Abstracts

87th Annual Pacific Northwest Section Conference

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Corvallis, Oregon

Summaries of

- Presentations
- Workshops
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Presentations

Thursday, March 21, 2019
10:15 a.m.—11:15 a.m.

Agriculture Leaders Room

Session 1A: Educational Technology and Spatial Skills

Utilizing AR Sandboxes for Civil and Construction Engineering Education

Joseph Louis
Oregon State University

Civil and Construction Engineering (CCE) is a discipline that seeks to engineer and transform the physical world around us, yet students in classrooms are limited to studying and applying concepts predominantly on paper or computer screens. These traditional mediums of instruction and practice create a disconnect between the concepts learned in class and their application in the field. A similar disconnect exists between the designers and builders of civil infrastructure, who necessarily work in two different environments (the office vs. the field). This disconnect is usually bridged only after the student has spent sufficient time out in the field and is struck by the inevitable, but much delayed "a-ha" moment - a congruence achieved when abstract concepts are finally placed within their rightful physical context. This research seeks to remedy this situation by proposing the use of Augmented Reality (AR) sandboxes to bring the vastness of the physical environment that characterizes the problem domains of civil and construction engineering and the students will eventually be working in, into the classroom. The AR sandbox, through its seamless blending of virtual content within a tangible interface, has immense potential to deliver concepts to students in an intuitive and engaging manner to obviate that disconnect. Because the surface of the sandbox can be intuitively fashioned to represent a scaled-down version of the wide range of terrain found in the physical world, this tool can demonstrate not just the application of classroom concepts, but even their development from first principles. To demonstrate the effectiveness of the AR Sandbox for civil and construction engineering education, a prototype application was developed to replace the traditional mode of teaching mass-haul diagrams for earthwork planning. Whereas traditional planning utilized static two-dimensional profile and plan views of three-dimensional terrain and roadways, this tool will enable the students to use their own hands to both construct roadways and modify surrounding terrain, while providing them with real-time quantitative feedback about the earthwork quantities involved. A description of the AR Sandbox is provided along with the software architecture that is created to enable course delivery to meet the related learning objectives for earthwork planning. The performance of the system is described along with a list of anticipated benefits to learning, particularly towards kinesthetic learners. Finally, the research identifies applications in other areas of civil engineering such as transportation, coastal, and water resource engineering that involve significant concepts that require intuitive understanding of physical terrains.

Students are improving their spatial skills in introductory engineering class through projects utilizing 3D printers and laser cutters

Patrick Burnett, Eric Davishahl
Whatcom Community College

A growing body of research indicates that well-developed spatial skills are important to student success in many STEM disciplines, including many engineering majors. This research has further found that spatial skills are malleable and can be improved with targeted training activities. This presentation will share strategies and successes with incorporating spatial visualization skills training in a freshman-level introduction to engineering course. This course is a general introduction that also includes orientation to the engineering profession, academic success strategies, problem solving skills, and introductory math and science applications to engineering. The course prerequisite is college algebra. Much of the spatial skills training content is combined with introductory design and teamwork activities and in total makes up approximately twenty percent of the course.

Students engage in two team projects which are supported by a series of spatial skills practice worksheets. The worksheets prompt students to sketch blocks of varying height in both elevation and isometric views and perform mental rotations about one and two axes. The team projects utilizing the OnShape CAD system, a cloud-based parametric solid modeling system that is available at no cost to educators and students.

The first project has teams of three students creating a Soma puzzle; a 3×3×3 cube assembled from seven pieces made out of unit cubes that has 240 unique solutions. The class follows a detailed explanation of how to create one of the seven pieces, then each student is required to create and share two of the remaining six pieces. Each student is then required to generate an assembly with two unique solutions. Groups then modify and 3D print their parts. There will be 3D printed models available at the presentation for participants to find their own solutions.

The second project has students working first as individual designers and then in pairs to designing a desktop organizer which will be created out of 3mm plywood on the laser cutter. After their initial sketches, individual students create a 3D model with card stock and tape. Students then pair up and negotiate for a final design that emphasizes their own ideas. Together students create a base CAD model, from which, they generate their own versions. Finally, they use the laser cutter and assembly their finished product. There will be models available at the presentation.

Students' pre- and post- test scores on the Purdue Spatial Visualization Test: Rotations (PSVT:R) assessment showed statistically significant improvement with mean scores increasing by 6% ($p < 0.0002$, $N = 76$).

Review of Educational technology: closing the gap between modern technology and the college engineering classroom

David Pinkerton, Krishna Pakala
Boise State University

This paper aggregates information from past and current studies regarding the implementation of technology in engineering classrooms and identifies the most promising ideas, technologies, and techniques. This paper provides insight into best practices for implementing technologies to improve the education of engineering students. This paper provides recommendations to adopt non-traditional teaching methods into action. Educational tools and techniques are evaluated on the basis of: Adoption and Assimilation, Access, Community, Intellectual Presence, Student Perception, and Development of Social and Professional Skills. Finally, this paper highlights best practices with descriptions of the technologies and techniques that were found most promising.

Tablet vs. smartphone use for freehand sketching and spatial visualization in large engineering graphics courses

Lelli Elinde
University of California, San Diego
Elizabeth Cowan
Spatial Vis & Spatial Kids

Mobile devices are becoming more prevalent and a common part of the education experience. Students can access their devices at any time to perform assignments or review material. Mobile apps can have the added advantage of being able to automatically grade student work and provide instantaneous feedback. However, numerous challenges remain in implementing effective mobile educational apps. One challenge is the small screen size of smartphones.

A freehand sketching and spatial visualization mobile app was implemented in two college freshman engineering graphics course to teach students how to sketch orthographic and isometric assignments. The app provides automatic grading and hint feedback to help students when they are stuck. The app was originally developed for iPads, but the wide prevalence of smartphones led to porting the software to iPhone and Android phones. The sketching assignments on a smartphone screen require more frequent zooming and panning, These classes were the first to use the spatial visualization training app on their smartphones to study if the experience was the same as on larger screen sizes using iPad tablets.

Students were assigned sketching problems as homework using their personal devices. Students were administered a pre- and post- spatial visualization test (PSVT-R, a reliable, well-validated instrument) to assess learning gains. The trial analysis focused on students who entered the course with limited spatial visualization experience as identified based on a score of ≤70% on the PSVT:R since students entering college with low PSVT:R scores are at higher risk of dropping out of STEM majors. In the first course, almost 60% of the class failed the pre-test, which was a significantly higher percentage than the same trial conducted at another large institution. Among the low-performing students in the first class, 35% of those who used the app showed significant progress, raising their test scores above 70% bringing them out of the at-risk range for dropping out of engineering compared to 71% at the other institution. These mixed results could be attributed to the software not being ready for prime-time during the initial trial.

In addition to the PSVT-R instrument, a survey was conducted at both institutions to evaluate student usage and their impressions of the app. Students found the app engaging, easy to use, and something they would do whenever they had “a free moment”. In the first trial, 79% of the students recommended the app to a friend if they are struggling with spatial visualization skills as opposed to 95% in the second course.

This presentation will compare the implementation of the mobile spatial visualization sketching app in two large college engineering classroom using smartphones vs. past trials using tablets, highlight the app’s impact in increasing self-efficacy in spatial visualization and sketching, and present a detailed comparison of the results of the pre- and post- test and survey related to smartphone usage.

Agriculture Production Room

Session 1B: Homework and Assessment

Enhancing Student Success Using Flexible Assessment

Bryan Mealy
Cal Poly State University

The primary responsibilities of instructors are to help students learn the course material and to assess what they've learned. These two responsibilities present somewhat of a problem because the more time instructors spend assessing students reduces the amount of time instructors can spend directly helping students. This notion is particularly important in flipped-type course, which is designed to maximize in-class learning. In designing and preparing course presentations, instructors inherently must delegate limited class meeting times between helping assessing students and helping students learn. Assessing student achievement using quizzes and exams is not a learning experience, but many students place a high value on such assessment techniques distributed throughout the course as "inspiration" for remaining current with course material.

This paper describes our continued work with Flexible Assessment (FAST) techniques where we give students some flexibility in the weighting of various assessed items. This paper builds upon our previous work where students were given the option at the beginning of the quarter to choose between final grade calculations based on weekly quizzes and final exams, or having no quizzes with more heavily weighted final exams. Our new approach allows students to choose to take a weekly quiz or not; each quiz a student takes reduces the final exam weighting by a fixed percentage. Our new approach addresses the primary student complaint in our previous approach, which was that students made the quiz vs. non-quiz decision at the beginning of the course and continue with that choice for the entire course.

Our new FAST approach treats student assessment with a more holistic approach with an overall goal of enhancing student success in the course. The flexibility associated with our approach recognizes that students generally have a wide range of academic responsibilities, which are typically non-flexible in nature. Our intention with this approach is to allow students to effectively prioritize their academic schedules without penalizing them for not having adequate time to prepare for a schedule quiz. In essence, this approach gives students a slight amount of wiggle-room in their task of juggling challenging academic schedules.

WeBWorK Online Homework in Material and Energy Balances

Jonathan Verrett
University of British Columbia

WeBWorK is an open-source online homework system originally created for mathematical disciplines and now used in a wide variety of courses involving numerical problems. With the system instructors can assign homework sets of problems to students. These problems can take in a variety of student inputs with the most commonly used being mathematical formulas or numerical answers. Using variables, the system can generate individualized problems for each students. These problems are stored on the instructor's course in WeBWork, but can also be shared with other instructors running the WeBWorK system through the Open Problem Library.

WeBWorK was implemented in a second year Material and Energy Balances course with 190 students enrolled. In previous years homework sets were done using paper submissions. Analysis was done on the shift of these homework sets from paper to WeBWorK. This analysis includes instructor and teaching assistant time and effort put into creating and administering the two types of homework. Student usage of the system was monitored including number of attempts and problem completion. Students were also surveyed for their opinion of the system and for elements of the WeBWorK system that they valued of disliked. The results of these analyses are used to inform best practices implementing WeBWorK in a Chemical Engineering classroom.

There are currently number of openly available resources for material and energy balance courses such as online videos and course packages from LearnChemE as well as multiple choice ConceptTests from the AIChE Concept Warehouse. Development of WeBWorK homework problems builds on these existing resources by providing homework problems with a greater variety of input possibilities.

Homework Assignment Submission: Gauging Student Responsiveness and Behavior

Kevin Chang
University of Idaho

One of the inherent challenges with student learning is gauging the degree to which that learning is occurring in real-time. For this reason, the assignment of homework problems or writing assignments serves as one way to determine how well the student is comprehending the information provided during in-class lectures or following their own self-study of assigned reading materials. The homework assignment also enables the professor to determine, to some degree, how well individual students and the class as a whole seem to be comprehending the information.

The self-initiated task of completing and submitting homework assignments, however, can significantly vary from person to person. As a case study to examine student responsiveness and perceived procrastination behaviors, students taking the Introduction to Civil Engineering (CE 115) course at the University of Idaho were evaluated based on their electronic submission of a weekly writing assignment for seven weeks. This presentation will discuss: how this process was administered, the challenges associated with this approach, student outcomes based on this form of assessment, and lessons learned from the professor. This presentation will also highlight the changes, if any, to student behavior after the introduction of a module focused on the urgency and importance of daily academic activities was introduced.

An Institution-Wide Student Outcome for Engineering: Development, Implementation and Assessment

Michael Anderson, Traci Sarmiento, Cory Cooper, Donald Rhymer
United State Air Force Academy

The United States Air Force Academy in Colorado is an undergraduate-only military academy whose mission is to “educate, train, and inspire men and women to become leaders of character, motivated to lead the United States Air Force in service to our nation.” All Academy graduates enter active duty service, (notwithstanding a small percentage of foreign exchange officers) and the Air Force desires well-rounded officer-graduates with a more-homogeneous education than would be expected at an otherwise similar liberal university. As such, the Academy prescribes a large general education (or “core”) curriculum, of 29 academic courses and 93 semester hours1, compared to a typical GE load of 15 - 30 semester hours. This core includes a cross section of courses in the humanities, social sciences basic sciences and engineering. The requirement that all students complete a broad and lengthy core sequence in engineering is especially unique. Recently, nine all new, Academy-wide Institutional Outcomes were developed to define the desired characteristics of graduates, help drive curriculum design and facilitate assessment and accreditation2. Of interest here is the “Application of Engineering Methods” (AEM) outcome, which specifies that ALL Academy graduates are expected to:

“…Recognize the engineering and technical challenges of the Air Force mission and the physical capabilities and limits within their assigned career fields and weapon systems. They need to not only be “operators,” but to become problem solvers that use engineering principles to devise enhanced capabilities essential to achieving and maintaining Air Force dominance in air, space, and cyberspace. Proficiencies are organized into two broad categories:

¬ Fundamental Domain Knowledge (i.e., knowledge of basic engineering principles across a variety of physical domains….)

¬ Problem-Solving Process (i.e., using a top-down, systematic problem-solving method…to address ill-defined problems….)”

To ensure effective implementation of these new outcomes, the Academy established Outcome Teams, composed of faculty across the institution and appointed by the Academy’s Superintendent and Board of Visitors (equivalent to the University President and Regents/Chancellors). The authors of this presentation recently served as Outcome Team Lead and team members during the development of the AEM Outcome. This work documents this implementation process and first assessment cycle with lessons learned, benefits and future initiatives. The definition of the outcome enabled the team to re-align the 6 core engineering courses (in computer science, mechanical, aeronautical, electrical, astronautical and civil engineering) to create a more-cohesive curriculum that follows a development arc of increasing proficiency and challenge. In addition, the new outcome’s equal emphasis on Fundamental Domain Knowledge and the Problem-Solving Process spurred an attempt to re-balance certain engineering core courses toward engineering design and innovation.

1https://www.usafa.edu/academics/core-curriculum/

2https://www.usafa.edu/academics/outcomes/

Agriculture Science Room

Session 1C: Professional Practice

Critical Balance Point: Considerations for Integration of Communication and Professional Skills into the Undergraduate Engineering Curriculum

Rachael Cate
Oregon State University

This presentation (only) will address the integration of communications and professional skill instruction into coursework in the discipline of engineering. Initially, the presentation will provide background and justification for an interdisciplinary approach to be taken to instruction of professional, teamwork, communication and project management topics in design engineering education. This background will include concepts from transformational education theory, experiential education theory, and case studies from engineering education programs. Next, the presentation will survey a variety of concerns that arise when introducing professional and communication skills into an existing technical undergraduate curriculum. These concerns include: cultural demands of interdisciplinarity; options for how early, how much, and with what emphasis to integrate these skills; and likely challenges communication and professional skill instructors face based on their co-instructional situation, the engineering program, and student perceptions. After introducing this variety of concerns, the presenter will focus much of the remainder of the presentation on offering her own experience navigating the terrain of integration of a communications and professional skills curriculum at a large northwest public university's school of electrical engineering and computer science. As a part of her experience, she was asked to develop and teach a communications curriculum for undergraduates that would meet ABET outcomes, fulfill the university's disciplinary writing instruction requirement, and support students in preparedness for work in industry upon graduation. This communications skill integration began with co-teaching an ECE senior capstone design year and since has expanded to a two-term junior design course, collaborative developmental research, "innovative program" development, and a charge to support faculty in incorporation of communications and professional skills throughout the broader undergraduate curriculum. Now in the middle of the third year of development, the presenter's strategy and approach to providing the needed instructional and program development support has shifted over time based on several key realizations (which she calls "turning points"). These turning points include: acquisition of "critical knowledge" about the needs and values of the school, the students, and co-instructors; collaborative reflection on frames of thought in the process of auto-ethnographic research with a co-instructor; and identification of a "critical balance point" between the need to engage in curriculum planning using best practice research and the need to maintain maximum flexibility in order to allow "primary" disciplinary demands to shape the overall curriculum and learning experience. The presenter will offer her insights into how others teaching communication and professional skills in engineering might intentionally steer themselves toward critical knowledge acquisition and collaborative auto-ethnographic reflection in order to discover what the critical balance point may be in their situation. Ultimately, to pursue a critical balance point, the presenter will suggest that co-instructors and program developers on both sides of the technical/non-technical divide should engage collaboratively in processes of deepening instructional, cultural, and perspectival awareness to create a balance between technical, communications, and professional skills that encourages students to realize a highly-integrated, multi-dimensional view of what it means to be an engineer and enriches the discipline of engineering on the whole by advancing this view.

Destigmatizing Confusion: Sense-Making in Professional Practice

Ed Michor, Milo Koretsky
Oregon State University
Susan Nolen
University of Washington

This research will be reported solely as a presentation. It is situated within a curricular reform project in 11 core studio courses using assignments that better resemble the work done in engineering practice. These group activities cast students in the role of professional engineers working on design projects, allowing multiple solution paths. In this paper, we examine an episode in which a student group exhibits "glorious confusion," a state of engagement that, we argue, shifts their orientation from students completing a course assignment to practicing engineers working on a design task. Our research questions are:

1) What triggers glorious confusion?
2) What interactions and types of thinking characterize glorious confusion?

Building on our previous clinical study, we adopt the framework of figured worlds, defined as socially constructed realms in which the participants adopt roles, cultural values and associated actions. We contrast two such worlds: (1) "engineering world," in which reasoning is grounded in engineering principles and the physical system being designed, and which values making meaningful progress on a task, and (2) "school world," in which reasoning is limited by the topic under current consideration in class, and which values completed assignments and a "correct" answer. This research takes place within the context of a larger and ongoing project studying the interactions of students from multiple courses that are implementing studio activities redesigned to elicit "engineering world" participation.

The concept of “glorious confusion” arises from video analysis of students working on revised studio problems. It is engagement characterized by extended discussion in which students appear to think like engineers but make little progress. It is “glorious” because it aligns with our goal of fostering more realistic engineering thinking. However, some engineering faculty viewing these videos have critiqued what they see as “floundering” and doubt the advisability of inducing it during studios. We present an analysis of six gloriously confused students working on one of the redesigned activities in a sophomore material balances class, in which they must redesign a candy production process, the hydrolysis of sugars in a solution of hydrochloric acid, to enable use of a new additive.
Initially the group engages in “school world” thinking, directed by a student oriented towards simply completing a class activity. When they fail to account for the acid, she argues that they are probably not expected to attend to it in a school problem. The group shifts to “engineering world” when a previously quiet student raises the ethical concern that the acid could end up in their product. The group members become engrossed in answering the practical question, where does the acid go? All six students demonstrate greater engagement and clearly reason using the core concept in the course, conservation of mass, as they refute ideas and propose alternatives. Importantly, the group leader also shifts her reasoning process in this way. We argue that glorious confusion is the precursor towards a more productive orientation that aligns with the types of thinking and reasoning of professionals.

The Things You Need but Weren’t Taught – an Engineering Professional Practice Course

Melinda Holtzman, James McNames
Portland State University

Engineering managers have long stressed both the importance of, and new employee shortcomings in, “soft skills” such as communications and teamwork. To address this concern, we introduced a new senior-level course, ECE 424 Engineering Professional Practice, in Fall 2017. This course covers a variety of topics to help prepare graduates for careers in electrical and computer engineering, such as written and oral communications, ethical reasoning and considerations, strategies for job acquisition, career planning, intellectual property matters, approaches to lifelong learning, and the relationship of engineering to global and societal issues. Some of these topics had previously been discussed in our capstone course, but creating a separate course has increased the time and attention given to these important areas.

The course is currently being taught for the third time. In each class, surveys were given at the beginning and end of the term asking students to rate what they believe is the importance of various soft skills, and their confidence in their abilities in these areas. We found that by the end of the term the gap decreased between students’ appreciation of the importance of soft skills and their confidence in their abilities in almost every area.

In our presentation we will provide a more detailed description of the class and discuss the results of the pre- and post-surveys as well as other student feedback.

Productive interactions in engineering practice: A comparison between student and expert teams using network analysis

Kritsa Chindanon, Milo Koretsky
Oregon State University

Engineering capstone projects provide students the opportunity to prepare for their careers by providing a messy, open-ended context where they do real engineering work. These projects are commonly seen as a venue for students to integrate and apply the foundational knowledge and skills that they have learned in their coursework. In this study, we examine interactions of teams completing a capstone project through the lens of disciplinary practice. We use process data to compare the interactions of three student teams and an expert team as they develop a process to deposit silicon nitride thin films using a virtual chemical vapor deposition (CVD) reactor.

Borrowing from Pickering's (1995) work in science education, we categorize engineering practice according to conceptual, material, and social aspects. We then apply Damsa's (2014) construct of productive interactions to analyze the teams' discourse. Damsa's two dimensions of productive interactions, epistemic and regulative, align with the conceptual aspect of practice and the social aspect of practice, respectively. To capture the material aspect of practice, we have added a third type of productive interactions, experimental.

This study examines in depth three teams of undergraduate engineering students and a team of expert engineers. This project has the participants take on the role of a team of process engineers who are tasked with optimizing a virtual CVD reactor. The simulation provides data representative of an industrially sized reactor, including common and special causes of variation. As in industry, each experiment and measurement costs the team money. During this three-week project, teams had weekly meetings with a faculty member who acted in the role of the project supervisor. The first meeting served as an authorization meeting where teams met with the supervisor to have their initial experimental parameters, experimental strategy, and budget approved before they were granted access to the reactor.

Teams were audio recorded whenever two or more members met during the project, and all audio was transcribed. Two meeting segments of approximately one-hour each were analyzed for each team (eight total) - one from just before the authorization meeting and another from between each team's first and second experiments. Open coding led to seventeen productive interactions codes, which aligned with the three aspects of engineering practice. We then used Epistemic Network Analysis (ENA) to identify relations between participant interactions and aspects of practice.

The findings reveal that interactions related to the social aspect of practice have the highest number of occurrence for all teams. This result emphasizes the importance of technical coordination in engineering practice. Results from ENA reveal consistently strong ties between the conceptual and material aspect of practice for the expert team while the student teams show episodic but not consistent ties between material and conceptual aspects. It appears that the experts use engineering tools to mediate their sense-making processes in a way that directs their experimental strategy. Students tended to become more immersed in first-principles, often in ways that did not directly apply to the experiments they were designing and analyzing.

Thursday, March 21, 2019
11:30 a.m.—12:30 p.m.

Agriculture Leaders Room

Session 2A: Pedagogy and Hands-on Learning

Problem-Based Lab Education: Redesign of a Senior Year Chemical Engineering Lab Course to Promote Autonomy, Critical Thinking, and Problem-Solving Skills

Gabriel Potvin
University of British Columbia

Upper-year engineering students are quite adept at collecting and organizing experimental data as part of prescribed laboratory exercises. Although these labs provide good opportunities to develop analytical skills, they offer few avenues to apply creative problem-solving or experimental design skills. Furthermore, when students are faced with technical difficulties in the lab, many rely on TAs or instructors to solve them and are reluctant to, or simply assume that it is not up to them to, attempt a solution themselves. To alleviate some of these issues, building on previous work, the senior year chemical engineering lab course at UBC was redesigned using a Problem-Based Learning (PBL) framework and greatly reduced formal supervision, with the aim to promote resourcefulness and problem-solving, troubleshooting, and critical thinking skills. The structure and deliverables of this course will be described, student performance assessed, and the feedback of students regarding this approach will be presented.

In this course, student teams perform a single multi-week PBL lab per term. An instruction manual for the relevant equipment is provided, but with no suggested experimental design or data collection protocol. Open-ended industrially-relevant problem statements, consisting of design, optimization or investigative objectives, are provided as suggested context, but teams are not bound by these statements and are encouraged to propose alternative problems based on their interests.

Before beginning their experimental work, each team prepares a formal project proposal, which includes a comprehensive review of background theory, experimental design, budget an environmental impact assessment, and safety audit of the procedure. At the beginning of each experimental session, teams provide an updated work plan outlining the work performed to date, the work to be performed during that lab session, and any changes to the original proposal deemed necessary, mirroring industrial protocols. Students present their work both orally and as a written report at the end of the session.

To increase the independence and self-reliance of the teams, TA and instructor involvement is greatly reduced. TAs are only present in the lab for the first hour of each experimental session to review and evaluate the work plan, ensure the students are prepared, and that they are able to perform their experiments safely. TAs are instructed not to directly answer technical questions and are there only as observers. This forced students to make their own decisions and judgements, troubleshoot any technical issues or unexpected results, and experiment with the process themselves.

When initially presented with the course structure, many students were apprehensive, with some voicing their displeasure at having traditional supports and direction removed. At the conclusion of the course however, student feedback, collected through a survey, was overwhelmingly positive. The vast majority of students reported benefitting from the independence and responsibility for their work, with the majority self-reporting improvements in confidence in their engineering judgement and critical thinking skills. A comprehensive analysis of student feedback will be presented.

The effect of deductive and inductive teaching methods in an introductory programming course

Jen Symons, Heather Dillon, Joseph Hoffbeck
University of Portland

Many first and second year engineering students are required to complete an introductory programming course as part of their program. Typically, class time within these courses is divided into traditional instructor lecture and student work time interacting with the software. This study aimed to determine the effect of different instructor teaching methods on student quiz performance as it related to challenging concepts (i.e. functions, loops, and conditional statements). A Latin square design was used to assess 3 different teaching methods across 3 course sections of students, all taught by the same instructor. Teaching methods included: a single deductive lecture explaining the concept (control), a similar deductive approach that divided content into two smaller lectures within one session, and an inductive approach that presented code within an applied context. After the teaching methods were delivered, points from quizzes completed by students were divided into categories based on the three course concepts. The effect of teaching method on percentage of points earned by students for each concept was assessed by ANOVA. Teaching method showed a trend, but failed to achieve statistical significance ($p=0.11$). However, post-hoc tests indicated a significant difference between the control teaching method and the inductive teaching method ($p=0.04$). The control teaching method yielded the best student quiz scores, whereas the inductive teaching method yielded the worst scores. These results support a deductive approach when teaching first and second year students introductory programming skills, as opposed to an inductive approach that may be more well suited outside foundational engineering courses.

Targeting Representational Competence and Spatial Skills Development with Hands-on Models in Calculus and Statics

Eric Davishahl, Lee Singleton
Whatcom Community College
Todd Haskell
Western Washington University

In this presentation, we will outline a new project that features cross-disciplinary collaboration between engineering, math, and psychology faculty to determine how to leverage hands-on active learning with physical models to improve spatial skills and develop representational competence in calculus and engineering statics. 3D printing technologies provide a readily available and affordable tool to develop learning aids that target these specific learning outcomes. There are three primary project goals:
(1) Develop physical models and associated curriculum that embeds spatial skills training with activities designed to develop representational competence in multiple content areas in statics and integral calculus.
(2) Assess the effectiveness of the models and activities on improving representational competence and relevant spatial skills.
(3) Identify the characteristics of modeling activities that make them effective for all learners and/or subgroups of learners.
The project began in fall 2018 with model and associated curriculum development work, pilot activities in classrooms, and a lab study exploring activity design parameters. Years two and three will feature a longitudinal study of students in intervention and control sections of both statics and calculus. This

presentation will include an overview of the research design, applications of the theory of representational competence to engineering mechanics, and targeted assessment instruments. We will also demonstrate an example modeling activity with emphasis on design elements intended to foster representational competence.
The term representational competence refers to the ability to interpret, switch between, and appropriately use multiple representations of a concept as appropriate for learning, communication and analysis. Science education literature identifies representational competence as a marker of true conceptual understanding and as key to knowledge transfer across topics and disciplines. When teaching engineering subjects, we use multiple representations (e.g. include graphics, diagrams, symbols, numbers and narrative) to develop concepts and analysis techniques. Through years of study as students, researchers, and teachers, we develop a fluency with representations rooted in a deep conceptual understanding of what each representation communicates. Many novice learners, however, struggle to gain such understanding and rely on superficial mimicry of the problem solving procedures we demonstrate in examples.
Spatial thinking connects to representational competence in that internal mental representations (i.e. visualizations) facilitate work using multiple external representations. A growing body of research indicates well-developed spatial skills are important to student success in many STEM majors, and that students can improve these skills through targeted training.

Invention Bootcamp: Teaching Design, Prototyping and Invention to High School Students

Gerald Recktenwald
Portland State University

Invention Bootcamp is an intensive four-week summer camp for high school students. The main goals are (1) to expose students to the invention process by applying design and prototype fabrication to problems in students' community, (2) to give students a deep exposure to being on a college campus, (3) to inspire interest in pursuing STEM, (4) to develop a resilient identity that would allow students to thrive in a rigorous STEM courses once they attend college, and (5) to focus these efforts on populations that are typically underrepresented in STEM curriculum and careers.
The Invention Bootcamp has been offered in three consecutive summers at the Portland State University campus. In Summer 2018, the curriculum was adopted independently at another site. Assessment by external evaluators show that we have had positive impacts on students attending the camp. Highlights of those assessments are summarized in the body of the paper.

The curriculum for the bootcamp was adapted from our first-year engineering course sequence. In addition to the engineering design and fabrication content, we introduce and have students practice a human-centered design approach. For each camp we set a theme and ask students to identify problems or opportunities related to that theme that they can develop into an invention. Guest speakers and field trips related to the theme are used to inspire creativity and help students see how the tools we are teaching them can be applied to produce products useful to people in their community.

Teaching design and fabrication to high school students has some of the same challenges as teaching design to engineering students: the difficulty of working with unstructured and ill-defined problems, inspiring creativity within constraints of time and lack of prior design experience, design fixation, the illusive process of identifying good problems and then refining the scope of those problems to fit the time and resources available. For high school students we must also teach programming, basic circuits, fabrication, testing and debugging, which adds more challenges. Despite, and because of, this challenging context, leading the Invention Bootcamp is a stimulating and rewarding experience.

In this paper, we briefly describe the Invention Bootcamp at Portland State University, and we present assessments by external evaluators. Our goal is to disseminate this model and invite a discussion of how our experience can be shared with the engineering education community. We also welcome feedback from the community to help us improve our work with the Invention Bootcamp.

Agriculture Production Room

Session 2B: Academic Skills and Sense of Belonging

Metacognition: are graduate students different from freshmen?

Branimar Pejcinovic, Donald Duncan, Melinda Holtzman
Portland State University

This report will be presentation only. Metacognition among engineering students is recently receiving attention that it deserves. Metacognition, i.e., the ability to understand the state of one's knowledge and thought processes, is an important component of learning and one that distinguishes experts from novices:

"To become self-directed learners, students must learn to assess the demands of the task, evaluate their own knowledge and skills, plan their approach, monitor their progress, and adjust their strategies as needed … these metacognitve skills … are often neglected in instruction. However, helping students to improve their metacognitive skills can hold enormous benefits." [1]

Metacognition and critical thinking are intricately related. Even though they can be difficult to disentangle, some recent research demonstrates that improvements in metacognitive skills result in improved critical thinking. In an ongoing NSF project, aimed at designing tools to teach and improve undergraduate students' metacognitive skills [2], the authors argue that "metacognition is particularly important in the training and development of engineers as problem solvers." This work has focused on freshman or lower-division engineering students. However, the development of metacognitive skills across years of study in engineering has not been addressed. In our own teaching of senior or graduate ECE courses we have observed that senior and graduate students frequently have poor metacognitive skills. By assessing their written research reports we can determine they do not understand the state of their own knowledge and how to improve it. Consequently, they are also not able to assess the state of the knowledge in their discipline. These shortcomings affect students' ability to become life-long learners and to deepen their knowledge on their own. Evaluation of one's own discipline is especially critical for research-oriented students who are expected to critically examine existing knowledge, find gaps in it, and come up with ways of filling them. Therefore, we believe that more attention should also be paid to metacognitive skills of graduate students.

We have just completed collection of survey data from five courses spanning freshman to graduate years. We used a survey from [3] which is a validated instrument and 235 students took it. Our goal is to understand if there are any significant differences between different levels of students, and if so, what they are. Our working hypothesis is that we will not see any significant differences between different student populations. We are in the middle of analyzing the data and will report results and our analysis at the meeting. We hope that these results will form the basis for improvements in both undergraduate and graduate education.

[1] S. A. Ambrose, et al., How learning works, 1st ed. San Francisco, CA: Jossey-Bass, 2010.
[2] P. Cunningham, et al., "Beginning to Understand and Promote Engineering Students' Metacognitive

Development," in ASEE Annual Conference & Exposition, 2016.
[3] H. Matusovich, private communication.

Storytelling in Thermodynamics: ABET, retention, and self-identification

Eric Jankowski, Sara Hagenah
Boise State University

In this work describe a project that simultaneously attempts to meet ABET outcome 3 (an ability to communicate effectively with a range of audiences), improve retention of at-risk students, and understand how students in an undergraduate materials curriculum develop their professional identity.
This project is inspired by prior research showing that self-identification with one's major is the strongest predictor of degree completion, especially among women and minority students in STEM.
We collaborate with The Story Collider, a national science storytelling nonprofit, to provide story development instruction and feedback to juniors taking Thermodynamics of Materials. We test a single storytelling intervention: An assignment in which students develop "True, personal stories about a time thermodynamics happened", and measure student attitudes with a Likert scale survey before and after the intervention. Preliminary results across two cohorts indicate increases in self-identification as materials scientists. We also discuss plans for measuring long-term success and retention as well as the impacts of hosting a public Story Collider wherein a selection of stories are performed live.

Explorations of reflection as a tool for writing knowledge transfer and writing skill appreciation

Natasha Mallette
Oregon State University
Jennifer Mallette
Boise State University

Professional writing skills are vital to engineering career success, although they are usually underappreciated by undergraduate engineering students. The students may understand hypothetically that writing will be essential after they graduate, but they do not always understand how. While engineering programs require writing assignments often rooted in genres students may use and situations they may encounter outside the classroom, little attention is paid to assessing writing learning beyond the specific assignment tasks.

To understand strategies to enable students to connect learning from individual assignments to other uses and contexts, we are piloting the use of reflection in senior-level project courses at two academic institutions. Reflection offers potential as a strategy to assess students' long-term learning of writing skills and connection with writing contexts in their careers. Reflection has long been used in writing studies to increase students' meta-awareness of how writing works in specific contexts and to facilitate transfer (Yancey, Robertson, Taczak, 2014). In this presentation, we (a faculty member in chemical engineering at Institution A and a faculty member in English/technical communication who works with engineering students at Institution B) explore reflection as a tool to improve course outcomes for writing proficiency and to facilitate continuous improvement in and outside the classroom.

To gather data, we will ask students at both institutions to complete a reflection at the end of one course and the start of another. At Institution A, approximately 200 students reflect on their learning; at Institution B, approximately 15 students will complete both reflections. These reflections will ask students to discuss which course writing concepts made the biggest impression, how they plan to incorporate those concepts in future writing, and their awareness of the importance of quality writing in a professional engineering career.

In this presentation, we will share preliminary findings on the impact of asking students to reflect on their writing and how it may affect their writing from one term to the next. In addition, we will assess the possibilities for reflection as a method to enable students to apply their classroom learning to writing post-graduation, in industry or graduate programs. We will conclude with the possibilities of expanding this work to explore best practices for improving student writing learning that they can transfer and enabling them to understand the value of writing education in engineering contexts.

Review of Living Learning Communities and their impact on first year engineering college students

Samantha Schauer, Krishna Pakala, Kim Tucker
Boise State University

Traditionally, first-year college students do not have a community of like-minded peers with whom they are able to learn. Adding to first-year engineering college students' (FYECS) struggles is the fact that many students do not have a mentor in their related field and are unable to start building their professional repertoire, network, and/or practical skills. Living Learning Communities (LLC) can offer a platform for postsecondary institutions to increase recruitment, engagement, and sense of belonging for students who live in an LLC. LLCs have been described in the literature as themed living and learning communities where students take a common course(s), participate in extracurricular activities with one another, and live in the same residence hall. This literature review examined relevant published work on 1) What impacts do LLCs have for all students who live in an LLC; 2) What are the impacts on first-year engineering college students living in an LLC, and 3) What theoretical frameworks are used in literature when examining the impacts an LLC has on first-year engineering college students.

Agriculture Science Room

Session 2C: Lab Experiences and Undergraduate Research in EE

Cost and Benefits of Volt-Var Optimization on Electric Power Distribution Systems: An Undergraduate Research Experience

Xichen Jiang
Western Washington University

This paper presents the results of an interdisciplinary undergraduate research project that investigated the economic cost and benefits of implementing Volt-VAR optimization (VVO) on distribution feeders with an emphasis on the Pacific Northwest region. The team comprised of two undergraduate students, an electrical engineering professor, and engineers from a local utility. Volt-VAR optimization is the combination of both conservation voltage reduction (CVR) and volt-ampere reactive (VAR) optimization. The goal of CVR is to reduce energy consumption by lowering the voltage magnitude toward the lower limit of the ANSI C84.1 range (i.e., 114 V). This scheme uses End of Line (EOL) measurements to control the substation voltage regulators so that the appropriate voltages are set. To implement VAR optimization, utilities switch shunt capacitors onto distribution system feeders to reduce the amount of power losses resulting from reactive power flow. Implementing both CVR and VAR optimization in tandem by using advanced communication and control schemes comprise the complete VVO system.

Time series data were collected from simulations conducted using GridLAB-D software at step sizes of 1 minute for an entire year. Loads on the distribution system were modeled using both the traditional static ZIP model, whose weights were determined through a least squares fit. Thermostatically controlled loads were modeled using the equivalent thermal parameter (ETP) model. The closed-loop control equations were described using differential equations due to their time varying nature. Finally, a composite model was developed by combining the two different types of loads that appear on a distribution system to develop a representative building load. The loads were then aggregated together and through the law of large numbers, appear identical to the actual behavior of loads on a distribution system. The relative weights of different loads were varied until they were found to match that of actual supervisory control and data acquisition (SCADA) data. Simulations on 24 prototypical distribution feeders were performed using GridLAB-D both with VVO and without. The resulting energy consumption was then analyzed for both cases. Estimation for the economic costs and benefits of VVO in the Pacific Northwest was done by combining both simulation data and past survey data from the Snohomish PUD. Energy cost savings are then converted to dollar amounts using market rate electricity prices for each region (i.e., typically 10 cents per kWh). It is found that implementing VVO technology can save utilities up to 4 percent per year on energy losses.

The challenges, opportunities, and student experiences of this research is also presented. As the nature of this research was interdisciplinary, it required significant cross-collaboration as well as background knowledge in both engineering and economics. The students performed extensive literature review on these topics before reaching out to the engineers from local utilities for guidance. The results of this research is highly beneficial to the students as well as to the utility. Along the way, the students develop communication, project management, and soft skills that will serve them well into their professional careers.

Development of Laboratory Assignments for Teaching Communication Systems

Aaron Scher and Eve Klopf
Oregon Institute of Technology

The high-cost of specialized radio test equipment, like spectrum analyzers and signal generators, presents a challenge to universities offering undergraduate communication systems engineering courses with large class sizes. Many universities either lack laboratory sections or offer limited laboratory assignments that focus on exploring individual concepts. As a result, current practice in teaching classes on communication systems typically rely on involved mathematical calculations and simulations. Students completing these classes may have a general understanding of analog and digital signal processing, but frequently lack hands-on experience in applying these concepts to build functional communication systems.

In recent years, affordable software-defined radio (SDR) platforms and open source software like GNU Radio have been developed by the research and hobbyist communities. The main idea of SDR is to use an analog-to-digital converter to sample radio signals and perform most signal processing in the digital domain using a computer (as opposed to using traditional hardware components like mixers and amplifier.) This technology is flexible, convenient, and offers similar capabilities as specialized radio test equipment, but at a fraction of the cost. Similar to SDR, the recent expansion of inexpensive transceivers and home network devices offer new possibilities for applied projects in the classroom.

We are developing a series of laboratory assignments for a senior-level Electrical Engineering course in communication systems that leverage the advantages of inexpensive tools like SDR, low-power transceivers and small home network devices. These experiments allow students to transmit and receive live radio systems to directly explore basic concepts like modulation, synchronization, filtering, and noise. By allowing students to build and test functioning radio system and small smart-device networks, students are able to gain a broader understanding of how communication systems work as opposed to the often piecemeal topic coverage in traditional classes. Using live signals also allows for a natural discussion of related topics such as FCC rules, antennas and signal propagation. Although still a work in progress, initial student response to this laboratory content has been positive.

Implementation of a Lab Section for Electricity and Magnetism with Transmission Lines

Eve Klopf, Aaron Scher
Oregon Institute of Technology

This paper focuses on the implementation of a laboratory section for an undergraduate course in engineering electromagnetics. This fall, both campuses of the Oregon Institute of Technology adopted a laboratory section for EE 341: Electricity & Magnetism with Transmission lines, a required class for all electrical engineering students. This paper will discuss the content of those labs, outline the challenges we faced when altering a well-established class to include a laboratory section, and discuss the outcomes that we have seen so far.
Engineering electromagnetics is a required class within the majority of electrical engineering programs, yet the class is typically offered without a laboratory component. We have seen that including a laboratory component has positive effects like helping students better visualize and understand the concepts covered in this class. Given that electromagnetics is fundamental to modern technology, we believe a meaningful, hands-on experience in this area is crucial for the success of undergraduate electrical engineering students.

Electric Power Distribution System Reliability and Outage Costs: An Undergraduate Industry Collaboration

Xichen Jiang
Western Washington University

This paper describes an undergraduate, cross-disciplinary research into the economic effects that result from power system outages, which are useful for utility planning and assessing the valuation of electric grid reliability. The Pacific Northwest region of the United States experiences a temperate climate with brief summers and long-lasting winters. Generally, the highest electric demand for the region occurs during winter months, due to the need for heating. Therefore, an outage that occurs during cold weather could result in additional non-financial costs for customers (i.e., loss of comfort services such as electric heating, etc.). Outages that occur due to natural disasters such as hurricanes are not present in this region, unlike the East Coast of the United States. However, the region’s abundant vegetation (i.e., trees) do impact the distribution system, especially during storm seasons, such as fall and winter, as they can cause faults on the distribution lines. This report examines the causes and consequences of electricity outages using a variety of metrics such as the Consumer Damage Function (CDF), Value of Lost Load (VOLL), Loss of Load Probability (LOLP), and other commonly used metrics for research and utility resource planning.

The methods for estimating and analyzing the economic impacts of power outages include post-event analysis, economic output to energy consumption ratios, and electric customer surveys. Regression analysis (i.e., using Tobit specification) is performed on the data collected from a survey of the Pacific Northwest electric customers to estimate the Customer Damage Function (CDF), based on factors such as the duration and timing of an outage. The Department of Energy’s (DOE) Interruption Cost Estimator

(ICE) Calculator is used to assess the impacts of outages based on reliability data provided from the region's largest investor-owned utility, Puget Sound Energy (PSE). The reliability metrics include System Average Interruption Duration Index (SAIDI), which describes the average length of an outage in minutes, the System Average Interruption Frequency Index (SAIFI), which describes the average number of outages a customer experiences, and the Customer Average Interruption Duration Index (CAIDI), which is the average outage duration any given customer would experience and is the result of SAIDI divided by SAIFI. These three metrics from Puget Sound Energy were used in the regression analysis along with the number of customers the utility serve, separated out between non-residential and residential customers.

This project was conducted in collaboration between two undergraduate students, an electrical engineering faculty specializing in power systems, and engineers from a local utility. The natural of the research was interdisciplinary as it required both economics and power engineering knowledge, which was a challenge but also very rewarding for the students. The students reached out to the local utility and worked with the engineering team there to conduct this research that is in turn both beneficial for the students and the utility. This partnership not only stimulated the students' interest in research but also helped them develop skills in communication, project management, and soft skills that will serve them well into their professional careers. The opportunities and challenges from this collaboration are also presented in this paper.

Workshops

Thursday, March 21, 2019
2:30 p.m.—4:30 p.m.
Agriculture Leaders Room

Session 3A: Uncovering the influence of contextual representation on engineering problem solving in engineering students and practicing engineers

David Hurwitz, Shane Brown, Sean Gestson
Oregon State University

Duration: Researchers involved in a 3 year NSF Research on Engineering Education study will present aspects of their experiments and findings during two 1-hour sessions. Participants will receive hands on training on approaches to implement the findings of the research in their classrooms.

Session 1 Orientation: During the first half of the presentation, participants will received an orientation to conceptual knowledge, the theory of situated cognition, and the impact of contextual representation on problem-solving capabilities of practicing engineers and engineering students. We will introduce the study and its methodology, including the steps taken to identify prominent concepts and contexts in transportation engineering and hydraulics engineering as examples of the process.

Session 1 Activity: After the orientation, workshop participants will be divided into groups and asked to provide feedback on the developed problem and associated contextual representations. Group discussions will be moderated by two researchers involved in the project and will revolve around 5 main questions:
1. Are the contextual representations authentic?
2. Is the problem authentic?
3. How could we improve this problem or the associated contextual representations?
4. Would you use this problem in a class that you teach?
5. Would you use this approach to design a question for your class?

Participants will be asked to summarize their answers (either as a group or as an individual) and report it back to the facilitators.

Session 2 Orientation: Second half of the presentation will follow a similar structure as Session 1. During the first 15 minutes, participants will be presented with the details of data collection and data reduction process from the project. They will also be provided with preliminary findings from eye-tracking experiments as well as reflective clinical interviews.

Session 2 Activity: The remainder of this session will be dedicated to group discussion. Here, participants will be asked to collectively design a new problem and identify its relevant contextual representations, in any content area of interest to them. By the end of this session, one person from each table will report back to the facilitators about their problem and associated contextual representations.

Session 3B: Focus More on Teaching than Grading: Try MATLAB Grader

Agriculture Production Room

Eric Davishahl
Whatcom Community College
Jeff Alderson
Mathworks

Get started with the web based auto-grading platform for MATLAB assignments named MATLAB Grader. Instant feedback on code accuracy and helpful hints on common programming errors help students learn at their own pace and schedule. As students get real-time feedback on their solutions and code, instructors can focus more time on effective teaching. Learning analytics embedded in the auto-grading platform provide instructors with insight into patterns of student learning.

Participants will learn how to set up auto-graded MATLAB assignments by adopting existing problems from a catalog, how to modify problems to better suit their assessment goals, and how to develop their own problems that can be automatically graded. Facilitators will share exemplar auto-graded problems, best practices for problem design and use cases for learning analytics built into the platform . The workshop will also include pedagogical models for incorporating auto-graded assignments into a broader assessment regime with more open-ended assignments.

The workshop will start with a brief presentation introducing the MATLAB Grader platform and its potential benefits for student learning. Next, participants will solve a sample homework problem in MATLAB Grader to get familiar with the student experience. Participants will then move to the role of the instructor. Facilitators will guide participants step-by-step as they work on their laptops to setup a "sandbox course" on MATLAB Grader and create an assignment using problems from a catalog. Once everyone has set up a course and an assignment, facilitators will demonstrate how to modify a problem and share their perspectives on best practices for developing new problems. Participants will also gain instructor access to a pre-populated example course they can use to explore the learning analytics features.

During the second half of the workshop, participants will work independently or in groups to develop their own custom assignments. Throughout the workshop, facilitators will be present to answer questions, offer technical support and aid discussions.

Required Supplies
Participants should bring a laptop, preferably with MATLAB installed. A local MATLAB installation is not required to use MATLAB Grader, but does make development work easier. Participants are encouraged to bring an existing MATLAB programming assignment that they would like to adapt to the MATLAB Grader environment.

Session 3C: Spatial Vis™: A sketching app with automatic grading to teach spatial visualization skills to introductory engineering students

Agriculture Science Room

Lelli Elinde
University of California, San Diego

Objectives:
Spatial visualization (SV) refers to the ability to manipulate geometric shapes in one's mind and is important in many STEM fields. Studies have shown that SV skills are learnable, and SV training can increase GPAs and graduate rates in engineering. Additionally, sketching has been shown to be an important part of increasing 3D visualization skills, which is key for creativity and team communication. However, few engineering curricula include SV training, and adding new content to an already full program can be difficult. The Spatial Vis™ App, developed by eGrove Education, was designed with the potential to teach SV training outside of scheduled class time. It allows for freehand sketches of isometric and orthographic assignments to be graded automatically and for hints to be provided when needed. The app has been tested in a number of trials at universities across the country and has been shown to be an engaging and effective tool in improving SV skills. The app is currently available on Android and Apple smartphones and tablets, as well as advanced touchscreen Chromebooks. Features of the app include automatic grading, personalized hints for students when stuck, teacher data for tracking student progress, gradual increase in difficulty of assignments, a gamification start system to encourage persistence, and several test questions the end of each lesson where the Hint and Peek questions have been disabled. Results from trials using the technology in a number of university classroom settings, which have demonstrated the efficacy of the app based on a pre- and post- standardized spatial visualization test, will be discussed.

Targeted audience:
First year engineering or engineering graphics college or community college instructors; K-12 pre-engineering teachers and administrators.
Activities Planned:
This workshop will provide an overview of the benefits and best practices of using the Spatial Vis app in your classroom. Participants will be given a license to the app to use on their own smartphone devices to engage in interactive spatial visualization (SV) activities.
Learning Outcomes:
Instructors will learn 1) spatial visualization skills such as 2D rotations, 3D isometric views, and 2D orthographic projections; 2) how to use the app including the algorithm that automatically grades students' sketches and provides guidance when requested; and 3) best practices for how to implement the SV training in their curriculum. You won't want to miss this interactive workshop!

Approximate length: 2 hours
Required supplies: Android or Apple touchscreen device such as a smartphone or tablet.

Friday, March 22, 2019
9:15 a.m.—11:15 a.m.
Agriculture Leaders Room

Session 4A: Safe Zone Ally Training Workshop: Level 1 and Level 2

Alexandro Longo
Rowan University
Robyn Sandekian
University of Colorado, Boulder
Eduardu Cotilla-Sanchez
Oregon State University

Did you know that 1 in 3 LGBTQ+ students are made to feel uncomfortable in our classrooms? Did you know that LGBTQ engineering students are more likely than women, underrepresented minorities, and non-LGBTQ peers to report a chilly climate in engineering (Cech et al., 2017)? Did you know that LGB students are less likely to be retained in STEM than their heterosexual peers (Hughes, 2018)? Did you know that LGBQ Faculty in STEM fields reported the highest level of discomfort on campus, in departments, and in classrooms (Patridge, 2014)? You can help change this!

Safe Zone Ally Training workshops are interactive training sessions for faculty, students, and the professional community that seek to raise awareness for LGBTQ+ inclusion in STEM and create a visible network of allies to foster a supportive atmosphere for LGBTQ+ individuals. During these research-informed workshops, participants will build the knowledge and skills needed to create a more inclusive and affirming environment for LGBTQ+ individuals in engineering. The workshops have been developed by a community of Science and Engineering professionals and students, specifically for a STEM audience. The workshops typically last 90 minutes and are facilitated by two members of our community of advocates.

Safe Zone Ally Training Level 1 workshops focus on understanding LGBTQ+ concepts, LGBTQ+ identity development and the coming out process, and simple strategies for building an inclusive environment and being an LGBTQ+ ally.

The key learning outcomes for Level 1 workshops are:
1) Understand the importance of Safe Zone Ally Training workshops and why it is necessary to build knowledge and skills related to LGBTQ+ individuals and STEM inclusion.
2) Understand the concepts of sex, gender, and sexual orientation.
3) Understand the identity development and coming out process for LGBTQ+ individuals.
4) Learn how to contribute to an inclusive environment for LGBTQ+ individuals through implementing inclusive strategies (special attention paid to beginner ally strategies).

These workshops are interactive and incorporate several brief individual and group activities to enhance learning. Participants do not need to bring supplies.

Participants in Levels 1 and 2 will receive a Safe Zone sticker to display in their workplace. Digital badges will be awarded for participation in each workshop in the Safe Zone series.

Friday, March 22, 2019
9:15 a.m.—11:15 a.m.
Agriculture Production Room

Session 4B: What's New with MATLAB

Divyanshu Tiwari
Mathworks

Objectives:
MATLAB has changed significantly over the last three years to address the growing needs of its users, but even experienced MATLAB users often do not take advantage of its latest relevant and useful features. This seminar will cover the newest MATLAB features, with a focus on how to utilize these features to simplify work, save time, and increase productivity. As an overall theme, this seminar will be grounded in encouraging computational thinking among students and the pedagogical practices that support it.

Targeted audience:
New and existing MATLAB users, Educators teaching STEM courses

Learning outcomes:
Attendees will understand and be able to utilize the following recent feature updates in MATLAB:
* MATLAB Foundation Updates - Faster execution engine, Graphics system, Live Editor
* Data handling and language enhancements - Simpler data importing, Improved datatypes, Big data capabilities
* App building - App Designer, Sharing apps, and Creating toolboxes
* Hardware support
* Other Toolbox enhancements

Activities planned:
This will follow an interactive seminar approach. Content for follow-up activities, including all functionality shown during the seminar, will be shared with the attendees.

Duration: 1 hour

Session 4B: Introduction to Scrum and how to use it in engineering education

Branimir Pejcinovic, Phillip Wong, Robert Bass
Portland State University

This is a workshop proposal. Scrum is a popular form of Agile project management. Its applications now include diverse areas such as software development, engineering, urban planning, and law. Scrum has also been used in software engineering educational programs, but its use in other engineering education is lagging. Within our electrical and computer engineering program, we introduced Scrum to help students improve their teamwork efficacy in projects and courses [1]. However, Scrum can be applied to all areas of engineering. Attendees of this workshop will first learn the basics of Scrum in general, followed by discussion and examples of how it can be applied to their engineering courses and overall program. We will also discuss ways to engage students in teamwork. Scrum methodology consists of (see www.scrumguides.org):

• Members: product owner, Scrum master, and development team
• Events: sprint planning, daily stand-up, sprint review, and sprint retrospective
• Artifacts: product and sprint backlog
• Definitions and rules governing Scrum implementation

We cannot expect freshman or sophomore engineering students to have the sophistication necessary for full implementation of all of these in addition to teamwork. Furthermore, Scrum in educational environments is a teaching and learning tool, and it needs to be modified from its original design. How to address these issues will be discussed during the workshop as will all of the tools used in implementing Scrum. Attendees will work in teams to write drafts of basic Scrum artifacts. We hope that our experience and information provided will enable others to implement Scrum in their courses and programs.

Learning outcomes - participants will be able to:
• Explain the main components of Scrum
• Learn the basics of Trello and CATME tools used in our implementation of Scrum
• Design a project board on Trello, fill in the backlog and design the first sprint
• Start using basic rubrics to evaluate Scrum and project management

Audience: instructors of undergraduate and graduate courses that have a significant term project component that requires use of project management.
Duration: 1 hour
Resources: laptop and Wi-Fi connection
Other outcomes: potential collaboration on educational research project(s) related to Scrum application to project management.

[1] B. Pejcinovic, R. B. Bass, and P. Wong, “Assessing Scrum Project Management and Teamwork in Electrical and Computer Engineering Courses,” in 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah, 2018.

Friday, March 22, 2019
9:15 a.m.—11:15 a.m.
Agriculture Science Room

Session 4C: Advancing Mechanical Engineering Education Through Mobile Learning Micro-Workshop Training

Krishna Pakala, Lana Grover, Devshikha Bose
Boise State University

Workshop Background and Motivation: Longitudinal data suggests that “Despite high ownership… the use of mobile technology in learning is not as widespread” (as cited in Chen, Seilhamer, Bennett, & Bauer, 2015). Moreover, “students are not as adept at using mobile technology as the devices' popularity suggests”, indicating that “ownership does not have a direct relationship to proficiency”. Although this gap is evident in higher education today, few institutions have specific programs designed to support faculty as they attempt to integrate emerging and mobile technologies into their teaching and learning. One survey indicates that “educators want to integrate technology at a much higher level than they currently are, but need support and assistance to do so” (The Center for Digital Education, p.18).

While most engineering curricula include technical and scientific topics, they often lack practical engineering experience and soft skills development (Burnik & Kosir, 2017). Evaluating and integrating current technology into the curriculum is essential to meeting 21st century educational expectations and workplace demands. Participants in this workshop will engage in active learning to analyze a variety of different teaching techniques, identify best practices for meeting learner’ needs, and design a plan for mobile learning integration in their courses. To maximize student success, over the past several years we explored how to use progressive learning theories, coupled with innovative mobile technologies.

Workshop Description: This workshop will introduce participants to mobile technologies and learning strategies which can enhance learning for mechanical engineering (ME) students. Participants will see examples of how a ME instructor used mobile learning strategies effectively in the classroom and identify ways to apply and transfer concepts through practice. Participants will engage in active learning through micro-workshops focused on relevant topics of digital learning such as, digital distraction, cloud-based collaboration, virtual office hours, and wireless presentation. Facilitators will also share highlights from a successful professional development program aimed at integrating mobile learning in higher education.

Learning outcomes attendees will take away by participating in this workshop:

1. Identify some mobile learning technologies and learning strategies which may be used for learning in a ME course
2. See examples of how effective mobile learning technologies and strategies were used by a ME instructor
3. Identify ways in which effective mobile learning technologies and strategies can be used in their specific ME courses
4. Will discuss the pros and cons of using mobile learning technologies and strategies in their course
5. Hear about a PD program designed to help a ME instructor in using mobile tech and strategies for increasing student learning.

Technology & Workshop Plan
Technology: Smartphones and Tablets

In this workshop participants will:

1. pair and discuss how mobile learning technologies and strategies are currently being used at their institutions to advance learning in ME courses (5m)
2. be introduced to a series of concepts related to digital learning; through corresponding micro workshops, participants will have the opportunity to transfer concepts to practice (40m)
3. hear methods by which the discussed digital concepts were applied by an instructor for ME learning (40m)
4. work in small groups to complete a provided template for mapping their individual plan for mobile learning integration in a ME course (15m)
5. hear an overview of a successful professional development program for mobile learning at Boise State University (15 min)

References

Chen B., Seilhamer, R., Bennett, L. & Bauer, S. (2015). Students' mobile learning practices in higher education: A multi-year survey research study. *EDUCAUSE Review Online*.

Burnik, U., & Košir, A. (2017). Industrial product design project: building up engineering students' career prospects. *Journal of Engineering Design*, 28(7–9), 549–567. https://doi.org/10.1080/09544828.2017.1361512

Posters

Friday, March 22, 2019
11:30 a.m.— 1:00 p.m.

Increasing student engagement in Digital Logic through game-based laboratory assignments

Kevin P Pintong, Allan Douglas, Phil Howard, Troy Scevers
Oregon Institute of Technology

Engaging Computer Engineering students at the freshman level can be a significant challenge since students at this level have not necessarily developed the skills necessary for more interesting tasks. Student engagement during this time can determine whether students will want to continue with the major. Another challenge in teaching students at this level is insufficient subject area to solve interesting and engaging problems. At Oregon Institute of Technology, this is particularly difficult as combinational logic and sequential logic are presented as a two course sequence. In this poster, we present problems encountered in implementing game based laboratories in Digital Logic I. We present how to cover course content and learning objectives through game based laboratory assignments through techniques such as compartmentalization and black boxing of unlearned concepts. Two examples, a Pong-based schematic capture lab and a Tic-Tac-Toe based game are presented. Qualitative and quantitative data is presented comparing student engagement and perception of learning before and after the change to game-based laboratory assignments. Preliminary data indicates that game-based laboratory assignments can increase student engagement while maintaining the same learning outcomes.

Conceptual Model: Situation of Key Influencers That Contribute to Transformative Learning in an Electrical and Computer Engineering Undergraduate Capstone Design Project Course

Rachael Cate, Donald Heer
Oregon State University

Electrical and Computer Engineering (ECE) design instructors and course developers at Oregon State University are conducting a longitudinal study to investigate the efficacy of Evidence-Based Instructional Practices (EBIPs) for supporting students' learning. In this study, the key research question is: What EBIPs best facilitate transformative learning experiences for ECE design students? For this mixed-methods action research study, the researchers will apply EBIPs in the form of programmatic interventions and collect both quantitative and qualitative empirical data to assess results. The first year of the study was devoted to literature review and data collection to identify EBIPs from prior research, guide the focus of educational interventions, and survey a “control” group. This poster presents the results of the extensive review of EBIPs in case studies and transformative education theory. Transformative learning theory is identified as a foundational framework for defining and measuring success in engineering education, and key transformative practices have been identified to guide this study and its interventions. The EBIPs presented here provide engagement opportunities that advance professional integrity and efficacy through collaborative design, project management, and critical reflection. They include critical awareness of culture, professional identity development, participation in communities of mentoring and learning, holistic skill integration through reflection, and the development of professional integrity through affective awareness. Based on this review, the researchers have also created a conceptual model (pictured here), that situates the key influencers for transformative education as they may be applied within a design engineering learning program.

You Can't Spell SUCCESS without a CC: Examining Non-Cognitive and Affective Factors of Community College and Four-Year Institutions

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Non-cognitive and affective (NCA) factors can drastically affect student success in college – both at four year and two-year institutions. We have developed the Studying Underlying Characteristics for Computing and Engineering Student Success (SUCCESS) survey to examine fourteen NCA constructs that may be predictive of student success. These constructs include Big Five Personality, Grit, Identity, Mindset, Motivation, Gratitude, Mindfulness, Belongingness, Test Anxiety, Time and Study Environment, Perceptions of Faculty Caring, Self-Control, Student Life Stress, and Meaning and Purpose. To date we have collected data from 2500 students at 17 four-year institutions and are just beginning to develop community college partners. After examining student characteristics at community colleges, we can begin to identify traits that may be most malleable and that most greatly affect student success, and then develop student support initiatives. We are currently collecting data at two community colleges, and will compare student traits at these institutions to those at four year institutions in our poster. Our goal is to track students after they matriculate to four year institutions, and see if and how the NCA traits change. We also hope to analyze the data to look for correlations between changes in NCA traits and voluntary student participation in extra-curricular and co-curricular activities such as student clubs, undergraduate research, peer tutoring, and internships.

Climate Perceptions of Transgender & Nonbinary Engineering Undergraduate Students

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Engineering remains the most male dominated professional occupation in the United States. Research into professional identity formation define engineering identity and culture as both existing within hegemonic masculinity. Gender in engineering research has traditionally investigated how this influences women and their gender identity & expression. Prior studies indicate that women may experience a lower perception of belonging in engineering and may alter their sense of self or gender presentation to "fit in." LGBTQ+ individuals in engineering are found to report similar experiences, navigating the field with a rate of "closeting" that is the highest among STEM disciplines. Unexplored are experiences of those whose relationship to gender is more nuanced than two binary categories and an assumed cisgender status. Results from the analysis of 2016 student survey data present climate perceptions which are significantly correlated with gender identity and gender status. Questions relating to sense of belonging, imposter syndrome, and perceptions of identity impact were asked by 32 questions which were averaged into 4 reliable social concept scales. Data interpretation was performed using IBM SPSS to ascertain trends, p values, and effect size represented by point biserial correlation (rpb) and eta. One's gender as nonbinary or a woman is correlated to a greater awareness of identity, employment of impression management tactics, diminished belonging, and sense of doubt when compared to men. There were similar relationships when comparing cisgender students against transgender students. The data suggest nonbinary and transgender students are navigating an inequitable social climate in engineering education, necessitating further investigation.

Take-apart, hack and design: Repurposing an ink-jet printer for prototyping in mechanical design

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We have used dissection and hacking of ink-jet printers as a source of prototyping parts and subsystems for mechanical systems involving motion control. In this presentation we describe two design challenges that used old ink-jet printers as a "kit of parts". In addition to supplying motors, bearings, gear trains and sensors, the printers provided working examples of how to control motion of the print head – at least until the printer was disassembled.

In the Fall of 2016, 93 students competed in a design challenge to move a radio-controlled (RC) truck over a 15cm high obstacle. Students could operate the RC controls to steer and move the truck, but they could not otherwise interact with their device that had to automatically raise the truck over the obstacle. In the Fall of 2017, 100 students competed a design challenge to "rescue" a Lego minifigure by transporting the minifigure from a tall tower with parapet walls to a "stretcher" at the base of the tower. For both design challenges, points were awarded for speed of operation, total weight of the device (lighter is better) and the cost of the bill of materials (BOM). To encourage maximum repurposing of printer parts, any components from the printer were assigned zero cost in the BOM when the score was computed. Each year, approximately 20 printers were obtained at no cost from a local electronics recycling organization.

A primary goal of the challenge was to give students experience with rapid prototyping in developing design concepts. Sketches and cardboard mockups were required before teams built fully functioning prototypes from their printer carcasses. The challenge occurred during the second half of a 10-week term, so teams had to work quickly while exploring different design solutions through multiple prototypes. In addition to the prototyping experience, the design challenge was intended to provide intrinsic motivation for learning design techniques, teamwork, and to develop a respect for the complications of manufacturing and testing.

Students worked in teams of 5 in open laboratories where they could learn from each other. Despite the close proximity a variety of design approaches were used for each design challenge. Teams were assigned by the instructor (using the CATME tool from Purdue) to balance prior experience and academic success. The resulting teams were generally diverse and usually involved students who have never worked together before.

In the presentation, we provide some details on how we implementation of the design challenge and printer disassembly, including the requirement of multiple stages of prototyping. We show examples of student designs, including the top designs in the competition.
The take-apart and hack a printer experience would be easy to transfer to another university. By suitable choice of a design challenge, the take-apart and hack experience could be applied from freshman through senior level design courses.

Integrating Ethics Across the Civil Engineering Curriculum

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Ethics is a critical topic that is often overlooked in engineering education. To improve understanding of the many ethical issues students may face as practicing engineers, we developed ethics modules in four civil engineering classes at the University of Portland (UP). These ethics modules ranged from traditional writing assignments to interactive class discussion. As a result, students receive ethics instruction at least one time per year throughout their four years at UP. Survey results indicate students thought their understanding of the ASCE Code of Ethics improved, and the ethics modules were helpful for their professional career. Student comments and survey results also indicated the interactive class discussion was more impactful than the writing assignments because they were able to learn about more than one ethical situation. The results of the survey will help improve the ethics modules, and continue our efforts to integrate ethics into the Civil Engineering Program at UP.