Research Experience for Teachers (RET)

Engineering for People and the Planet:
Research Experiences for Teaching Integrated STEM

- **Target Audience:** 6-12th grade science, math, engineering or computer science educators in the Central MA area
  (Teachers of color, teachers that serve a large number of students from underrepresented groups, and teachers from WPI practicum placement schools are strongly encouraged to apply)
- **Dates:** July 5 – August 16, 2022; and 6 follow-up sessions during the academic year for continued PD as a cohort *(dates TBD)*
- **Time:** 8 am – 5 pm *(with lunch break)*
- **Format:** In-person lab work during the Summer with weekly PD sessions *(academic year sessions may be virtual)*
- **Stipends:**
  - **In-service educators** = $9,250
    ($8000 paid for full 6-week summer session + $1250 paid following the academic year sessions)
  - **Pre-service educators** = up to $9,750
    ($7000 paid for full 6-week summer session + optional $1500 paid for an extended 1.5 weeks of summer research + $1250 paid following the academic year sessions)
  - **Materials** – In-service educators will also receive $500 for classroom materials that support project
  - **Travel** – Each educator will receive $250 in support of registration or travel to conferences to disseminate their research and/or teaching results from the program
- **PDPs:** 28 professional development points will be awarded at the end of the summer

Description: WPI was awarded a grant by the National Science Foundation (NSF) to offer a Research Experience for Teachers (RET) program for pre- and in-service teachers. The experience focuses on the United Nations Sustainable Development Goals for an integrated approach of learning and doing science, math, and engineering through real-world problems that focus on people and the planet.

Five ***pre-service*** and five ***in-service teachers*** will be paired to do summer research for ***six-weeks*** in a lab with a WPI faculty mentor on topics such as healthy lives, clean energy, and quality education *(see project descriptions on the following pages)*. In addition, the teachers will participate in professional development workshops to translate their research experience into lesson plans and classroom activities, as well as present their work to broader audiences during the academic year.

Expectations:
- Participate in 6 full weeks of research, including weekly PD workshops *(Summer 2022)*
- Create a poster of the research experience for a poster symposium at the end of RET *(Summer 2022)*
- Develop a lesson plan based on research experience and PD workshops *(Summer 2022)*
- Implement, share, modify and submit lesson plan *(2022-23 Academic Year)*
- Participate in cohort activities and PD sessions (6 TBD) *(2022-23 Academic Year)*

Visit our website to **APPLY**.

Timeline:

- Pre-Service teacher applications due 3/4/22; notifications by 3/11/22
- In-Service teacher applications due 3/14/22; notifications by 4/1/22

For questions, contact Kathy Chen, kcchen@wpi.edu

WPI

SUSTAINABLE DEVELOPMENT GOALS

Engineering for People and the Planet: Research Experiences for Teaching Integrated STEM

The Research Experiences for Teachers (RET) in Engineering program at WPI is funded by the National Science Foundation (NSF) and supports **authentic summer research experiences** for K-12 educators to foster long-term collaborations between WPI, school districts, and industry partners. K-12 educators will enhance their scientific disciplinary knowledge in engineering and translate their research experiences into classroom activities and curricula to broaden their students' awareness of and participation in computing and engineering pathways.

The research experiences focus on the United Nations Sustainable Development Goals (UN SDG) for an integrated approach of learning and doing science, math, and engineering through real-world problems that focus on people and the planet. The research projects (associated with an UN SDG goal) and the WPI faculty mentors available for Summer 2022 are listed below.

3 GOOD HEALTH AND WELL-BEING

Ensure healthy lives and promote well-being for all at all ages

Target 3.3: End the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

1. The Impact of Environmental Conditions on Evolution of Drug Resistance in Bacterial Pathogens

Scarlet Shell | WPI (Biology & Biotechnology, Bioinformatics & Computational Biology)

Tuberculosis is a bacterial disease that kills over a million people around the world each year, in part because the bacteria rapidly evolve resistance to antibiotics. Bacteria face a variety of microenvironments during human infection, and these environments affect the evolution of antibiotic resistance in ways that are poorly understood. We will therefore use a related but non-pathogenic bacterial species to test the impact of environmental stressors on development of antibiotic resistance.

Teacher component: *The teacher will carry out experiments in the lab to address the broad question described above. In the process, they will learn state-of-the-art techniques in microbiology and molecular biology. The teacher and PI will also work together to develop a set of related experiments that the teacher can carry out with their students. These will be designed to be feasible with the resources available in a high school setting and to align with the curricular objectives of the target class.*

2. The Development Process of Neurosurgical and Cardiological Medical Devices

Yihao Zheng | WPI (Mechanical & Materials Engineering, Robotics Engineering)

My research focuses on medical and manufacturing innovation. Via transdisciplinary collaborations among medical and engineering subjects, I apply manufacturing science and technology to develop medical devices to tackle cardiovascular disease, create simulation systems for medical training and planning, and analyze clinical procedures to optimize the operational guidelines.

Teacher Component: *The teachers will perform research in developing and testing medical devices for interventional neurosurgery or cardiology. They will communicate with clinical collaborators to understand the unmet clinical needs and design objectives. This research experience will expose the teachers to a medical product development framework, the transdisciplinary collaboration approach, and the synergy between fundamental research and medical application.*

SUSTAINABLE DEVELOPMENT GOALS

4 QUALITY EDUCATION

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Target 4.A: By 2030, build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive, and effective learning environments for all

3. Real-time Brain Sensing for Personalized Learning Environments

Erin Solovey | WPI (Computer Science, Interactive Media & Game Development)

This project explores the use of measurements of brain activity from lightweight brain sensors alongside student log data to understand important mental activities during learning. Bringing together cognitive neuroscience, computer science, and STEM education, the project will build a better understanding of when and how learning occurs during tutoring system use, enabling the creation of adaptive interventions within tutoring systems that are better personalized to the needs of the individual.

Teacher Component: *Teachers will be trained in human-subjects experiment design and execution, including methods for non-invasive, lightweight, portable brain imaging with functional near-infrared spectroscopy. They will be involved with running studies in human subjects. Once data has been collected, teachers will be exposed to machine learning approaches for automatically classifying relevant learner states from brain data.*

4. Developing and Studying Novel Sign Language Technology

Erin Solovey | WPI (Computer Science, Interactive Media & Game Development)

This project takes a human-centered computing approach to build a foundation that advances understanding of how deaf individuals could work and learn in environments that are designed with their needs and preferences at the forefront. Members of the Deaf Community whose first or primary language is American Sign Language (ASL) currently engage with interactive computer tools presented exclusively in English, including those designed expressly for ASL content and educational materials. This project explores the feasibility, challenges and effectiveness of incorporating representations of the linguistic features of ASL vocabulary, such as handshapes, movement patterns, and location (i.e., placement on the signer’s body) into educational technology.

Teacher Component: *Teachers will explore previously developed and novel approaches that will allow users to engage with technological tools through a signed language with no reliance on conventional written language. They will gain an understanding of interdisciplinary human-computer interaction and accessibility research methods, and exposure to American Sign Language. This also may include conducting literature reviews and coordinating studies and interviews with human subjects to advance the research.*

7 AFFORDABLE AND CLEAN ENERGY

Ensure access to affordable, reliable, sustainable and modern energy to all

Target 7.2: By 2030, increase substantially the share of renewable energy in the global energy mix

5. Waste Not, Want Not: Converting Waste to Fuels and Chemicals

Michael T. Timko | WPI (Chemical Engineering, Mechanical & Materials Engineering)

We are studying efficient ways to convert food waste (over 100 million tons a year in the US) into renewable energy, including both renewable natural gas and renewable diesel. Food waste consists of several energy rich components, including carbohydrates, proteins, and especially lipids. Recovering this energy in a usable form is challenging due to the water content of food waste (>50 wt%). The project includes experiments and mathematical modeling on processes to convert food waste, biomass, and sewage sludge to fuels and chemicals.

Teacher Component: *The teacher would either perform reaction experiments in the lab, including product analysis, or run computer codes to predict performance. Specific activities might include synthesizing catalysts using chemical methods and characterizing them using various techniques to measure properties (e.g., surface area, acidity). After each experiment, products are recovered using a protocol involving solvent extraction, filtering, drying, and weighing. There will be opportunities to characterize the product using gas chromatography and spectroscopic methods to shed light on the molecular basis of the mechanism.*

6. New Catalysts for Carbon Dioxide Photo-Reduction Using Modern Computational Methods

N Aaron Deskins | WPI (Chemical Engineering, Chemistry)

This project drawing from Prof. Deskins' research will utilize modern computational methods to understand, characterize, and predict how catalyst materials could enable the carbon dioxide reduction reaction. Just as Google uses state-of-the art computational resources to predict the best search hits, computational methods can be used to predict which materials may be good catalysts for carbon dioxide reduction or how such catalysts work.

Teacher Component: *Teachers will learn to use computational chemistry software to simulate chemical systems and materials using WPI's high-performance computer systems. Primary work will be data generation and analysis, focused on modeling catalyst materials that could be used for CO2 reduction. Teachers will learn how modern computational methods can be applied to scientific research, and also how such tools could be used to clarify abstract, difficult chemistry concepts in their classrooms.*

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Build resilient infrastructure, promote sustainable industrialization and foster innovation

Target 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

7. Spectroscopy for a Smarter, Safer World

Douglas Todd Petkie | WPI (Physics, Electrical & Computer Engineering)

This research will lead to new methods to detect hazardous chemicals that pose direct threats to people in urban and rural settings. Gas phase ammonia (NH_3) is classified as a toxic atmospheric pollutant that arises from agricultural, transportation, and industrial activities. Leveraging advances in photonic integrated circuits and the 5G and 6G millimeter-wave technologies for communications, new spectroscopic sensing platforms are being developed that are inexpensive and deployable in many environments. This project will focus on designing, building, and testing a spectrometer-based sensor for chemical sensing.

Teacher Component: *Teachers will learn the different stages of the development of a sensor, from identifying the need for the sensor, the benefit that it will provide, the physics of detection, to the integration of technologies. Activities have a wide span to match the interest and background of the teacher, from the quantum mechanics of the spectral signature to hands-on building and testing the system, to collecting and analyzing data for specific applications to validation of the sensor performance. As a side project, there will be the complete development of a radar unit that will be able to sense the location and speed of targets by sensing the Doppler shifted frequency. The unit will be comprised of relatively inexpensive components from tech hobbyists companies and the teacher will be able to take it back to the classroom for experiments or interactive demonstrations.*

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Ensure sustainable consumption and production patterns

Target 12.2: By 2030, achieve sustainable management and efficient use of natural resources

8. Synthetic Biology Route to Sustainable Medicine Production

Eric Mosher Young | WPI (Chemical Engineering, Biology & Biotechnology)

Prof. Young's research focuses on applying chemical engineering tenets to designing biology; specifically, rewiring the metabolism of yeasts and fungi to produce interesting molecules. His group uses techniques from metabolic engineering, protein engineering, synthetic biology, and bioinformatics to rewire yeasts faster and more effectively. Ultimately, this work will develop improved, sustainable production methods for fuels, chemicals, materials, and medicines. This impacts the health and energy sectors, but primarily creates sustainable use of resources through engineering biosynthetic processes.

Teacher Component: *Teachers will be trained in DNA cloning, microbial growth, and flow cytometry. They will be involved in creating genetically engineered yeast to produce new proteins and be exposed to analytical techniques to characterize genetic engineering. They will also contribute to developing learning outcomes and curricula for cutting-edge synthetic biology techniques.*