COLLEGE OF ENGINEERING
ENGINEERING EDUCATION
VIRGINIA TECH.

Funded Research Portfolio

2023-24

(listed alphabetically)

GRANTS

Advancing Student-Centered Teaching for Engineering Disciplinary Knowledge Building

Dr. Nicole Pitterson

Award Amount: **$299,959**

Project Dates: **Oct. 2022 to Sept. 2025**

This project aims to serve the national interest by improving student learning outcomes in engineering using student-centered teaching practices. This research and development investigation directly address two unresolved challenges in undergraduate STEM education: the slow adoption of effective instructional practices and the assumption that effective teaching is of a generalized form.

The mixed methods participatory action research (PAR) study will examine the uptake of student-centered teaching in middle and upper level courses. Furthermore, the investigators seek to understand institutional change in engineering through guided reflection of an effort to integrate research and practice. The PAR approach entails scholarly reflection on knowledge and learning with a small team of exemplary faculty to accomplish a complex change agenda. These faculty are acknowledged for utilizing student-centered teaching practices within their courses and will be drawn from several engineering departments. In addition, faculty will engage in research that seeks to foster the development and continued support of a community of practice (CoP). This CoP intends to build on and contribute to an understanding of how disciplinary knowledge can transform undergraduate STEM education.

The project team will examine the adoption and implementation of effective instructional practices to understand the types of such practices found in middle and upper level engineering classes, with an eye towards instantiating sustainable transformation of undergraduate STEM education.

Read the full grant summary at bit.ly/Student-CenteredTeaching

Accelerated Learning and Assessment in Engineering Mechanics

Drs. Nicole Pitterson & Jake Grohs

Award Amount: **$298,535**

Project Dates: **March 2019 to Feb. 2024**

Repeated deliberate practice in problem-solving can increase students' understanding of difficult engineering concepts. In addition, students who receive frequent formative feedback are better able to identify and correct problems with their reasoning. Unfortunately, few undergraduate engineering courses provide students with such opportunities for repeated practice, targeted feedback, and focused tutoring.

This project aims to enable these opportunities by developing an automated educational intervention tool for learning engineering mechanics. This open-access, problem-solving interface will provide engineering students with feedback and tutoring, based on their performance on practice exercises. Since all developed materials will be open-source and open-access, the project can also inform and support the work of students and teachers beyond the local institution.

By focusing on developing strong analytical problem-solving skills, this project directly responds to industry and the federal government priorities for developing an engineering workforce that is capable of innovative problem solving. Thus, this project has the potential to contribute to the ability of the U.S. to maintain its economic competitiveness and position as a global leader in innovation.

Read the full grant summary at bit.ly/AccelLearn

Artificial Intelligence for All: A Framework for a College Certificate

Dr. Sarah Rodriguez

Award Amount: **$119,592**

Project Dates: **Oct. 2021 to Sept. 2025**

This implementation and evaluation project from Miami Dade College (MDC) aims to serve the national interest by increasing community colleges' capacity to develop and offer courses in artificial intelligence (AI) with the AI for All project. MDC plans to attract and train more students in AI by creating a College Credit Certificate in AI Framework.

Innovative features of the project include an HSI community college adapting AI courses originally developed for a four-year university program and combining them with multiple on-ramps and supports for engaging students such as bootcamps, workshops, and mentoring. The interdisciplinary focus will allow for weaving AI engagement across MDC's colleges and programs providing students with a foundational literacy of AI that will inform whatever career path they follow. The long-term impacts will include increasing awareness and engagement for non-computer science students in AI courses, developing a four-year AI degree at an HSI community college; and broadening participation of groups historically underrepresented in computing careers.

The project's goal is to develop AI courses and an interdisciplinary certificate that will lead to successful student outcomes, while building capacity for the development of a four-year degree in AI at an HSI community college. The STEM education research will explore the computing identity development of students participating in the AI for All project activities, examining how multiple entry points into and paths through the certificate program function to build STEM identity and AI self-efficacy, particularly in Black and Hispanic students.

This will be a subaward from Miami-Dade Community College to Virginia Tech.

BCSER: Building Capacity for Research in Technology-Based Social Entrepreneurship Education for the Next Generation of Engineering Leaders

Dr. Dayoung Kim

Award Amount: **$349,957**

Project Dates: **Oct. 2023 to Sept. 2026**

Despite the emphasis on both entrepreneurship and social responsibility for engineering students, education, and research on the two topics have been mostly separate efforts. Technology-based social entrepreneurship education for engineers has ample potential to give engineering students the opportunity to become socially responsible engineering leaders with an entrepreneurial mindset. However, very little research on the topic has been conducted in the field of engineering education.

This project aims to advance understanding of how engineers who have launched technology social ventures identify business opportunities that can fulfill the goal of utilizing technology to solve societal problems and the required competencies for successful technology-based social entrepreneurship. Based on this knowledge, the project team will develop a measurement instrument to assess these competencies in undergraduate engineering students. The research findings and the resulting instrument will provide a basis for technology-based social entrepreneurship education for engineering students and students from other disciplines who intend to collaborate with engineers. In the process of participating in this project, the principal investigator (PI) will establish domain-specific knowledge in engineering entrepreneurship education and in-depth knowledge and experience in educational research methods as well as project development and management.

The PI will also develop new undergraduate and graduate course modules based on the findings.

Read the full grant summary at bit.ly/RsrchTechSocEntrep

BPE Track 3 Inclusive Mentoring Hub: Raices Institute for Transformative Advocacy RITA

Dr. Homero Murzi

Award Amount: **$250,895**

Project Dates: **Oct. 2023 to Sept. 2026**

This NSF-BPE Track 3: Inclusive Mentoring Hub project, called Raíces Institute for Transformative Advocacy (RITA) will equip engineering contingent faculty (adjuncts, part-timers, and non-tenure track), who are Black, Indigenous, People of Color of all intersecting identities (BIPOCx), to form their own transformative grassroots advocacy strategies for attaining equity in promotion pathways and working conditions at their hiring academic institutions. Project objectives center around: developing authentic mentor/mentee relationships, learning/developing transformative individual/collective advocacy plans, and raising awareness for the promotion and/or working conditions of BIPOCx contingent faculty in engineering.

Due to the scant attention paid to contingent faculty, this population is severely understudied and undersupported. In the United States alone, there are ~1.5 million faculty employed in higher education out of which over 46% are contingent, the majority composed of marginalized groups, creating a missed opportunity to broaden participation. To broaden participation, our nation needs to leverage a diverse and inclusive science and engineering enterprise to secure economic, national security, and jobs of the future. This project attends to all aspects of this national need. Contingent faculty typically serve fundamental undergraduate courses and large class sizes, indirectly impacting the educational experience of students. Yet, continual stresses of an unstable and non-permanent contingent workforce with limited professional development, promotion opportunities, and benefits, negatively affects higher education.

This is a subaward from University of Florida

CAREER: Disrupting the Status Quo Regarding who gets to be an engineer

Dr. Jeremi London

Award Amount: **$580,582**

Project Dates: **March 2021 to Feb. 2026**

While there has been extensive research on the barriers Black and brown students face as they strive to participate in engineering education and the workforce, there is less scholarship on solutions for addressing this complex challenge. One reason for this is because the scholarship on how change happens in engineering education tends to focus on course content and classroom instruction.

Unfortunately, such findings do not easily lend themselves to value-laden, systemic issues like diversity, equity, and inclusion (DEI). Fortunately, some Colleges of Engineering (COEs) throughout the U.S. have adopted change strategies that have resulted in consistently being named among the top-ten producers of Black and brown engineers. This project is motivated by a desire to learn from and follow their example.

This CAREER project will disrupt the status quo regarding who gets to be an engineer by investigating five COEs that have significantly changed the face of engineering over the last 20 years. This project will: (1) Advance our understanding of the change strategies that exemplary COEs have used to improve Black and brown students' access to engineering education and careers; (2) Identify evidence-based models for broadening participation of underrepresented racial/ethnic groups in engineering; and (3) Set COEs on a path to parity, such that the student body demographics in COEs across the country reflect the racial/ethnic makeup of the nation.

Read the full grant summary at bit.ly/LondonCAREER

CAREER: Engineering Pathways for Appalachian Youth: Design Principles and Long-term Impacts of School-Industry Partnerships

Dr. Jake Grohs

Award Amount: **$724,031**

Project Dates: **Feb. 2020 to Jan. 2025**

Engineering-related industries can be vital to rural communities, yet many youth in these communities do not commonly have educational experiences that introduce them to locally relevant engineering career pathways. In this project, engineers from local manufacturing companies will partner with educators to co-design learning innovations spanning in-school and out-of-school settings for over 2,500 high school youth from Appalachian counties.

As part of these learning innovations, industry partners will introduce youth to the many applications of engineering that are present in their communities. Across a range of formal and informal spaces, such as schools and libraries, the youth will then have opportunities to use engineering practices and computer programming skills to address local issues of their choosing.

Longitudinal research will determine whether and how different groups of rural youth develop and maintain interest in engineering career pathways over a sustained duration of time, from middle school through the period after high school graduation. This project will advance knowledge and practice by generating empirically-based findings that illuminate the features of innovative and responsive approaches for broadening participation in engineering careers among youth from rural communities.

This project, submitted to the Faculty Early Career Development Program (CAREER), will generate knowledge regarding how rural youth develop, maintain, or shift engineering interest pathways in the context of sustained engineering activities provided across formal and informal settings.

Read the full grant summary at bit.ly/NSFCJAKE

CAREER: Responsive Support Structures for Marginalized Students: A Critical Interrogation of Navigational Strategies

Dr. Walter Lee

Award Amount: **$599,944**

Project Dates: **May 2020 to April 2025**

Fostering educational environments that empower every student to access available and necessary resources in their pursuit of undergraduate engineering degrees is a national imperative. To support this goal, colleges and universities provide numerous forms of student support intended to increase the retention and graduation rates of its undergraduate engineering students (e.g., peer mentoring programs).

Because of the current lack of diversity in engineering, support often focuses on marginalized groups, such as Black and Latinx students. However, student outcomes and previous research reveals the need for more responsive student support tailored to individual students? needs. Accordingly, the aim of this CAREER project is to advance the extent to which the engineering education community understands how marginalized students 1) navigate undergraduate engineering programs, and 2) make decisions with respect to seeking help.

The study will provide information directly to student support services. By understanding the experiences and decision-making of Black and Latinx students, colleges and universities can support educational environments that are more responsive to the potential diversity of the student populations. The impact of this work will be the more intentional use of university investments and resources focused on broadening participation in engineering.

Read the full grant summary at bit.ly/WalterCareer

CAREER: Sustainable Racial Equity: Creating a New Generation of Engineering Education DEI Leaders

Dr. Homero Murzi

Award Amount: **$663,883**

Project Dates: **May 2022 to April 2027**

The Faculty Early Career Development (CAREER) program is a National Science Foundation-wide activity that supports early-career faculty who have the potential to serve as academic role models in research and education, to lead advances in the mission of their department or organization, and to build a foundation for a lifetime of leadership in integrating education and research.

This CAREER project aims to explore the beliefs, experiences, educational training, and research that supports the development of effective engineering education leaders who are assuming roles focused on diversity, equity, and inclusion (DEI). Advancing equity and broadening the participation of historically marginalized populations in engineering remain a priority for sustaining U.S. global leadership and economic progress.

DEI initiatives, programs, and research are increasing in number across the country in an effort to better understand and dismantle the challenges. However, many DEI efforts are developed in isolation and are not supported by strong institutional commitment and policy. Results from this work will advance understanding of DEI issues, approaches, and effective institutional implementation and will prepare the next generation of DEI leaders to promote long-term, sustainable racial equity initiatives.

Read the full grant summary at bit.ly/HomeroCareer

Center for Equity in Engineering: Organizational Transformation for Graduate Education

Drs. Julia Ross, David Knight, Bevlee Watford, Holly Matusovich, & Walter Lee

Award Amount: **$1,199,981**

Project Dates: **Aug. 2022 to July 2024**

University-level administrators, College-level personnel, academic departments, graduate programs, and individual advisors all play important roles in graduate engineering education, but integrating those different influencers to achieve an overarching, coordinated goal is quite challenging.

This project will establish a Center for Equity in Engineering focused on organizational transformation for graduate education at Virginia Tech (VT). Establishing such a center is important because the highly decentralized nature of graduate education in engineering makes integrated reform strategies extremely challenging and fosters inequities throughout the system. Importantly, the Center will reframe broadening participation such that the focus is on changing systems to promote student success rather than trying to "fix" graduate students.

We will focus on organizing, aligning, and integrating many interconnected systems and processes within the system of graduate education (e.g., recruitment, admissions, funding, research, professional development) to promote student success and wellbeing and disrupt systems of oppression across these systems.

Aligned with the vision for an ideal STEM graduate education system set forth by the National Academies and the objectives of the National Science Foundation's Broadening Participation in Engineering program, we envision a more equitable and inclusive graduate engineering education where student experiences and outcomes are not predicted by demographic variables or citizenship.

Read the full grant summary at bit.ly/CenterforEquity

CIVIC-FA Track A: Youth-centered civic technology, science, and art for improving community heat resilience infrastructure

Dr. Jacob Grohs

Award Amount: **$81,089**

Project Dates: **Oct. 2023 to Sept 2024**

This Civic Innovation Challenge Full Award (CIVIC-FA) project addresses the risk of increasing temperatures in cities due to climate change. It develops and pilots a novel approach that integrates youth arts, science and technology, and spirituality. The planned activities provide governments and residents with rich data to guide their planning and mitigation efforts. The project brings together academic researchers, government officials, and civic organizers to facilitate healing from trauma and planning for the future. Central to climate change adaptation and resilience is the creation of meaningful roles for youth as well as a deep understanding of organizational partnerships. The project also explores how technology can make decision-making more inclusive.

Within cities, historically marginalized neighborhoods often have measurably higher temperatures and fewer resources to reduce heat-related risks. Engaging with the residents living in those neighborhoods is critical yet difficult, due to the legacies of discriminatory urban planning practices that have left deep traumas. The Roanoke Method (trauma-informed resilience planning) is developed to support community well-being and healing through public policies. The project evaluates how participation in cross-organization partnerships affects conceptualizations of the problem of urban heat and potential solutions. The team also creates new digital platforms designed to present past, present, and future visions of the city in the context of shocks and disasters.

Read the full grant summary at bit.ly/CIVIC-FA_YthCntr

Collaboration in Engineering Student and Practitioner Teams: A Study of Beliefs about Effective Behaviors

Dr. Nicole Pitterson

Award Amount: **$264,946**

Project Dates: **Oct. 2022 to Sept 2025**

Effective collaboration is a key aspect of engineering learning and practice. Researchers in the field of engineering education have put considerable attention on understanding the nature of team behaviors, structures, and dynamics and their effects on design quality and problem solutions. However, we know little about why engineers choose to perform collaborative behaviors or not. This project aims to uncover 1) similarities and differences between engineering students and practitioners in the performance of effective team behaviors, 2) understand the reasons why engineering students and practitioners choose to perform particular effective behaviors or not when working in engineering design teams, and 3) examine similarities and differences between engineering students and practitioners in their reasons for choosing to perform particular behaviors or not . Effective team behaviors in collaboration settings are central to any engineer's formation as a professional.

The project findings will provide necessary insight into how to support engineers to become even more effective collaborators in both academic and professional contexts. Also, research products will enhance understanding of how engineers' collaborative behaviors (and reasons for performing particular behaviors or not) are similar or different in school and work contexts.

Read the full grant summary at bit.ly/StuPracTeams

Collaborative Research: Intelligently Connecting the Professional and Educational Communities to Prepare the Future Construction Engineering Workforce

Dr. Homero Murzi

Award Amount: **$2,163,084**

Project Dates: **Aug. 2022 to July 2024**

While universities equip students with theoretical knowledge for STEM, there can be challenges in employing those theories to solve real-life problems. This challenge has resulted in an imbalance between the preparation of graduates entering the workforce and the demands of the industry. This disconnection is persistent in the construction industry as construction practitioners continue to highlight skill shortages that have resulted in low performance and low productivity.

This research project is designed to connect learners with communities of practice thereby giving them access to expert ways of knowing, thinking, reasoning, and solving real-life problems. The research team will develop a tool that connects construction engineering programs with communities of practice thereby enabling instructors access to industry practitioners with the appropriate expertise to meet their practical course-support needs (e.g., site visits, guest lectures, and mentors for capstone projects). As learners interact with communities of practice, this has the potential to inform the ways learners perceive the profession and the development of their own professional identity. These two phenomena will be examined through a qualitative study.

This project is designed to create a collaborative network (called ConPEC) to investigate how the accessibility of construction industry practitioners to instructors, influences construction engineering students' disciplined perception and professional identity development.

Read the full grant summary at bit.ly/ConnectingPro

Collaborative Research: Intersections between Diversity, Equity, and Inclusion (DEI) and Ethics in Engineering

Dr. Andrew Katz

Award Amount: **$49,339**

Project Dates: **March 2021 to Feb. 2024**

Efforts focused on diversity, equity, and inclusion (DEI) and ethics are often siloed in engineering. While generally pursued as separate lines of investigation, we hypothesize that the aims, objectives, and goals pertaining to ethics and DEI often overlap. By investigating this potential overlap, we hypothesize that we can help improve overall efforts at promoting DEI and ethics in engineering.

Our primary research objective is to synthesize intersections between ethics and DEI among engineering academic and workforce communities. In this study, we begin with a systematic literature review that explores potential overlap in literature in ethics and DEI. Second, we will study how engineering academics view (consciously and subconsciously) ethics and DEI as related. Finally, we will study how industrial practitioners view (consciously and subconsciously) the potential overlap between ethics and DEI.

Collectively, this study will enable us to compare how literature, academics, and practitioners view ethics and DEI as related. We will use findings to generate curricular and workforce training efforts to better integrate ethics and DEI in engineering. This study will benefit society by promoting the formation of engineers who can engage with different values and perspectives in ethical ways.

Despite various models, initiatives, and pockets of innovation by scholars and programs, we have not realized widespread changes in the diversification of the engineering workforce. We theorize that one barrier to change is the disjuncture between lines of scholarship from engineering education researchers in the intersecting spaces of DEI and engineering ethics.

Read the full grant summary at bit.ly/IntersectsDEI

Collaborative Research: Overcoming Isolation & Scholarly Devaluation by Bolstering the Collective Agency of Black Discipline-Based Education Researchers

Drs. Walter Lee & Jeremi London

Award Amount: **$1,095,344**

Project Dates: **Sept. 2023 to Aug. 2027**

There is a growing need for scholars specializing in discipline-based education research (DBER) due to the importance of STEM in preparing the technical workforce and a science-literate citizenry. DBER is defined as a collection of related research fields (e.g., physics, biology, engineering, computer science) executing basic and applied research centered on education research questions anchored in the context of their specific field of study.

The proposed project aims to advance understanding and mitigate the impact of systemic racism on the collective agency of Black scholars engaged in DBER focused on engineering and computer science. The project team conceptualizes systemic racism as the complex array of practices, policies, and systems of evaluation that contribute to the de facto segregation and scholarly devaluation of Black scholars. This combination of challenges presents obstacles for scholars working to maximize their potential impact as change agents within their disciplines. This project aims to examine how systemic racism restricts scholars' impact and shapes their individual and collective agency.

The long-term goals of the project are to foster collaboration among STEM education researchers who are geographically dispersed across the country; build capacity for culturally-competent STEM education research and dissemination; enhance the visibility of the work done by Black scholars; and advocate for field-level changes to practices and policies that reinforce systemic racism.

Read the full grant summary at bit.ly/agencyblkDBER

Collaborative Research: Research Initiation: Formation of the Foundations for Engineering Intuition in Structural Engineering with Mixed Reality

Dr. Diana Bairaktarova

Award Amount: **$25,000**

Project Dates: **Sept. 2023 to Aug. 2025**

The design of large-scale structural systems such as buildings and bridges require practicing civil (structural) engineers to understand the linkage between the physical built environment and abstract descriptions, idealized depictions, and mathematical models used to explain their behavior. This formalized understanding is often developed through experience and forms the basis of engineering intuition. Students, or engineer trainees, lack this engineering intuition and are known to have difficulty making these connections and constructing mental models of the abstract concepts and complex systems in the absence of first-hand observations, which are challenging to replicate in the classroom.

This project will utilize mixed reality technology, specifically a mobile augmented reality application that is deployable on mobile devices, to accelerate the educational experiences of students in a core structural design course. In the classroom, the technology integration will allow for collaborative (peer-peer and student-instructor) real-time engagement with models of real-world structural systems aimed at providing the essential linkage between physical representations and their theoretical abstractions. The research will evaluate the impacts of technology integration on instructional methods, student engagement, learning outcomes, and formation of engineering intuition. The collaboration will serve as a pilot study on the integration of mixed reality as an accelerator of the development of engineering intuition, a key characteristic in the formation of holistic engineers prepared to communicate effectively in a technology-driven world.

Read the full grant summary at bit.ly/EngrIntuition

Collaborative Research: Responsible Engineering across Cultures: Investigating the Effects of Culture and Education on Ethical Reasoning and Dispositions of Engineering Students

Dr. Qin Zhu

Total Award Amount: **$404,205**

Project Dates: **June 2021 to Aug. 2026**

The goal of this project is to identify educational interventions with the greatest effects on ethical reasoning and dispositions of engineering students, whether these effects differ among cultural and national groups, and if/how to modify these interventions to respond effectively to cultural and national differences. To do so, researchers from Colorado School of Mines, University of Pittsburgh, Delft University of Technology, and Shanghai Jiao Tong University will implement mixed-method, quasi-experimental, longitudinal, and cross-sectional research to: (1) determine the effects of culture and foreign language on the ethical perspectives of first-year engineering students; (2) assess the relative effects of culture and education on these perspectives over four years; (3) use engineering ethics assessment tools across cultures and countries to examine their cross-cultural validity.

Findings from this project will be essential to develop educational interventions that effectively respond to the globalized environments of contemporary engineering practice. They will also contribute to the development of more inclusive engineering education, by identifying perspectives potentially marginalized in the reigning paradigms. Finally, this project has implications for the development of responsible research education at the graduate level. Despite the fact graduate student bodies in STEM fields have become increasingly international, limited work has focused on developing culturally responsive ethics curricula for graduate students from diverse backgrounds.

This is a subaward from Colorado School of Mines to Virginia Tech.

Collaborative Research: RFE: An exploration of how faculty mentoring influences doctoral student psychological safety and the impact on work-related outcomes

Dr. Mark Huerta

Award Amount: **$197,016**

Project Dates: **June 2023 to May 2026**

There is a need to better understand how engineering departments can cultivate more inclusive, psychologically safe environments in which doctoral students feel safe to engage in interpersonal risk-taking, especially in research settings.

A psychologically safe environment is characterized by people who feel safe to voice ideas and concerns, willingly seek feedback, have positive intentions to one another, engage in constructive confrontation, and feel safe to take risks and experiment, all of which are inherently risky interpersonal behaviors. In academic research environments, faculty have a major leadership role in cultivating a psychologically safe environment within research groups.

While engineering faculty possess strong research skills, they often receive minimal to no training on how to effectively provide psychosocial support to graduate students and how to create a positive team climate. The literature suggests women and other underrepresented groups still frequently encounter "chilly" academic climates in STEM, or experience a lack of sense of belonging, leading to negative outcomes such as increased psychological distress and/or a fear of intellectual risk-taking that is essential to learning, creativity, and innovation.

These outcomes hamper graduate students' ability to fulfill their academic responsibilities, may dissuade them from continuing with their degree program, and contribute to a growing mental health crisis that is already plaguing graduate education.

Read the full grant summary at bit.ly/FacMentor

Collaborative: IUSE: SensDat: End-User Development for Advancing Sensor Data Analytics and Computational Thinking in CEM Education

Dr. Homero Murzi

Award Amount: $477,340

Project Dates: June 2021 to May 2024

This project aims to serve the national interest by creating a tool to help students learn computational thinking skills in construction engineering and management courses. The project focuses on active learning experiences in which students learn how to extract meaningful information from large datasets and use the results to make informed engineering decisions.

These experiences can help better prepare students to address construction industry needs, such as increasing productivity, reducing waste, and improving worker safety. The use of sensors on construction sites is a growing trend because they provide real-time data showing what is happening on a site. Students need to develop skills in data analytics and computational thinking so that they can process sensor data, perform data analyses, and develop an understanding of construction site operations.

To accomplish these aims, the project team will develop a web application that provides students with a graphical interface to select, analyze, and display sensor data. Students will be able to explore a construction site in real-time to understand behaviors and relationships between objects on a site and how they relate to construction project safety and productivity. The web application software will be made available to the engineering education community through public software repositories. By addressing the computational skills gap in the construction industry, this project will benefit construction workers and the economic competitiveness of construction companies.

Collaborative: Research Initiation: Assessing Global Engagement Interventions to Advance Global Engineering Competence for Engineering Formation

Dr. Homero Murzi

Award Amount: $23,973

Project Dates: July 2022 to June 2025

Engineering students live and work in an increasing global environment. Graduates with experience in understanding, interacting with and valuing differing cultures have advantages in the workplace compared with those who will need to learn those skills post-graduation. This underlying global learner mindset is a key ingredient in cultivating a global engineering competency.

Most intercultural competence research and associated global engineering education is focused on developing the global engineering skillset of students through long-term travel experiences such as study abroad programs. These programs can be expensive, requiring a significant investment of time and money, limiting the participation to more privileged members of a community, and are not scalable to support participation from large numbers of engineering students.

The proposed work will fill a gap in the research by focusing on the development of the students' global learner mindset without requiring extensive international travel. Specifically, the project will investigate how four different global engagement interventions (the use of engineering case studies, the intentional formation of multi-national student teams, a Collaborative Online International Learning (COIL) research project, and a community engaged project within a short course) can develop a global learner mindset.

Four engineering educators who are new to the field of engineering formation research will be trained by social science and engineering education researchers in research methods in order to assess the global engagement interventions that will be developed and implemented in this study.

Read the full grant summary at bit.ly/CultureEd

Design for Sustainability: How Mental Models of Social-Ecological Systems Shape Engineering Design Decisions

Drs. Andrew Katz & Marie Paretti

Award Amount: **$332,655**

Project Dates: **Oct. 2023 to Sept. 2025**

The work engineers do and the designs they create have long-term, often unforeseen, impacts on people, infrastructure, and the environment. To help ensure that the results of engineering work advance human and environmental well-being, we need to first understand how engineers currently connect their technical work to these broader contexts and systems.

To achieve this understanding, this project will integrate cognitive and behavioral science, social theory, and advanced computational methods to connect theories of mental models and planned behavior with engineering design practice. In particular, the project will examine the beliefs and p ractices of students in civil and chemical engineering programs across the country, two fields that have substantial impacts on the Nation's infrastructure and environment.

The results will enable future researchers and educators to predict how students' mental models of social and ecological systems will inform their engineering design work. Such predictions in turn will assist educators to more effectively develop students' ability to account for the broader impacts of their work. In doing so, this project will also help educators better understand how students transfer their learning about design as undergraduates into the practice of design in the workplace.

Read the full grant summary at bit.ly/MentalModelDecisons

Developing a Quantification System for Robot Moral Agency

Dr. Qin Zhu

Award Amount: **$13,099**

Project Dates: **Aug. 2022 to 2024**

Establishing when, how, and why robots should be considered moral agents is key for advancing human-robot interaction (HRI). Whether a robot is considered a moral agent has significant implications for how researchers, designers, and users can, should, and do make sense of robots and whether their agency in turn triggers social and moral cognitive and behavioral processes in humans. Robotic moral agency also has significant implications for how people should and do hold robots morally responsible, ascribe blame to them, develop trust in their actions, and determine when these robots wield moral influence. Measuring or quantifying moral agency is thus of critical importance for human-robot interaction research.

Although there have been some recent attempts to develop scales that might achieve this goal, these approaches do not align with the philosophical literature on machine moral agency, and moreover, mistake agency (which we argue to be an ontological state of being) for a psychological construct. In this work, we thus seek to develop a tool for quantifying moral agency that better aligns with the philosophical literature which offers rigorous frameworks for conceptualizing machine moral agency. Specifically, we aim to create new methods for quantifying Moral Agency in which researchers (1) separately assess the core constructs of moral agency: capacity for moral action, autonomy, interactivity, and adaptability (the MIAA scales), and (2) logically combine the outputs of those scales. We will draw upon experimental psychological approaches for construct measure development and merge them with techniques rooted in mathematical logic and philosophical theory for determining robots' ontological status as moral agents. We will also demonstrate the usefulness of the MIAA scales to assess moral agency of artificial agents and the logical procedures for combining the four constructs measured with the scales in empirical studies.

This is a subaward from George Mason University to Virginia Tech.

EAGER International Type II: Collaborative Research: Reimagining International Research for Students in a Virtual World

Dr. David Knight

Award Amount: **$110,000**

Project Dates: **May 2021 to April 2024**

International research collaborations provide important opportunities to support innovative research and address the significant global challenges facing the world today. To develop U.S. researchers who are both interculturally competent and able to navigate global research networks within their field, it is important to provide international research experiences for students.

Reimagining international research programs for students in a virtual environment will ensure the resilience of future international engagement to sudden changes such as COVID-19 and potentially broaden access to such opportunities. This project will explore the future of international research experiences for STEM students in the post-COVID era. Building on prior research of student experiences and program structures for these programs, we will convene stakeholders to think creatively about how similar experiences can be provided for students in a virtual environment.

To strengthen the international research collaborations of the future, we need to understand the challenges, benefits, and supports necessary to provide international research experiences for students in a virtual environment. Developing virtual programs that maintain the learning outcomes students gain from the traditional format will require intentional design based on the experiences and best practices of the community of educators who have coordinated international research experiences for students previously.

This project will explore the design of international research experiences for STEM students in virtual environments.

Read the full grant summary at bit.ly/InternationalVirtual

EAGER: Collaborative Research: Changing the Paradigm: Developing a Framework for Secondary Analysis of EER Datasets

Dr. Jenni Case

Award Amount: **$252,650**

Project Dates: **March 2021 to Feb. 2024**

To help develop the nation's engineering workforce, the National Science Foundation has invested substantial public funding in engineering education research over the past twenty years. This investment has helped markedly improve courses and programs at many universities by testing and sharing research-based practices that promote active learning, increase student motivation and engagement, diversify the field, and better prepare students for work. At the same time, the investment has typically focused on researchers collecting new data, resulting in hundreds of data sets that remain underexplored.

These existing data sets have significant potential to be analyzed and even combined in new ways to further support large-scale changes in how we recruit, teach, and prepare engineering students for the demands and challenges of the 21st century. Currently, however, engineering education researchers do not have productive and effective ways for sharing and analyzing data beyond the original project. Thus, the full potential of these data sets remains untapped.

This project will address that gap by developing and promoting a viable approach that will enable researchers to leverage the rich data currently available. In doing so, it will simultaneously improve engineering education nationally and increase the return on investment of public funds. The project will bring experienced researchers together with those just beginning their careers to identify the major roadblocks to sharing and re-using data, develop strategies and practices for overcoming those roadblocks, and conduct a series of test cases that demonstrate how to put those strategies and practices into action.

Read the full grant summary at bit.ly/EERDataset

EAGER: Natural Language Processing for Teaching and Research in Engineering Education (NLPTREE)

Dr. Andrew Katz

Award Amount: **$299,647**

Project Dates: **March 2022 to Feb. 2024**

In ecosystems that form professional engineers, community members produce text through many activities such as end-of-semester feedback to instructors, transcripts of instruction, open-ended survey items, and interviews. In each case, there is abundant text available to educators and researchers that could provide insight into how we form engineers. Unfortunately, while these texts have the potential to provide novel insights, traditional analytic techniques do not scale well.

Time investments, bias, interrater reliability, and interrater reliability each present significant challenges. To address this problem, we aim to develop and characterize approaches for human-in-the-loop (HITL) natural language processing (NLP) systems to augment human analysis, facilitating and enhancing the work of one person (or team). Such systems can help reduce the amount of time needed to analyze texts by grouping similar texts together.

The human user can utilize these groupings for further analysis and identify meanings in ways only a human could. The system will also improve consistency by analyzing across the entire collection of texts simultaneously and grouping similar items together. This is in contrast with a single person or a team that would analyze responses sequentially, creating the potential for inconsistencies across time.

We will accomplish this work in three phases. In Phase 1, we will conduct a series of experiments to test potential system configurations. The goal will be to identify optimal components and parameter settings for four of the steps in the proposed pipeline. We will use datasets from (i) students' written responses to an instrument for assessing their systems thinking and (ii) students' responses to open-ended course feedback surveys.

Read the full grant summary at bit.ly/NLPTREE

Energy, Environment, and Future Electric Transportation Systems (E-FETS)

Dr. David Knight

Award Amount: **$360,000**

Project Dates: **March 2019 to Oct. 2024**

Approximately 95% of all land, sea and air vehicles in the world today rely on petroleum to move passengers and freight both locally and internationally. This transportation fuel mix produces ~25% of all greenhouse gas emissions and is projected to grow in the future with modernization of developing countries. International energy agencies note that if transport is to contribute to CO2 reductions to meet the 2 degree C global average temperature target, use of technologies such as hybrid electric and all electric transportation will have to increase in the future.

Thus, advances in transportation technologies are clearly a national and international issue, and require globally-minded engineers and scientists to advance interdisciplinary technologies to develop cleaner regional and global transportation systems. Virginia Tech (VT) proposes to expand upon the Future Electric Transportation Systems (FETS) IRES partnership with the University of Nottingham (UoN), with a broadened scope and stronger engagement with industry and the UK government to establish the Energy, Environment, and Future Electric Transportation Systems (E-FETS) IRES program.

E-FETS cohorts of ~9 per year will investigate next generation electrical power systems for environmentally-friendly fuels and extraction methods; energy-efficient, hybridized power train vehicles and systems; light-weighting of vehicle structures; and the human factors issues that accompany their use and adoption. Among the broader impacts of this IRES program are the promotion of international research collaborations that foster innovative technical leaders capable of creating and effectively integrating electric transportation systems into our society as a means to address efficient energy use.

Read the full grant summary at bit.ly/EFETS

Examining the impact of mechanical objects in students learning of thermodynamics-related engineering problems

Dr. Diana Bairaktarova

Award Amount: **$338,798**

Project Dates: **May 2018 to April 2024**

As technology quickly advances in modern society, it is important that the engineers of tomorrow fully learn the basic concepts of engineering so that they can apply these concepts throughout their careers to a range of new applications. Many engineering courses in college involve teaching abstract concepts that are often difficult for students to understand. For example, "Thermodynamics" is an important course that involves learning about relationships between heat, energy, and mechanical work.

Thermodynamics is known to be a difficult course for many students since some of the concepts in the class, such as heat and energy, are abstract. One method for teaching difficult engineering subjects is to use physical or mechanical objects that a student can touch and manipulate in order to demonstrate important concepts. This project examines new approaches for the use and evaluation of mechanical objects as teaching tools in a thermodynamics course with the idea that results from this work can then be applied to additional engineering courses.

This project examines person-object interactions, a significant and critical aspect of engineering, to examine how these interactions affect comprehension of challenging concepts. The primary question to be addressed in the project is fundamental to engineering education and practice: What is the value of mechanical objects in learning engineering related concepts? This study uses quasi-experiments in a mixed methods design where different mechanical objects are used in several problem-solving activities in Thermodynamics classes.

Read the full grant summary at bit.ly/ThermoEngProb

Faculty Assessment Mental Models in Engineering Education

Drs. Andrew Katz & Holly Matusovich

Award Amount: **$349,157**

Project Dates: **Sept. 2021 to Aug. 2024**

The process of forming engineers is an iterative one that requires feedback to indicate developmental progress and identify areas for improvement. A primary source of feedback comes from assessment, which can play many roles in engineering education: a signal to students of what they do and do not understand about a concept; feedback to instructors about students' conceptual understanding as well as what may or may not be working regarding their own teaching approaches; and information to administrators and prospective employers evaluating students' abilities.

Although assessments function as a linchpin in the formation of engineers, it is unclear how faculty members - i.e., the individuals typically designing and implementing these assessments - think about this pertinent signaling mechanism. Because faculty members often have autonomy in making course decisions, understanding how they think about assessments is essential to establish the foundation on future efforts in promoting diverse and improved assessment approaches in engineering education. To better understand how faculty think about and make decisions on assessment, we have designed a three-phase study that uses interviews, surveys, and natural language processing techniques to gather extensive data from a diverse sample of faculty who will undoubtedly have diverse views on students and assessment.

The outcomes of this study will include characterizing faculty mental models of assessment and how those models inform instructional decisions. In developing these outcomes, we will also identify potential biases, misconceptions, and problematic, systemic patterns in assessment implementation. The knowledge generated through this project will inform better faculty training and policies to advance this vital area in the formation of engineers.

Read the full grant summary at bit.ly/FacultyMentalModel

Growing a Community of Compassionate Higher Education Teachers in Science, Technology, Engineering, & Mathematics (STEM)

Dr. Qin Zhu

Award Amount: **$41,499**

Project Dates: **Feb. 2020 to Jan. 2025**

Our project aims to develop a community of compassionate teachers who are dedicated to bringing a loving mindset into their classrooms. This proposal targets STEM higher education teachers, but we hypothesize that shifts in teacher classroom attitudes and practices will affect student character development.

In the future, insights from this project can be further extended to education in other fields and at different levels, particularly K-12 education. We are interested in exploring the following lines of inquiry: (1) What does a character of love (heart) in the STEM-classroom in higher education mean, and in what ways might it be expressed to be beneficial for students and teachers? (2) How can we grow a character of love in STEM teachers in higher education, and how is this shaped by their beliefs and practice? (3) How can a character of love be nurtured in STEM higher education teachers?

Teaching with a Heart will use workshops and subsequent community building among participants to assist teachers to become aware of their beliefs and attitudes about their teaching roles, to reframe these beliefs and attitudes in a positive way, and to incorporate a character of love into their teaching practice in STEM higher education.

Sponsor: John Templeton Foundation. This will be a subaward from Colorado School of Mines to Virginia Tech.

Institutional Transformation: Cultivating an ethical STEM culture through an integrated undergraduate general education

Dr. Diana Bairaktarova

Award Amount: **$599,282**

Project Dates: **Aug. 2017 to Dec. 2023**

This project will study the implementation and effectiveness of a university wide ethical reasoning curriculum. The project will identify and assess the culture of ethics education that emerges from "Pathways to General Education" at Virginia Tech. The project will do a systematic analysis of institutional transformation. It will focus on the culture of STEM ethics by tracing the implementation of ethical reasoning into a new general education curriculum.

The research will evaluate the transferability of this approach to other institutions. The project will contribute to broadening students' expertise beyond their field of study and to provide competencies that will transfer to the workplace. Summer institutes, webinars, on-line training modules and workshops will be developed for faculty to promote ethical considerations in teaching and doing STEM. The findings of this project will be of interest to faculty members, students, university administrators and businesses.

The project will include multi-pronged evaluations of the efficacy of a new curriculum program at Virginia Tech. It will understand the dynamics of the individual, collective, and institutional processes evident in their implementation; and test the overall utility of the ABCD theory of change as employed in this transformation effort.

There are four categories of anticipated impacts from this project: 1) evaluation for direct improvement in faculty ethics teaching competency, 2) evaluation of students' ethics learning competency, 3) estimation of changes to ethical climate in an R1 STEM focused university, and 4) dissemination of findings and best practices from this project's research to other institutions. The project will collect qualitative and quantitative data through interviews, surveys and participant observation.

Non-Academic Career Paths of Master's and Ph.D. Engineers

Dr. David Knight

Award Amount: **$191,434**

Project Dates: **Sept. 2021 to Aug. 2024**

Most engineering Master's and PhD graduates will enter careers in sectors such as industry and government, yet research and resources focused on graduate education have historically focused on preparation of future faculty members in academia. This project will meet the call for enhancing the professional preparation of engineers by focusing on non-academic career pathways of both Master's and PhD students in engineering.

Advanced engineering degrees are becoming increasingly important in these non-academic sectors for both individual career trajectories as well as for continued competitiveness within the global innovation landscape. The project will identify how graduate programs can better support students for these careers so that they may successfully and quickly make contributions in their new positions. Additionally, both industry and government have emphasized the need to broaden participation in engineering, and this project will pay particular attention to the experiences of how minoritized graduate students may be best supported on their career paths.

The project aligns closely with the goals of the Professional Formation of Engineers funding program "to create and support an innovative and inclusive engineering profession for the 21st century." At its core, the project aims to understand and identify ways to enhance the professional formation of engineers at the graduate level so that they are best prepared to transition successfully into the non-academic workforce.This project will seek to understand: 1) how recent alumni of engineering graduate programs describe being exposed to, preparing for, and making decisions about non-academic careers, and 2) how engineering faculty, staff, and administrators support students to prepare for such careers.

Read the full grant summary at bit.ly/NonAcCareer

Operationalizing, Validating, and Scaling Health Systems Citizenship Assessment in Undergraduate Medical Education

Drs. Jake Grohs & Andrew Katz

Award Amount: **$31,038**

Project Dates: **Aug. 2023 to July 2024**

The purpose of this research is to establish a framework for "health systems citizenship" (HSC) within undergraduate medical education, develop a generalizable multi-scenario objective-structured clinical case-based exam (OSCE) of HSC for third- and fourth-year medical students, and examine the relationships between HSC performance and other measures of medical student academic performance. Relying on a unitary concept of construct validity, three research questions will be addressed: (1) Can the Delphi method and cognitive interviewing be used to define a HSC framework consisting of inter-related measurable constructs? (2) What are the HSC performance classifications and standards for medical students and to what extent is performance related to performance on traditional assessments of academic achievement, including resident and physician written narrative feedback and the quality of student notes? (3) What is the composition of the variance components and to what extent can we generalize Systems Citizenship OSCE scores across scenarios and raters? This project will result in a framework for medical student HSC, a rigorously developed and pilot tested multi-scenario OSCE, knowledge on inter-related constructs that characterize health systems citizens at the medical student level, and a multi-dimensional performance assessment with empirically established performance standards.

RESEARCH: Faculty Assessment Mental Models in Engineering Education (FAME)

Dr. Andrew Katz & Dr. Holly Matusovich

Award Amount: **$411,179**

Project Dates: **Sept. 2021 to Feb. 2025**

The process of forming engineers is an iterative one that requires feedback to indicate developmental progress and identify areas for improvement. A primary source of feedback comes from assessment, which can play many roles in engineering education: a signal to students of what they do and do not understand about a concept; feedback to instructors about students' conceptual understanding as well as what may or may not be working regarding their own teaching approaches; and information to administrators and prospective employers evaluating students' abilities.

Although assessments function as a linchpin in the formation of engineers, it is unclear how faculty members - i.e., the individuals typically designing and implementing these assessments - think about this pertinent signaling mechanism. Because faculty members often have autonomy in making course decisions, understanding how they think about assessments is essential to establish the foundation on future efforts in promoting diverse and improved assessment approaches in engineering education.

The outcomes of this study will include characterizing faculty mental models of assessment and how those models inform instructional decisions. In developing these outcomes, we will also identify potential biases, misconceptions, and problematic, systemic patterns in assessment implementation. The knowledge generated through this project will inform better faculty training and policies to advance this vital area in the formation of engineers.

Read the full grant summary at bit.ly/KatzFAME

Rising Doctoral Institute

Dr. Holly Matusovich

Award Amount: **$370,948**

Project Dates: **Jan. 2021 to Dec. 2025**

Research has shown that underrepresented historically underrepresented racial and ethnic groups (African American, Hispanic American, Native American, and Pacific Island) are finishing the doctorate in engineering in lesser rates than their majority peers. For every seven doctorates in engineering granted to majority students, only one minority will obtain one.

To address this problem, we developed the Rising Doctoral Institute (RDI) which aims to provide a timely and preparatory experience for rising doctoral students in engineering to address issues related to transitioning into the PhD encountered by underrepresented students. However, we understand that a single intervention will not change the landscape for underrepresented PhD students. For this reason, our proposed project aims to develop a research-based intervention model of this preparatory experience and develop a community of practice among institutional partners to develop and adapt this model for local contexts. Integral to the project is an investigation of the dynamics of academic systems and how implementing programs like the RDI can influence systemic change within the institution.

Thus, the goals of the proposed project are to (1) research the effect of early interventions for doctoral students on the transition into the engineering doctorate, and (2) develop sustainable models for institutions to implement on their campus to help underrepresented students? transition into the doctorate.

The intellectual merit of this project lies in the integrated research-to-practice design. Using quantitative and qualitative research methods, we will uncover the factors that lead to a successful transition into the doctorate among underrepresented students as well as strategies for designing context-appropriate local RDIs.

Read the full grant summary & view publications at bit.ly/RisingDocInstitute

S-STEM Organizational Partnerships Research Hub: Inter- and intra-institutional partnerships to support low-income engineering students

Drs. David Knight, Walter Lee, Jacob Grohs & Bevlee Watford

Award Amount: **$2,399,501**

Project Dates: **Jan. 2022 to Dec. 2026**

This S-STEM Research Hub will contribute to the national need for well-educated engineers by supporting the retention and graduation of high-achieving, low-income students with demonstrated financial need. The research hub is a collaboration between Virginia Tech, Northern Virginia Community College, Weber State University, and the University of Cincinnati.

This project will reframe the many challenges associated with these students to be "organizational" challenges as opposed to "student-related" challenges, working on making the complex web of student supports work better for students. This research hub's explicit focus on both first-time-in-college and transfer students ensures that this research will support ongoing efforts to broaden participation in STEM and identify more cost-effective ways for students to earn a bachelor's degree.

The hub will support a series of integrated activities, each designed to engage a diverse set of programs with a core focus on low-income engineering students. This hub will support accelerator grants from the Scholarships in STEM (S-STEM) program community (40 total) focused on understanding the efficacy of their partnership designs, processes, and structures; four cohorts of grant teams will receive structured mentoring from hub leadership.

Read the full grant summary at bit.ly/ENGEResearchHub

Scholarships to Support a Co-Op Based Engineering Education

Dr. Michelle Soledad

Award Amount: **$1,499,808**

Project Dates: **Oct. 2022 to Sept. 2027**

This project will contribute to the national need for well-educated scientists, mathematicians, engineers, and technicians by supporting the retention and graduation of high-achieving, low-income students with demonstrated financial need at Minnesota State University, Mankato.

Over its six-year duration, this project will fund scholarships to 120 unique full-time students who are pursuing Bachelor of Science degrees in engineering. First-semester junior, primarily transfer, students will receive scholarships for one semester.

The Iron Range Engineering (IRE) STEM Scholars Program provides a financially sustainable pathway for students across the nation to graduate with an engineering degree and up to two years of industry experience. Students typically complete their first two years of engineering coursework at community colleges across the country. Students then join IRE and spend one transitional semester gaining training and experience to equip them with the technical, design, and professional skills needed to succeed in the engineering workforce.

During the last two years of their education, IRE students work in industry, earning an engineering intern salary, while being supported in their technical and professional development by professors, learning facilitators, and their own peers. The IRE STEM Scholars project will provide access to a financially responsible engineering degree for low-income students by financially supporting them during the transitional semester, which has two financial challenges: university tuition costs are higher than their previous community college costs, and the semester occurs before they are able to earn an engineering co-op income. In addition, the project will provide personalized mentorship throughout students' pathway to graduation, such as weekly conversations with a mentor.

Read the full grant summary at bit.ly/ScholCoOp

The Computer Science as a Career (CSAC) Scholarship Program

Dr. Sarah Rodriguez

Award Amount: **$408,884**

Project Dates: **Aug. 2022 to July 2027**

This project will contribute to the national need for well-educated scientists, mathematicians, engineers, and technicians by supporting the retention and graduation of high-achieving, low-income students with demonstrated financial need at Texas A&M University (Commerce) and two community colleges in northeast Texas (Collin College and Dallas College).

Over its 5-year duration, this project, the Computer Science as a Career (CSAC) Scholarship Program, will provide 179 scholarships to students who are pursuing degrees in Computer Science. The goal of this project is to increase the recruitment, retention, transfer, and graduation of academically talented students with demonstrated financial needs from diverse sociodemographic backgrounds.

This goal will be accomplished by providing co-curricular activities and programs that recruit students to computing and related fields, increase the rate of transfer from local community colleges to universities, and improve the retention and graduation rates of computing students. This program will contribute to the pool of career ready professionals capable of supporting a globally competitive technical workforce.

The project will encourage students to pursue and complete computing degrees and improve computational thinking skills through many existing high-quality, evidence-based program elements such as summer camps, workshops, and student mentoring programs.

This is a subaward from Texas A&M University – Commerce to Virginia Tech

The Skillful Learning Institute

Dr. Holly Matusovich

Award Amount: **$724,031**

Project Dates: **Feb. 2020 to Jan. 2025**

The Skillful Learning Institute is a virtual short course experience for 25-30 engineering educators to expand the explicit engagement of engineering students in their metacognitive development. Such intentional engagement with students, helping them become more skillful learners, is critically lacking at present. Metacognition is instrumental in being able to independently assess and direct one's learning - a lifelong skill to propel ongoing growth and development. As such, metacognition is important for engineers because it empowers them (i.e., builds their agency and self-efficacy) to handle ambiguity inherent in navigating and solving engineering problems.

The ultimate goal is to enhance the education of engineers through explicit metacognitive training, and the focus is on educators for their enduring and multiplicative impact on current and future engineering students, and, secondary impacts on their colleagues. The experience is designed to build educators' capacities to teach metacognition and to continue to use and develop engaging metacognitive activities. Intentional elements are included to build a sense of community and mutual support where participants are actively engaged with each other and the facilitators. The aim is to enhance the translation of the resulting metacognitive activities into practice and to develop a lasting community of support after the completion of the short course.

This project will create a diverse virtual community of scholars organized around the desire to see metacognition explicitly integrated into existing curriculum. By eliminating the time and cost of travel, this project will enable populations that might otherwise be limited in attendance such as professional-track faculty, teaching focused faculty, community college faculty, adjunct faculty.

Read the full grant summary at bit.ly/SkillfulInstitute

The Use of Mobile Technology & Innovative Pedagogy to Improve Undergraduate Thermal-Fluid Science Learning

Dr. Diana Bairaktarova

Award Amount: **$42,912**

Project Dates: **Sept. 2021 to Aug. 2024**

Student retention remains a problem in science, technology, engineering and mathematics (STEM) programs. This project will utilize mobile technologies and a technology-enhanced curriculum to improve student engagement and learning in STEM undergraduate courses. The technology-enhanced curriculum will be fully integrated in the thermal-fluids course to deliver content and to facilitate student engagement with the content, instructor, and peers.

This research project will measure how mobile technology, when purposefully integrated into engineering teaching, impacts student engagement, enhancement, and extension of learning to real-life problems. Through the full integration of mobile devices, findings from this research will transform the teaching and learning of the thermal-fluid science curriculum. The study will be led by a researcher who is new to the field of engineering education research who will be mentored through research methods by an engineering education researcher.

This aligns with the Research Initiation in Engineering Formation program's goal of initiating new researchers into engineering formation research to meet the needs of a diverse workforce. Undertaking such research project will supplement the lead researcher's experience in developing and implementing mobile learning in the classroom while using social science research approaches to advance both the professional formation of future engineers.

Read the full grant summary at bit.ly/MobileTechPed

Transforming Cultures of Responsible Research through the Development of Ethics Expertise and Self-Efficacy among Faculty through Social Networks

Dr. Qin Zhu

Award Amount: **$699,706**

Project Dates: **Sept. 2023 to Aug. 2028**

Given the serious and wide-ranging implications of STEM (science, technology, engineering, and mathematics) research, it is important that STEM practitioners conduct research in a responsible manner. However, is unclear whether existing approaches to RCR (responsible conduct of research) education (1) help practitioners to identify and address ethical issues in their own research, (2) are relevant to researchers across the disciplinary spectrum, or (3) contribute to the development of more responsible, ethically-attuned research institutions and environments.

To address these issues and foster cultures of responsible research, this project will leverage the disciplinary expertise and social networks of STEM faculty to empower them to engage with ethical issues in their own research fields. It will result in programs that better engage and are more relevant to a broader range of STEM practitioners, thereby helping to ensure that the results of STEM research better serve social interests.

The goal of this project is to transform cultures of responsible research throughout Virginia Tech, developing a research-based model of peer-to-peer RCR education that can ultimately be used beyond the university. The project will also encourage faculty, especially those participating in our intervention programs, to share this model with their networks outside Virginia Tech through cross-institutional research collaborations and academic engagement with industry.

Read the full grant summary at bit.ly/RespRschFacNetworks


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