the classroom.

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Low-Cost, Biomimetic, Vibrotactile Stimulation for Non-Invasive Sensory Feed- back

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Prosthetic limbs provide individuals with amputations the ability to regain function in lost body parts. However, most prostheses are seen as tools rather than the embodiment of the user's missing limb. To strengthen the connection be- tween prosthesis and user, a sense of touch can be enabled via vibrotactile feedback. The goal of our experiment is to find the just-noticeable-difference (JND) in stimuli that an individual can distinguish while using two different wave-forms: biomimetic and traditional. The biomimetic waveform mimics rapidly and slowly adapting receptors in the body by encoding rate-of-change in stimuli at the onset and offset of a more traditional 1.6 sec square wave. A graphical user interface was programmed in Matlab to control an Arduino Nano and an inexpensive coin vibrator. During the JND experiment, various pulse-wave-modulation (PWM) duty cycles were compared to a standard (58.8%) and the subject was asked to respond whether the first or second stimuli felt stronger. Our data shows that the biomimetic waveform yields a lower JND and could provide a more refined sense of touch. Future work includes integrating vibrators with a virtual hand for real-time sensory feedback.

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Creating Sustainable Resources for Our Cities Via Collaborative Community Engineering Projects: Using Problem Based Learning to Empower Future Engineers and Society

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Dr. David Welty
Miss Demi Mayella, University of Massachusetts - Dartmouth

Nature and society share a common problem: both are compromised. Natural resources such as air, soil, and water continue to be compromised, devastating biological ecosystems and earth habitats. Simultaneously, disparities in health, education, housing, and income inequality continue to persist across diverse social, racial, ethnic, gender, and age groups. To date, these issues are researched as separate domains. However, research shows that natural and social systems are interconnected, and inequities in one area are more likely to impact the disparities in others. In this study, we present collaborative research between university researchers, science teachers, and high-school students about how to empower a community using a local assets-based integrated STEM approach to environmental and social issues. More specifically, we will provide an analysis of STEM integrated projects that use local assets to design sustainability and social-economic development projects using fluid dynamics, biomimicry, and piezo-electric method to engineer smart and sustainable energy harvesting and storing process. This project aims at not only reducing human impact on land, soil, water, and atmospheric degradation but also the potential to transform the social, economic, and environmental conditions of the local vulnerable communities by centering on community members' voices, knowledge, skills, and needs through transformative educational models.

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A STEM Outreach Project for High School Students: Optimization of the Design Parameters for the Antibiotic Manufacturing Process Using R

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The antibiotic manufacture process depends on design parameters, such as temperature, pH value, and feed rate. Optimization of these parameters is the most common way to achieve the maximum growth of fermentation microorganisms the production of a certain antibiotic. In this word, an ordinary differential equation (ODE) model for the manufacturing of nosiheptide, a sulfur-containing peptide antibiotic principally used for livestock applications, was introduced to four high school students along with instruction materials and videos so that they evaluated an unexplored optimization problem in this specific manufacturing process. Sensitivity analysis, the most common approach for evaluating the change of the output for the change of each parameter, was used to determine which of these design parameters had the most impact on the production of the antibiotic. By simultaneously changing the design parameters that have an impact on the product production, the manufacturing of this antibiotic can then be optimized. It was found that the production of nosiheptide generally increases with the increasing temperature, but the increase becomes limited when the temperature reaches 37.5 ℃. As for the pH, the feasible range is around 6.5-8.5, with the optimal value as 7. Due to the limitation in the ODE equation, the production and biomass continues to increase infinitely as the feed rate decreases. This may be due to the washout of bacteria from the reactor due to increased flowrate. This project offers high school students hands-on experience in applying math to solve a real-world problem with engineering approaches. The students were asked to develop their own R programs before the programs were given to them for simulation-based process design. Most of students understood the ODE models, the R programs, and the engineering design approaches (i.e., sensitivity analysis). All students were motivated to become engineers, and two of them are applying STEM majors in their college application. Since all training materials, including instruction videos, were offered online, this STEM outreach project can be done by high school students on computers anywhere anytime. A larger scale testing of the project with more high school students will be conducted in the future. It has the potential to be used as supplemental materials in high school classes to inspire the interest of high school students in both math and engineering. This low-cost project can make STEM outreach activities more accessible and inclusive.

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Universal Design Learning Approach: Its Paradigm and Application in Engineering Education

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Learners within engineering classrooms possess disparate background knowledge and experiences. As a result, proactively designing a learning environment that values the learners' uniqueness and variability would immeasurably help overcome learning barriers and inevitably maximize strengths. Universal Design for Learning is an instructional framework that when implemented could foster such environment. Derived from knowledge of the three networks of the brain – the recognition network, the strategic network, and the affective network – and the need to activate these networks for learning to take place, UDL uses three principles: multiple means of representation – the "what" of learning; multiple means of expression – the "how" of learning; and multiple means of engagement – the "why" of learning. The principles of UDL provides a learning environment that is flexible yet planned, and results in the development of strategic, motivated, purposeful, and goal-oriented learners.

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Improving Cognitive Learning with Effective and Interactive PowerPoint Presentations

Felix F. Udoeyo, Ph.D. Department of Civil and Environmental, Temple University, 1947 N. 12th Street, Philadelphia, PA 19122

The aim of a good engineering professor is to use creative and engaging technologies to strengthen the educational process and ultimately enhance cognitive learning. One of the multimedia often used for teaching in higher education is PowerPoint. PowerPoint's effectiveness is consistently debated although an estimated average of 30 million presentations are made using such medium. Observers offer diverse opinions regarding the efficiency and value of disseminating information through PowerPoint. For example, many are proponents of PowerPoint as an effective tool, others believe that PowerPoint violates the principles of multimedia learning thus making cognition difficult, while some state that PowerPoint presentations neither hinder nor enhance student learning. This paper discusses best practices, when using PowerPoint, to boost learning and create effective and interactive presentations that ensure the principles of multimedia learning are not violated.

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Designing the Department of Engineering Studies' Sub-baccalaureate Programs for Future Deaf Students at NTID: A SWOT Analysis

Dino J. Laury, Ed.D. and James Fugate, Rochester Institute of Technology, National Technical Institute for the Deaf, Department of Engineering Studies

In response to feedback and strategic planning, the National Technical Institute for the Deaf (NTID) Department of Engineering Studies Curriculum Committee unanimously approved modifications to the Computer Integrated Manufacturing Technology and Computer-Aided Drafting Technology programs. This case study examines the phenomenon of curriculum development for undergraduate engineering technology programs specifically serving deaf and hard of hearing (D/HH) students. One purpose of this case study is to share knowledge that manifests engineering technology studies through curriculum development and exchanges with other institutions offering associate and transfer degrees. The significant features of methods used to increase validity in this research included a five-year strengths, weaknesses, opportunities, and threats (SWOT) analysis for academic years 2017-2018 through 2021-2022. Results suggested, through several document analyses, that most faculty members recognized that faculty members possess longevity (i.e., many years of teaching, significant experience working in/with industry), course delivery through sign language, and faculty retirements and replacements are concerns. Another majority of the members recognized that the department offers limited career-focused programs for D/HH engineering studies students who cannot qualify for higher-level associate degrees. This case is a significant weakness and an opportunity to create new programs.

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First-Year Catapult Design Experience for Deaf and Hard of Hearing Engineering Technology Students' Incidental Learning at NTID

Dino J Laury, Ed.D. Rochester Institute of Technology, National Technical Institute for the Deaf, Academic Affairs / Department of Engineering Studies

At the National Technical Institute for the Deaf (NTID) at Rochester Institute of Technology (RIT), deaf/hard of hearing (D/HH) engineering technology students receive their first formal engineering technology education in the NETS-101: Fundamentals of Engineering course. The ultimate exercise in this course is to ask students to design and build a catapult worth 30% of the final grade. Six D/HH students were (a) divided into groups of three using a lottery format, (b) provided with basic engineering technology theory, tools, and components, and (c) asked to consider different mechanisms that associate with potential energy and other mechanical devices. The students were exposed to a meaningful freshmen design experience that included engineering ethics, decision-making, communication, the Engineering Design Process framework, free-body diagrams, and an incidental learning environment. The D/HH students learned about the basic structure of the catapult, background design, examples of innovative solutions documented in engineering document notes, and selected student works. This experience encourages D/HH students to consider Undergraduate Research Experience (URE) opportunities prior to transferring to the bachelor's degree in mechanical engineering technology at RIT.

Keywords: *Freshman, design experience, engineering design process, catapult, incidental learning, research opportunities, deaf and hard of hearing*

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