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Peer teaching research group model for upper level environmental engineering class with student-led lectures and journal article discussions

Dr. Thomas S. Soerens, Messiah University

An upper level environmental engineering class focusing on hazardous waste and air pollution was organized to mimic a graduate school research group. It is an upper-level required class for environmental engineering majors. In most weeks of the MWF class, a different student each week prepared a lecture and taught that week's material on Monday. On Wednesday the faculty member followed this up with more explanation and clarification. Friday was a class discussion of a journal article related to the topic. The student would prepare the lecture a week or so in advance and faculty member and student would meet the previous week to go through what they had prepared. The student was directed to work at least one example problem from the text and to assign at least three text problems. The faculty member chose the journal article for each Friday and the students were responsible for reading it before class. The class format was well received and all students rose to the challenge and presented good lectures. A year later elements of this model were used in a water and wastewater class that had three students from the previous year's hazardous waste class. Although there are not enough data to make strong conclusions based on these initial offerings, the next offering of the course will include feedback from students during and after the course so the faculty can monitor impact of the graduate research model in undergraduate courses.

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Incorporating Software Simulation into Electric Circuit Experiments

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A report by the United Nations estimates that closures of schools and other learning spaces due to the COVID-19 pandemic impacted 94% of the world's student population in 2020. At xxxxx University, most courses during the 2020-2021 academic year were offered remotely while some included a mixed-mode delivery mode when appropriate. In laboratory courses, however, a combination of in-person and online experimentation was a reasonable option. While simulation exercises are helpful in the learning experience, there is no doubt that hands-on experimentation is crucial to the learning process and simulation cannot be a substitution for the experience of building and troubleshooting a circuit on a breadboard. In Circuits and Devices, a sophomore electrical engineering course, a number of laboratory experiments were revised to accommodate students' needs while ensuring that a reasonable level of hands-on experience with electrical components and basic laboratory equipment such as power supplies, multimeters, still takes place. To accomplish this objective, the laboratory portion of the course included three hands-on experiments that students completed on campus, six experiments that involved design and analysis followed by software simulation, and a final project with an oral presentation. Some final projects included hardware and software while a few relied only on design and software simulation. This paper will briefly describe the experiments and provide details about an experiment that uses Multisim, a National Instruments Software package, and employs the Thevenin equivalent theorem to the analysis of a circuit with a dependent source. While there were several challenges, overall students were able to perform the experiments and successfully complete a final project. One positive outcome of this experience is the integration of Multisim in several experiments in a very meaningful way. As we prepare to teach the course in-person this coming fall, we expect to continue using Multisim but with some additional improvements. Most experiments this time will include two phases: (1) Students will complete a pre-lab that involves two steps, theoretical analysis and software simulation, and 2) Hands-on experimentation by building and testing the circuit in the laboratory.

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A Qualitative Study of Engineering Students' Reasoning About Statistical Variability

Riya Aggarwal, Franklin W. Olin College of Engineering
Mira Flynn, Olin College of Engineering
Sam Daitzman, Olin College of Engineering
Dr. Diane Lam
Prof. Zachary Riggins del Rosario, Franklin W. Olin College of Engineering

Every aircraft you have ever flown on has been designed using probabilistically-flawed, potentially dangerous criteria (del Rosario et al. 2021, AIAA-J). That these criteria have been in use for over a half-century—but were only recently identified as dangerous—speaks to the difficulty of teaching such concepts to engineering students. Clearly, improvements to teaching probability and statistics to engineers are needed. Key to statistical thinking is an understanding of and facility with variability (Wild and Pfannkuch, 1999).

This work lays foundations for improved statistical literacy among engineers, enabling a multi-disciplinary approach to engineering statistics. We present a novel theoretical framework for both teaching statistical variability and studying engineers' reasoning under variability. While past frameworks for variability focus on a statistician's perspective (e.g. Peters 2011), our framework centralizes the engineering perspective by explicitly considering physical modeling, and makes use of established insights in manufacturing variability (Shewhart 1931).

Using this framework, we have developed an interview protocol and deductive coding scheme, and deployed these qualitative tools in interviews with engineering students. Results from these interviews support the validity of the coding scheme, agree with documented trends in current aerospace practice, and suggest possible teaching interventions for innovative engineering pedagogy. Implications for future multi-disciplinary teaching of engineering statistics will be discussed.

del Rosario, Fenrich, and Iaccarino, "When are Allowables Conservative?" (2021)

AIAA Journal

Wild and Pfannkuch, "Statistical Thinking in Empirical Enquiry" (1999)

International Statistical Review

Peters "Robust Understanding of Statistical Variation" (2011) Statistics

Education Research Journal

Shewhart, Economic control of quality of manufactured product (1931) Macmillan

And Co. Ltd, London

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Lessons Learned in Adopting a Multi-Site Combined REU/RET Program for Exclusive Remote Participation Due to the COVID-19 Pandemic

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Dr. Sacharia Albin, Norfolk State University
Dr. John Okyere Attia P.E., Prairie View A&M University

The Smart City Research Experience for Undergraduates (REU) and Research Experience for Teachers (RET) (SCR2) Mega-Site program, which is supported by the National Science Foundation (NSF) (#1849454), was formed in 2018 to address the low participation and graduation rates of post-secondary students belonging to underrepresented minority groups in the engineering field. The participating schools in the program are all minority serving and members of a consortium consisting of 14 Historically Black Colleges and Universities (HBCUs) and 1 Hispanic Serving Institution (HSI), where Morgan State University (MSU) serves as the lead institution. The program targets lower division underperforming REU students who are less likely to have the opportunity to participate in research as undergraduates. Participation in this type of experience has been demonstrated to be transformative and to have the potential to increase retention and graduation rates at these institutions. RET participants are recruited from local community colleges and high schools that serve as feeder schools to the consortium institutions. These teachers are responsible for preparing students who could potentially be interesting in pursuing a college major in engineering by exposing them to hands-on engineering design practices. Over the last two years of the program's existence, 61 students and 24 teachers have successfully participated. As with most 2020 summer programs, the SCR2 program was challenged by the novel corona virus (COVID-19) pandemic, which hit the United states during the recruitment period of the project. Consequently, the project leadership team decided to offer the summer program remotely (on-line) rather than bring students to the participating three campuses across which the program is distributed. The planning and execution of the program during a global pandemic has brought key insights into techniques, methods, and technologies for effective cross-site communication, faculty advisor/mentor involvement, participant engagement, and leveraging the strong network that connects the participating schools. Essentially, a multi-site remote only combined REU/RET program is efficacious in increasing participant's confidence, knowledge and desire to pursue further engineering research experiences. This paper presents these insights along with supporting program evaluation findings.

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Limits, Singularities and other concerns in the Elementary Functions of Calculus

Andrew Grossfield Ph. D, Vaughn College of Aeronautics and Technology

Conventional calculus textbooks needlessly introduce the concepts of singularities and limits in a strange way that confuses many students who could be practical engineers and technicians. This expository paper is intended to provide a view of the singularities or problem points of calculus functions that a beginning student can grasp.

The elementary functions of calculus, which are the functions most used by most engineers, are single-valued, smooth and have relatively few extreme points. The singularities occur when problems arise in the computing the functional values. Perhaps for some of the horizontal values, a division by zero may occur. Perhaps over some interval of horizontal values, even roots of negative values may require computation. Computation at these problem points can result in the graph of the function having infinite jumps, finite jumps or point gaps. Another kind of discontinuity is an excessive number of extreme points, that is a pile-up of maxima and minima, as occurs at the origin of the function y = sin(1/x).

This paper provides an intuitive, visual interpretation of the concepts of continuity, discontinuity, limits, right and left-hand limits. The paper finishes with the advance of mathematics over the past two centuries and how math pedagogy changed to go beyond the grasp of the ordinary engineer.

Conventional math pedagogy obfuscates the limit concepts treated forcing students to memorize what they do not understand. An initially clear presentation of the simple cases, lets in fresh air, enabling the student to envision intuitively, the arc of the study.

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Using a Whole House Generator as a Teaching Aid

Mr. Harley H. Hartman P.E., Pennsylvania State University, York Campus

This paper explores the pedagogy of engineering education with reference to using real-world examples of the materials learned in the classroom. Making this unique to other tours or demonstrations is the fact that it is exposing the student to information learned in many classes and how each of these classes provides material that contributes to form a complete system. Teaching several courses in the EMET (Electro-Mechanical Engineering Technology) program, I have shared, with the use of field trips to my house, a custom-built whole house generator system. The system includes systems and components discussed in courses ranging from Electrical Machines, Operational Amplifiers, Digital Systems, Programmable Logic Controllers (PLCs), and Automatic Control Systems.

Synchronous machines and generators are discussed in the electrical machines class and a demonstration of voltage regulation as well as frequency control is performed during the visits. This involves the use of automatic control systems associated with the machine and are also discussed. The system is monitored and controlled by a Programmable Logic Controller with numerous remote I/O systems which directly relate to the PLC classes. Digital I/O is used for entering a fuel level via thumb-wheels, incorporating concepts discussed in the digital systems class. The Operation amplifier class is related through the coolant temperature monitoring system with custom built transducer providing an analog current loop signal to the PLC. Also related to the electronics course is the choke control system which accepts a current loop signal from the PLC and controls an RC servo to position the choke plate of the engine for starting.

Although this is a one-of-a-kind system, the pedagogy of exposing the students to systems as apposed to individual applications can be presented in a variety of other ways. For example, factory tours with an emphasis on the many parts and components learned about in various classes and how they're used to form a complete system.

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Summer Engineering Education Program: Formal-Informal Model

Dr. Suzanne Keilson, Loyola University Maryland

The STEM segment of Beat The Streets: Baltimore was conducted for six weeks during the Summer of 2021. The program was held at Cherry Hill Elementary/Middle School for one hour (10 – 11 A.M.) Monday – Thursday. This allowed for 24 contact hours in person between the students and instructor. Students used their personal or school provided laptops to access materials in class. The coding environments were intentionally online and web based to minimize complexity and the need to download software.

The six weeks were divided into two three-week segments. The first three-week segment introduced students to programming in both Python and Scratch formats. Python coding was introduced in the context of Computer Science Unplugged Programming challenges (www.csunplugged.org). This provided students with an introduction to binary numbers and command line text-based programming challenges that introduced them to fundamental concepts of computer science such as loops, conditionals, and data types. The students were then presented with a programming challenge in the Scratch platform. (www.scratch.mit.edu). They created their own accounts on this web-based platform and used 'drag and drop' and object (sprite) centered programming to create their own versions of the classic Pong game. At the end of the first three weeks students presented their programs to the group.

In the second three weeks students were provided with Arduino Uno development kits (https://www.arduino.cc/). They were introduced to the hardware of the Arduino microcontroller which included breadboarding with switches, resisters, potentiometers, LEDs, phototransisters, and an LCD screen. They completed or attempted eight different projects that were detailed in a projects book that accompanied the kits. This reinforced their exposure to software environments and fundamentals of programming as well as introducing them to the frustrations, care and patience required for breadboarding circuits. On the last day of the program, they again presented what they had accomplished and were asked to provide a 'lesson learned'. Most of the lessons learned in both the first and second segments of this summer program focused on the need for care, attention to detail and the challenges of troubleshooting a project.

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Online Hands-on Embedded System Project in Virtual Classroom

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Across the world, COVID-19 has shifted the education model by forcing classroom in-person classes to transition into the distance and online learning mode. Engineering and technology programs having a curriculum with a strong emphasis on hands-on labs are facing challenges. The education community around the world is looking for options to adopt the online approach to deliver hands-on courses via Zoom, Blackboard, or video conferencing services, using simulators and other digital tools. To measure the effectiveness of the new educational model, the assessment must be redesigned. We must examine student mastery of the course learning outcomes as measured by several instruments, including labs and hands-on projects. In this paper, we present the design of a hands-on project lab for embedded systems and its corresponding assessment instruments. The embedded system project lab includes topics such as circuit analysis, analog, and digital electronics, computer programing skills, basic instrumentation, and computers to aid in the characterization and troubleshooting. As part of the requirements in this hands-on project lab, students must connect the electronic components and devices correctly on the breadboard without the instructor's in-person supervision. Students need to use instrumentation, for example, a multimeter, an oscilloscope, and a function generator in the project lab. The paper also presents a practical approach using the Tinkercad simulator for hands-on labs and teaching students in a virtual classroom. The assessment model includes a rubric and a content validity form with performance indicators to assess ABET Student Outcomes (a) and (b) and the program-specific criteria for Electromechanical Engineering Technology.

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In Search of Architectural Engineering Education in South Asia

Dr. Amitabha (Amit) Bandyopadhyay P.E., State University of New York, College of Technology at Farmingdale

Architecture is the art and science of designing and erecting buildings. Architecture precedes architectural engineering by centuries in existence and leans more toward being an art than a science, although one must have knowledge of construction methods and materials to work successfully. Architectural engineering combines all aspects of the building design and construction, involving mechanical, electrical and structural and other notions of mathematical precision. It is a field that uses far more technology than its predecessor. Architecture focuses more on the aesthetic design and the functional and spatial layout of buildings as opposed to the engineering that architectural engineering incorporates. Architectural engineers apply engineering principles to the construction, planning and design of buildings and other structures. Architecture has been closely associated with engineering in the history of the building construction. The engineering for buildings was determined empirically in the early periods; later, scientific calculations for structures were developed in the 17th century, and engineering was taught as a separate course in the 18th century. Architectural Engineering was established as a discipline in the formal realm of engineering in United States in the late 19th century when the University of Illinois became the first of many universities to offer an architectural engineering program.[1] The university with the longest ABET (Accreditation Board for Engineering and Technology, Inc.) accreditation is Pennsylvania State University, which received theirs in 1935

In South Asia the Sir J.J School of Architecture (originally called the Government College of Art) in Bombay was the first modern school to introduce a structured course in architecture. In its initial years the one architectural event to capture the imagination of the profession was the building of the Capital city of New Delhi by Lutyens. Many of the faculty, such as Claude Batley, while intellectually sympathetic to the need for an Indian identity but were grounded in the nineteenth century European Beaux Arts tradition. A thorough grounding in the art and craft of construction was always held to be a prerequisite for architectural training. This was reflected in the fact that the Bombay school had a strong technical component and all the schools that followed it, such as the Bengal Engineering College at Calcutta, Baroda's Kalabhavan, Delhi's Polytechnic, were primarily technical institutions with a department of architecture. Engineering and construction courses took up the lion's share of the curriculum.

This paper intends to explore the current state-of-the-art of architectural engineering education in south Asia.

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Overview of Student Innovation Competitions and Their Roles in STEM Education

Dr. Sadan Kulturel-Konak, Pennsylvania State University, Berks Campus

Student innovation competitions have long been an essential part of Science, Technology, Engineering, and Mathematics (STEM) education. Higher education institutions and foundations have expanded their co-curricular program offerings to recruit and support student innovators, such as design challenges, hackathons, start-up incubator competitions, boot camps, customer discovery labs, and accelerator programs. Therefore, student innovation competitions and challenges are increasingly playing a role in educating the next generation of innovators and critical thinkers. This paper focuses on student innovation competitions, which are usually non-credit, co-curricular, and team-based programs in which student teams aim to solve open-ended problems. The benefits and challenges of student innovation competitions for the participants in STEM education are summarized. Hence, the specific focus and details of the reviewed competitions are not in this paper's scope.

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Additive Manufacturing Applied to Authentic - Industry Micro-Fluidic Systems for DNA Sequencing: A product realization experience at the community college level

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Mr. John Migniuolo, Mig-Tech Fluidics Design
Mr. Bernard Hunter

Employers demand higher education institutions to prepare engineers with a relevant array of industry skill-sets aligned to the current and rapidly evolving needs of the technology work place. As is well known, professional, interdisciplinary, and critical thinking skills developed under authentic-industry learning experiences makes for a highly preferred and desired job candidate.

In this paper, we present a mixed-method, undergraduate research case study for an authentic-industry, product development experience with two main objectives: 1) determine the viability of using additive manufacturing (AM or 3D printing) to produce the high count, 32-channel micro-fluidic dispenser module, a critical component in DNA sequencing technology offerings, and 2) develop the professional and business soft skills in working with industry partners under real meetings as well as role playing. Our third objective was to create an outreach effort to raise awareness of the bio-technology sector as viable employment sector often overlooked for traditional engineering majors, (ie, electrical , mechanical , computer science) majors. Our outreach effort took the form of building a demo showcase of automated robotic micro-fluidic liquid handler, which was outside the original scope of this study but graciously funded with by our industry partners.

Spanning over three semesters, we surveyed N=49 students in thermodynamics, AC circuits, and Control Systems for the purpose of building and estimating self-awareness to the DNA instrumentation industry and to create a framework for an authentic product development effort with industry partners over an 8 week duration by leveraging our under graduate (UR) research program at our school.

Successful outcomes included 3D printing verification of a complex 32-channel micro-liter dispenser, and raising awareness and attitude by 55 % and 65% respectively, with correlations of interest in these three majors (incidental). Through periodic interviews, reflective expositions, oral discussion and a final deliverable to our industry partners and a final ”corporate-like” presentation to our UR committee, this demanding performance provide to be a transformational learning experience. Self-efficacy, enhanced discernment in technical and business negotiations, planning contingencies against potential design & manufacture risk were evident and highly valued. Adaptability, increased professional and interdisciplinary skills were also pointed out as increasing self-identity of the meaning of being engineers in the rapidly evolving soft skills. Experiencing the product developing effort—even only after an 8 week span was enough to demonstrate this case study as a significant, accountable and realistic experience not often experience regularly at two year schools and it is hoped that this experience will prove useful in cultivating a sense of responsibility and professionalism in future schooling.

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Cybersecurity Issues in Crowdsourcing Engineering Initiatives

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Ms. Jillian Drake, Marymount University

Cybersecurity Issues in Crowdsourcing Engineering Initiatives

As crowdsourced engineering-related projects become more wide-spread and global, we must pay attention to cybersecurity issues that can emerge. Sharing data is fundamental to crowdsourcing, and that requires attention to protecting privacy. This issue is exacerbated if participants use common technologies, e.g., cell phones, that are used for other purposes and may be subject to cybersecurity vulnerabilities.

Cybersecurity issues can arise during recruitment, by which social media is a prevalent tool, to projects in that bad actors can solicit input into malicious and false projects.

Furthermore, the results of crowdsourced engineering projects may provide foundations for policy and legislation; thus, integrity must be maintained and bad actors prevented from manipulating data and/or results.

Governance of crowdsourced projects must include attention to cybersecurity issues, regardless of their scope and scale. The exploitation of cybersecurity vulnerabilities are often result from ethical lapses. Just as engineers respect engineering professional ethics, so must citizens who participate in gathering data.

In this paper, we will share a taxonomy that identifies how professional engineering ethics are represented and brought to life in 21st century crowdsourced engineering projects, which include commercial initiatives from Anheuser-Busch, Nokia, and FedEx as well as research initiatives like the Digital Humanitarian Network, the Humanitarian OpenStreetMap Team, and KeralaRescue.

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Utilizing Computational Tools to Enhance Student's Understanding of Linkage Mechanism

Dr. Zhiyuan Yu
Dr. Jiawei Gong, Pennsylvania State University, Behrend College

This research presents analysis of a quick return linkage mechanism utilizing computational software Mathcad and Inventor. It is implemented as a class project to enhance Mechanical Engineering and Mechanical Engineering Technology students' understanding of linkage mechanism in courses Dynamics and Machine Dynamics. The objectives of the project are to teach (1) kinematic and kinetic analysis of linkage mechanism (2) engineering math software Mathcad to solve the analytical model, (3) verifying the model by multibody dynamics simulation software Inventor. Loop closure equations based on complex number are first modeled and solved to find positions, velocities and accelerations of the linkage in Mathcad. Based on the kinematic solution, a kinetic analysis is carried out using distributed mass models in Mathcad as well as in Inventor simulation. The reactions and torques at the input link are found identical to those derived from simulation with negligible deviation. Integrating industry commonly used software Mathcad and Inventor in the project reduces the mathematical difficulties often encountered by engineering students. The course project assignment grade demonstrates that the use of these tools enhances the student's understanding for linkage mechanism. The feedback from instructors shows the project make the course dynamic and engaging. The software-based project suits well for online teaching and learning.

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A Review of Psychosocial Factors Associated with Undergraduate Engagement and Retention in STEM

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

Low retention rates of undergraduate students in science, technology, engineering and math (STEM) fields is a persistent problem in the United States (U.S.), with the U.S. lagging behind many countries in producing a sufficient number of STEM graduates. A better understanding of the barriers that result in students dropping out of STEM fields is essential for increasing engagement and retention of STEM undergraduate students. In this regard, a growing body of research demonstrates that psychosocial factors such as STEM self-efficacy, sense of belonging, intelligence beliefs, and grit are associated with STEM outcomes such as engagement and retention. In this review paper we examine how these key psychosocial variables (STEM self-efficacy, sense of belonging, intelligence beliefs, and grit) impact engagement and retention of undergraduate STEM students. An introduction to each of these factors is given, major work in the field is discussed, and typical instruments used to assess or measure these factors are described. It is hoped that this review may form the foundation of larger studies seeking to understand how nurturing and supporting these psychosocial factors may help support retention of undergraduate STEM students, particularly from those student populations underrepresented in the STEM fields.

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Enhancing Math and Stat Courses with Surveying Engineering Problems

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Enhancing Math and Stat Courses with Surveying Engineering Problems

This Work In Progress (WIP) paper aims to enhance mathematics and statistics courses taken by engineering students with real life numerical problems and examples. Mathematics and statistics courses instructors often report that students may lack the motivation to study, participate, and engage in their courses. Students often fail to connect Mathematics with real life problems, and they have limited comprehension of how what they learn in class can be applied in real life. The importance of taking a generic math problem and relating it to a real-life problem while in college cannot be over emphasized enough. It is these problems that help you the most in determining which measurements are needed when you reach the actual workforce. When some students enter into an engineering major they lack the mathematics background needed to enter directly into calculus one. This means they must usually take one to two semesters of college algebra and/or trigonometry. It is in these prerequisite courses that students would benefit the most from practical surveying problems. Normally in these courses, students practice routine generic problems. The problem consists of a formula such as the Law of Sines or the general equation for a parabola and a set of numbers are given which are then plugged into a formula and some desired quantity is calculated. The numbers lack units of measurement and the problem lacks any real-life practicality and it reinforces the concept that math is plugging plain numbers into a formula. While this type of problem solving is essential initially to help students become familiarized with a formula, the transition to real-life problems must always follow. To enhance mathematics and statistics courses we aim to enrich instruction and assignments with real life problems from surveying engineering. Surveying engineering is a major with frequent use of trigonometry and statistics problems. Surveyors routinely collect distance and angle measurements to determine coordinates and shapes, and make area and volume calculations. Many of those surveying tasks are related to mapping and boundary determination, concepts that many students are already familiar with. In addition, surveyors collect measurements and use statistics to check accuracy requirements and ensure that their instruments are performing according to manufacturer standards. The introduction of real-life surveying problems into mathematics courses answers the question so many mathematics instructors hear every day, ”where am I going to use this”. The WIP paper will discuss the importance of students connecting math with real life problems, provide examples of surveying problems in mathematics and statistics, present the courses that we have identified for integrating surveying content, and planned implementation and dissemination. Furthermore, surveying is a profession with a low public profile and only a few accredited programs exist in the US. Thus, as a secondary objective, engineering students of any major will learn about surveying and be exposed to real surveying problems. This can help students identify themselves as future surveyors and aid in recruitment and enrollment.

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Examples of Virtual Teaching Implementations in Chemical Process Control during the COVID-19 Lockdown

Jacky Huang, Villanova University

COVID-19 has caused more than 4.54 million deaths and infected more than 219 million people in the world by Sep 3, 2021. The high infection rate of this deadly virus had imposed the lockdown of mangy schools in the US in the rest of Spring semester since the late March of 2020. This virus has resulted in the switch of the traditional in-person teaching to totally virtual format. This brought significant challenges for teaching engineering courses like Chemical Process Control, in which difficult math operations require high interaction between the instructor and students. In addition, real-life experiments like PID controller design that offer students practical control experience are not able to implement due to the campus lockdown. In this work, we present the approaches implemented in the course Chemical Process Control in Spring 2020 at Villanova University and share the feedback from the students on the virtual teaching format. In particular, every lecture was recorded and annotated note was provided on Blackboard for students. Video-based trainings were given so that students were able to implement the mathematical operations they learned from classes in MATLAB. In addition, MATLAB models were developed by students to simulate typical biochemical processes such as chemical reactors and cell growth in bioreactors. These simulation models offer students a chance to obtain deeper understanding of the processes. In order to offer lifelike experience on data-driven modeling and PID controller tuning, recorded-videos were offered to students so that they were able to learn the experimental approaches. Real experimental data were then given to students to practice how to derive first-order-plus-time-delay model from the provided data and to evaluate the effect of the controller parameter settings on the controller performance. Moreover, MATLAB models were used as in-silico objects for students to practice PID controller tuning. Homework assignments and exams were used to evaluate the students' technical performance. In particular, the same final exam problems as last year were used to compare students' performance between the in-person and on-line formats. Two sample t-test indicates that Class 2020 students had better final exam performance than Class 2019 (P-value 0.0059). Two sample t-test was also implemented on the teaching evaluation data for 2019 and 2020 (including evaluation of the teaching effectiveness as it contributed to students' learning, and students' own work in the course). While the individual items in the teaching evaluation data will be disclosed in detailed in the formal paper, the t-test turns out that the online format got better evaluation in both teaching effectiveness (P-value 1.5971e-05) and students' engagement (P-value 0.0046). All these survey results are surprising, as certain students mentioned in the open-ended section that they preferred the in-person format. Potential explanations for online format getting better survey results are implied from the following comments from students: 1) the recorded videos, provided notes, and Zoom office hours offered students flexibility in the pandemic lockdown; 2) the modeling and simulation assignments provided certain compensation for their practical experience in designing controllers; and 3) additional resources were provided to help students master the skills.

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A Pilot Interdisciplinary Robotic Mentorship Project to Study Engineering Soft Skill Development

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Mr. Seth Pearl, Pennsylvania State University

A Pilot Interdisciplinary Robotic Mentorship Project to Study Engineering Soft Skill Development

As the complexity and diversity of general engineering practices continue to increase, it is becoming apparent that simply providing technical knowledge within the chosen discipline is insufficient to prepare our engineering students for related employment opportunities. The engineering workforce today is expected to perform effectively in a multi-disciplinary environment, underlining the importance of soft skills that include interdisciplinary communication, teamwork and leadership. Despite the increasing awareness, the gap between graduates' soft skills prepared by academics and those required in the job force stays significant, if not continues to widen. In collaboration between the engineering and education departments at XXXXXX, a robotics mentorship program was designed as a platform to foster soft skill development of engineering students. The program entails participation from three groups: mechanical and electrical engineering students, adolescence mathematics teacher candidates, and high school students in an afterschool robotics club. A two-semester pilot project was conducted for feasibility study, comprising weekly planning and training between engineering students and adolescence mathematics teacher candidates at XXXXXX. Furthermore, a resulting workshop series to mentor the robotics club at XXXXXX High School in XXXXXX School District was developed to cover topics from CAD and microcontroller to engineering notebook and experience in robotics competition. Even though the execution was abruptly interrupted by the COVID-19 pandemic in the first semester and completely moved to online in the second semester, survey and interview data was collected on five undergraduate engineering students and three mathematics teacher candidates, which offer encouraging qualitative evidence of their soft skills development, particularly for the engineering mentors. In this presentation, we will introduce the collaborative mentorship program and the differentiating design considerations, then discuss the results with focus on: 1) the journey of these engineering students as they collaborate with mathematics teacher candidates and serve as mentors in the afterschool program, 2) the impact of the interdisciplinary model on fostering their soft skills, and 3) lessons learned from this pilot project and the plans for broader study in the next phase.

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McMillan Water Treatment Plant DC: embedding culture in civil engineering

Prof. W. M. Kim Roddis, The George Washington University

McMillan Water Treatment Plant DC: embedding culture in civil engineering

W. M. Kim Roddis

George Washington University

Abstract Submission

The McMillan Water Treatment Plant (WTP) in Washington, DC is a case study in CE 1010 Introduction to Civil and Environmental Engineering. It not only surveys 100 years of urban drinking water technology, but also includes multiple cultural aspects.

Washington, DC has historically been plagued by poor drinking water quality. Union troops stationed In Washington during the Civil War suffered from waterborne diseases. Abraham Lincoln's son Willie died at age 11 of typhoid fever.

Public health improved with the opening of the original McMillan WTP in 1905. This was a slow sand filter plant, purifying water using physical and biological filtration processes. Such slow sand filters provide potable water without the use of chemicals but are land and labor intensive. The cells for the sand filters covered many acres. Fredrick Law Olmsted designed a 25 acre public park over most of the grid of cells. McMillan Park, opening in 1912, was the only de facto racially integrated park in DC at the time. The park provided a rare opportunity to enjoy this public good for people in the surrounding communities until it was fenced off at the beginning of WWII.

In 1986, the WTP was decommissioned with the opening of the adjacent rapid sand filter WTP. This technology uses physical and chemical processes to provide potable water. Potomac River water flows from the Great Falls raw water intake and the Little Falls raw water pumping station. Pre-sedimentation occurs at Dalecarlia Reservoir. Fluoride and the coagulant, alum, are added and the water enters the Georgetown Sedimentation Basins. The water flows underground through the Washington City Tunnel to the McMillan Reservoir. Power actuated carbon and chlorine are added and the water flows through the rapid sand filter. Lime, orthophosphate, and chlorine are added and primary disinfection takes place during dwell time in the clearwell. Ammonia is added and the water passes to the storage clearwell. DC WASA Bryant Street Pump Station drives the water to storage tanks from which the water is distributed to consumers in the District of Columbia, Arlington County, and the City of Falls Church.

The McMillan WTP is still in use today. It has been and continues to be upgraded with modern advances in water treatment. One change, made before 2001, had dire unintended consequences. Chemical treatment was changed from chlorine to chloramine. This provided longer term disinfection when water flowed through distribution pipes. Tragically, this also destabilized the pipe chemistry, resulting in harmful lead levels. The problem was fixed in 2004, but thousands of children suffered permanent damage.

With the less land intensive rapid sand filter in place, the 25 acre fenced and closed McMillan park was sold to the government of DC. In 2021, this space remains chained off and idle, with the city unable to formulate a development plan acceptable to the neighborhoods.

My teaching philosophy is to approach engineering problem-solving in a broader societal context. Civil engineering inherently serves society. Selecting case studies that embed significant cultural content into the civil engineering problem statement allows me to emphasize to my students that solving the right problem is as important as solving the problem right.

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

From Social Distancing to Enhanced Learning in the Laboratory

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The COVID-19 pandemic will undoubtedly remain an infamous landmark in the world of higher education. While every area of education was impacted, overcoming the challenges of reduced capacity, remote learning, etc. was a particular challenge in laboratory settings. Similar to many others, our institution's return to campus included a Hyflex modality (i.e., students rotating through in-person and remote learning for individual lessons) to allow for social distancing within classroom spaces. Following these guidelines, our environmental engineering laboratory space could only accommodate one-third of the registered students in each of the Spring 2021 lab sections. To overcome this, I created a weekly rotational schedule of in-person, virtual, and field/home activities, which allowed me to still give each student a full three-hour lab session for each exercise. This rotational schedule left me with smaller groups of students for the in-person labs and increased my ability to assess individual student progress toward specific learning objectives. Students indicated that this implementation allowed them to work more independently on experiments, improved skill development and retention, and ultimately created a more personal learning environment. In addition to student feedback, I will also evaluate how the rotational system impacted student content mastery based on assignment grades. Finally, I will present lessons learned and suggestions for continuing this model in a post-COVID world. As we return to our "new normal," we should deliberately and critically evaluate whether our pandemic-induced innovations created an enhanced learning environment when compared to traditional course delivery.

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A Shoestring Grassroots Approach to Publishing an Open Educational Resource Engineering Textbook

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The lack of affordable and accessible education is one of the major obstacles inhibiting the upward social mobility of New Yorkers from low to middle socioeconomic classes. Students from lower income, underrepresented and first-generation college households in an urban setting, are particularly affected by the rise of higher education costs, which further marginalizes the members of these communities. The availability and adoption of good quality Open Educational Resource (OER) textbooks, has the ability to significantly ease the economic burden on the student population; however, upper level engineering text books, available as OERs, are scarce and vary in quality. This case study presents a grassroots approach for the creation of a Soil Mechanics Engineering Textbook on a shoe string budget. This ongoing work is being done by putting into play an array of interdisciplinary resources, available within the New York City College of Technology and the City University of New York. These include library collaborations, communication design professionals, students, undergraduate research programs, surplus technician funds and professional community goodwill. The result is a well-rounded, visually engaging and appealing, peer reviewed OER textbook, which when published will become available free to any student and faculty member worldwide. This translates to direct savings of approximately $112 per student, at local and/or national higher education institutions that make use of the textbook for their entry level soil mechanics course. The author estimates that when adopted at the New York City College of Technology, the entire cost of publication of the textbook will be recovered through student savings within three semesters, by conservative estimates.

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Improve Technical Communication Using Scaffolding Method in Mechanical Engineering Courses

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Aws AlShalash

One of the most effective and well documented ways, throughout literary sources, to educate and develop capable and independent professionals such as engineers combines lecture sessions with step-by-step synergistic activities (experiments and reports). Therefore, many engineering educators are seeking experiential learning techniques and implementations that are innovative to assist students understand, exercise, and communicate engineering concepts they learned. Although project-based learning allows students to be able to deduce and apply concepts effectively, students continue to struggle to communicate their work and results effectively from such experiential learning and other projects. Thus, to overcome the deficiencies in writing skills such as poor grammar and formatting, and effective literature review in reports, an instructional scaffolding plan has been developed and implemented in two junior level courses in parallel (Mechanical System Design and Thermal Fluid Laboratory course). The scaffold activities include incremental class activities and assignments as well as access to support resources. The scaffolding activities in the instructional plan will allow students to develop confidence from completing shorter and targeted assignments successfully earlier in the semester as they build their report for more complex and involve analysis and writing activities over the semester. The initially collected data for the two courses show above average performance based on student surveys before and after the scaffolding activities. This reflects an indirect assessment where students share their opinion of themselves. The collected data on direct assessment shows incremental improvement in performance of students based on relevant assignments completed in the courses. Additional assessments will be conducted in future offerings as well as other courses including Dynamics of Machinery, Measurement and Instrumentation, and System Dynamics and Control as part of an ongoing study. Although these are preliminary findings, such pedagogical technique has the potential to enhance the student learning experience and develop mindset to continue their life-long learning in their professional careers.

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A Comparison of Self-Reported Weekly Time Demands for Cadet and Faculty Populations the United States Military Academy

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In the immediate and continued aftermath of the COVID-19 pandemic, colleges and universities have adapted and shifted to alternate, sometimes novel, modalities of learning, all the while preserving the academic rigors and standards necessary to develop competent, critical thinkers across every discipline. Adaptation to new modes of learning, followed by the "bouncing forward" of institutions resuming use of teaching frameworks ubiquitous to the pre-pandemic classroom, requires one resource common to both individual and institutional inputs: the use and management of time. The authors have previously observed that the different teaching methods and technologies propagated in the 2020-2021 timeframe have shifted the in- and out-of-classroom time necessary for learners to achieve markers of academic proficiency and wonder if a comparison of where time commitments peak between faculty and cadet (student) samples over a mid-semester span of time may indicate a point where time becomes a limiting factor in student preparedness capacity or faculty available time.

One institution that historically places high demands on the time of its learners is the United States Military Academy (USMA). Cadets spend four years at USMA preparing to become commissioned military officers who must be able to prioritize and process a diverse stream of requirements and tasks spanning the three pillars of USMA – academics, physical fitness, and military training. Those cadets currently in their sophomore, junior, and senior year have already navigated three challenging semesters, and due to the recent global pandemic, varying degrees of shifting time ratios of in-person, remote, hybrid (combination of both in-person and remote) and asynchronous learning modalities.

This study examines the self-reported time commitments for a sample of both USMA faculty and cadets at over several mid-semester weeks during the fall semester, following further evolution to USMA's institutional learning practices. We approached this topic with the hypothesis that the relative ranking of highest to lowest weekly time commitment over a several week span is unrelated in faculty and cadet respondents as a result of manipulating the group type of respondents. Our survey is designed to tabulate several types of academic-related time commitments to include real-time class attendance, lesson preparation, time spent on graded work and other categories with a parallel faculty and cadet activity set.

The results of this study may impact, narrowly, the time management and self-awareness of respondents who did not previously account for their evolving needs in time management amidst a campaign of "bouncing forward" and in a broader sense, can open additional avenues for considering the evenness of time demands by-week for courses at USMA, alongside the academic and non-academic demands placed upon both educators and learners at this institution.

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A DEI Task Force within a Mechanical Engineering Department

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Most engineering departments in academic institutions are not doing enough to address issues of social justice, diversity, equity, and inclusion among undergraduates. More specifically, these topics are often considered tangential to core engineering topics, and are therefore relegated to breadth requirements for coverage, if at all. Over the course of the last several months, our department, college, and university have begun to create institutional structures to support these efforts. There is a new Associate Dean for Diversity, Equity, and Inclusion (DEI) at the college level, and a new Director of DEI at the department level. This person has also created a DEI Task Force within the department.

While the full mandate of the DEI Task Force is still taking shape, the main goal is to tackle pressing issues related to DEI in the department, and to develop a longer-term action plan to address these issues. This will begin as a descriptive research project to take an honest look at where we are as a department to generate baseline data against which future interventions can be compared. Over the past year there have been several curricular (e.g. teamwork and bias training, inclusive teaching) and extra-curricular (e.g. a #ShutdownSTEM discussion, undergraduate DEI town hall) efforts made along these lines, and this Task Force will continue and coordinate these efforts. External funding is currently being sought after to support these longitudinal efforts. So, while this is submitted as a work in progress paper, we are looking forward to sharing our efforts in more detail on how re-thinking institutional structures that support DEI efforts can look and on the results of our early efforts.

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An REU/RET Project: IoT Platform and Network Data Visualization

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Internet of Things (IoT) is a connected network of devices that exchange data using different protocols. The application of IoT ranges from intelligent TVs and intelligent Refrigerators to smart Transportation. This research aims to provide students with hands-on training on how to develop an IoT platform that supports device management, connectivity, and data management. People tend to build interconnected devices without having a basic understanding of how the IoT platform backend function. Studying the Arm Pelion will help to understand how IoT devices operate under the hood.

This past summer, Morgan State University has hosted undergraduate engineering students and high school STEM teachers to conduct IoT security research in the Cybersecurity Assurance & Policy (CAP) Center. The research project involved integrating various hardware sensor devices and real-time data monitoring using the Arm Pelion IoT development platform. Some of the student/teacher outcomes from the project include: 1) Learning about IoT Technology and security; 2) Programming an embedded system using Arm Mbed development board and IDE; 3 3) Developing a network of connected IoT devices using different protocols such as LWM2M, MQTT, CoAP; 4) Investigating the cybersecurity risks associated with the platform; and 5) Using data analysis and visualization to understand the network data and packet flow.

First, the student/teacher must consider the IoT framework to understand how to address the security. The IoT framework describes the essential functions of an IoT network, breaking it down into separate layers. These layers include an application layer, middleware layer, and connectivity layer. The application layer allows the users to access the platform via a smartphone or any other dashboard. The Middleware layer represents the backend system that provides edge devices with data management, messaging, application services, and authentication. Finally, the connectivity layer includes devices that connect the user to the network, including Bluetooth or WiFi. The platform consists of several commercial IoT devices such as a smart camera, baby monitor, smart light, and other devices. We then create algorithms to classify the network data flow; to visualize the packets flow in the network and the structure of the packets data frame over time.

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Introducing and Facilitating Internet of Medical Things (IoMT) Research for Undergraduate Students and High School Teachers

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The Internet of Medical Things (IoMT) is a rapidly growing community of intelligent medical technologies dedicated to sensing, monitoring, and reporting patient vitals, often with the intent of communicating findings with healthcare professionals (HCPs). For the past two summers, 2020 and 2021, four undergraduate electrical/computer engineering and computer science students, and two high school STEM teachers, worked with two graduate student mentors to explore various IoMT use cases via their participation in a Research Experiences for Undergraduates (REU) and Teachers (RET) program. During both summers, the REU/RET program was conducted remotely over nine weeks, not including pre-summer engagement activities. These pre-summer activities were designed to promote and encourage healthy mentor-mentee interactions while also providing an additional opportunity for participants to acclimate to their research projects before the program start.

Throughout this work, participants were able to gain or further develop skills in some of the following areas: Ethical Hacking, Data Science, Intrusion Detection Systems, Linux, Machine Learning, Networking, and Python, as well as interact with a designated smart device and testing environment. In the first summer, participants were assigned a smart glucose meter and tasked with 1) exploiting the potential threats associated with installing smart devices onto unsecured network configurations via address resolution protocol (ARP) poisoning, and 2) exploring social engineering tactics through cloning the device user application. Additionally, in the following summer, participants became acquainted with an existing IoMT dataset, developing an intrusion detection system (IDS) to accurately distinguish between normal and abnormal network packets due to a deployed Man-in-the-Middle (MitM) attack. The outputs of this work include: both sets of participants preparing verbal presentations, including demonstrations, and written papers outlining their results and experiences. After the project, participants should understand and implement a set of guidelines for utilizing IoMT devices more securely and with added privacy.

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A Capstone Project: Designing an IoT Threat Modeling to Prevent Cyber-attacks

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The NTT (Nippon Telegraph and Telephone) Data Corporation report found that 80% of U.S. consumers are concerned about their smart home data security. The Internet of Things (IoT) technology brings many benefits to people's homes, and more people across the world are heavily dependent on the technology and its devices. However, many IoT devices are deployed without considering security, increasing the number of attack vectors available to attackers. Numerous Internet of Things devices lacking security features have been compromised by attackers, resulting in many security incidents. Attackers can infiltrate these smart home devices and control the home via turning off the lights, controlling the alarm systems, and unlocking the smart locks, to name a few. Attackers have also been able to access the smart home network, leading to data exfiltration. There are many threats that smart homes face, such as the Man-in-the-Middle (MIM) attacks, data and identity theft, and Denial of Service (DoS) attacks. The hardware vulnerabilities often targeted by attackers are SPI, UART, JTAG, USB, etc. Therefore, to enhance the security of the smart devices used in our daily lives, threat modeling should be implemented early on in developing any given system.

This past Spring semester, Morgan State University launched a (senior) capstone project targeting undergraduate (electrical) engineering students who were thus allowed to research with the Cybersecurity Assurance and Policy (CAP) center for four months. The primary purpose of the capstone was to help students further develop both hardware and software skills while researching. For this project, the students mainly focused on the Arduino Mega Board. Some of the expected outcomes for this capstone project include: 1) understanding the physical board components, 2) learning how to attack the board through the STRIDE technique, 3) generating a Data Flow Diagram (DFD) of the system using the Microsoft threat modeling tool, 4) understanding the attack patterns, and 5) generating the threat based on the user's input.

To prevent future threats and attacks from taking advantage of systems vulnerabilities, the practice of "threat modeling" is implemented. This method allows the analysis of potential attackers, including their goals and techniques, while also providing solutions and mitigation strategies. Although Threat modeling can be performed throughout the development of a system, implementing it during developmental stages will prevent further problems in the future. Threat Modeling is crucial because it will help identify any potential threat before it propagates in the system. Identifying threats and providing countermeasures will save both time and money while also keeping the consumers safe. As a result, students must grow to understand how essential detecting and preventing attacks are to protect consumer information systems and networks. At the end of this capstone project, students should take away hands-on skills in cyber defense.

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Design of novel courses to bridge knowledge gaps in engineering and reduce attrition and graduation delays

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Nationally and internationally, engineering programs experience more attrition and longer times to graduate than other majors. A majority of the attrition and delays occur in the first few years of study, when students are taking foundational prerequisite courses such as mathematics and science and sophomore level engineering courses.

The goal of this research is to assess the academic challenges students face at the early college level that potentially lead to attrition and delays to graduation, to design two novel preparatory courses to bridge gaps in technical and professional knowledge, to refine these courses, and ultimately to numerically assess the efficacy of the courses towards reducing attrition and duration in the program. While the conceptual models developed in this work are applicable to studies in any engineering discipline, the study is conducted in the undergraduate Civil Engineering program at The City College of New York, a minority serving institution and a flagship campus of The City University of New York (CUNY), the nation's largest urban public university.

This paper details the full study design and reports on the first two completed elements of the research. Academic challenges were determined by anonymous survey of all currently enrolled students. Questions pertained to their academic preparation before entering the program, their performance in the program, and their attitudes towards the importance of prerequisites, study habits, understanding of the curriculum, and participation in extracurricular activities. The findings suggest a need for two student-responsive preparatory courses. The first course bridges the professional knowledge gap and is to be taken during the first year of major coursework. Students will learn about the curriculum, the value of participation in valuable extracurricular activities, and potential career paths; will connect with practicing engineers; and will gain insights into the practice of engineering. The second course bridges the technical knowledge gap and is taken alongside mathematics and science prerequisite courses and during their first semester of major coursework. This course will teach students to think critically and to connect theory to application, and will help them to develop effective and efficient study habits. Both courses will seek to instill passion, drive and a strong sense of morale into students that persists throughout their time in the program. Recognizing that many courses in engineering curricula are traditionally-taught with the midterm-final model and lecture driven instruction, both of these courses will employ novel pedagogical approaches to help students make the transition to engineering. Examples include project-based learning, modular delivery of course topics, metacognition of learning, and the incorporation of technology.

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Engineering by Remote Online Learning During COVID-19

Marvin Gayle,
Danny Mangra

Living with the Covid-19 pandemic has been a challenge. The decision in March 2020 to flatten the curve and control the transmission of the SARS Covid-19 virus by lockdown, forced educators across all levels to aggressive consider, evaluate, and incorporate Learning Management System [LMS] and collaboration platforms for virtual classroom instruction. For engineering educators, the LMS is often utilized as a complement to in person classroom instruction. Platforms choices included, but were not limited to Canvas, Blackboard, Microsoft Teams and Google Classroom. The adaptation and integration of video conferencing software also became increasing significant. Educators had to quickly overcome the learning curve and effectively utilize Google Meets, Zoom, Slack or Skype to satisfy their classroom needs. The challenge becomes not only how to get proficient with these tools, but in short order, figure out how best use them for effective pedagogy. These tools had to be integrated without having them become an ineffective distraction. All this while content was retooled for the transition to a fully online teaching modality. How do you satisfy the required learning outcomes, and still maintain effective academic rigor.

This paper will look at some of these questions. Studies in several STEM related disciplines have shown that it is possible for remote instruction to preserve academic rigor, satisfy the programs required learning outcomes all while maintaining academic integrity . Still many issues are at play that affect how to realistically and efficiently engage remote students. We will look at some of these remote learning challenges encountered at Engineering Technology program at Queensborough Community College of the City University of New York [CUNY]. We present here some of the techniques and strategies employed to overcoming the difficulties of remote learning at a minority serving institution. Some of the complexities included how to engage learners with limited or inconsistent internet access, the strategies and decisions in using synchronous versus asynchronous delivery. One of our particular concern was how would instructors to be able to teach and conduct laboratory experiments in this remote mindset. Instructors were also mindful of the social isolation of our students and the need to create a community like environment as we isolated physically. We will also look at how our assessment strategies had to evolve, from the traditional multiple-choice exam, to other methods all while still preserving the academic integrity.

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The Use of Mixed Methods in Academic Program Evaluation

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The Accreditation Board for Engineering and Technology (ABET) and Middle States Commission on Higher Education (MSCHE) accredit engineering degree programs. Their accreditation efforts assure the public that programs successfully prepare their graduates to enter critical STEM fields in the global workforce. An ongoing assessment and evaluation process must support engineering degree programs in higher education institutions. These assessments result in quantitative and qualitative data used in evaluation processes that integrate learning attainment goals and all assessment data. Engineering degree programs present unique organizational and logistical challenges in meeting accreditation requirements, such as integrating qualitative and quantitative data and information in a meaningful way that facilitates continuous improvement and supports inferences about student achievement of learning objectives. Programmatic success is predicated on using the results from programmatic evaluation in an ongoing program control process, commonly known as "continuous improvement." This control capability requires the ability to detect deviations from the program baseline or learning outcomes and promptly intervene to correct the problem.

In 2020, the XXX, XXX school of engineering was readying for an accreditation visit. Part of that process was preparing a self-study report. A survey of other program reports indicated a common approach to integrating data and information was to use weights to combine the various data elements (quantitative and qualitative). The practice then was to set a "target" value that signified an acceptable level of student attainment. A criticism of this approach is that it isn't sufficiently granular to detect early problems or trends and, more importantly, doesn't adequately support corrective action by the program. The XXX BSCE program did not choose this integration method.

The program choice was a method often used in the Federal government where data sources are highly diverse and varied in quality. The Federal government, like accreditation agencies, wants to integrate all assessment data and learning objectives to make valuable inferences about programmatic success. The methodological approach in those Federal contexts is to focus on broad themes and longitudinal studies. This results in programmatic decisions based upon trends with pre-established trigger points that signal the need to intervene and is well adapted for application in an environment such as ABET/MSCHE accreditation efforts. A literature search indicates this approach is known in other disciplines as mixed methods. While mixed methods offer rich potential, there has not been extensive research on specific applications to solve problems such as academic program evaluation. The significant finding of this paper is that this approach to academic program evaluation by XXX is innovative and constitutes a new application of mixed methods relevant to the engineering education community. It also presents recommendations for applying the mixed-method approach in an environment where engineering degrees conduct program assessments that must meet ABET and MSCHE requirements.

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Developing a Web-based Advising Application for an Engineering Program

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Efficient academic advising is essential for college students regardless of major. For a successful college experience, academic advising is needed to build a solid foundation. Students receive guidance through advising sessions so they can stay on track to graduate on time. To make the advising process the most effective, computer or web-based tools are used to make course plans for students at many institutions. An effective advising tool as well as the proper guidance from an adviser not only enhances the quality of education for students in four-year degree programs but also helps to ensure the success of the institution overall. There are many tools available in academia developed by both commercial businesses and individuals in academia. In the current research, an innovative web-based advising tool has been developed and successfully used to advise students in a mechanical engineering-focused program at Southern Arkansas University, where this web app has been specifically customized for this curriculum. The application takes the necessary input, such as a student's ACT Math score, the courses the student completed, and the courses the student is taking currently (if any). Once the required information is entered in the corresponding fields, the application provides a detailed output of semester-wise proposed courses that the student needs to take to graduate on time.

The application has options for adding summer courses, reordering specific courses, and changing the anticipated hours per semester. Thus, a student can vary the parameters and create the optimum semester-wise course plan for the remainder of their education at Southern Arkansas University. The adviser can print it for record-keeping in the student's folder or save it as an electronic pdf file for later use. The application has a user-friendly graphical user interface that shows all courses relevant to the engineering program. Course selections are also color-coded for better visualization purposes. The application can be used at any level, from freshman through senior, and anytime during the year. For example, if the application is used in October, it will assume that Fall is the current semester. Therefore, the application will propose courses for Spring (as the advising semester) as well as for the subsequent semesters until graduation, based on the course offering by the department and the courses the student needs to take to graduate. Also, there is a unique feature that if the user wants to exclude a course or courses from the advising semester, he/she can check the relevant box(es), and the application will provide alternate courses based on the course offerings in the advising semester. The detailed developing process is described in this work.