

PROJECT SUMMARY

Overview:

This full research and development project will focus on The Teaching and Learning Strands. It will lower the barriers for science, technology, engineering and math (STEM) disciplines for students through professional development (PD) of middle school science and math teachers by using robotics as the curriculum focus. Offering meaningful and motivating engineering contexts, such as robotics, within science and math courses constitutes a compelling strategy to address the Next Generation Science Standards and the Common Core State Standards for Math while enhancing science and math learning for all students. Using design-based research, with teachers as design partners, the project will create and refine project-based, hands-on curricula such that science and math content inherent in robotics and related engineering design practices are learned. To provide teachers with effective models to capitalize on robotics for elucidating science and math concepts, a design-based PD program will be built on the construct of technological, pedagogical, and content knowledge (TPACK). To ensure that teachers are well prepared, research-based practices and features of effective PD will be adopted. Experts in robotics, engineering, education, curriculum design, and assessment--with experience in K-12 education, training, and outreach--have formed an interdisciplinary team to make robotics central to and sustainable in middle school science and math classrooms.

Over the four year project duration, 44 NYC middle schools teachers will participate in a research-based, year-long, PD program, which includes 120 contact hours during summer and 40 contact hours during the academic year. By synthesizing answers to research questions under four categories (curricula, PD, classroom implementation, and students), the project will investigate the following overarching question: Whether the motivational power and new affordances of robotics can be effectively harnessed to positively influence the learning of science and math in middle school classrooms? The PIs hypothesize that the proposed curriculum and PD models, which apply what the field knows and what they know empirically from their prior work, will (1) build teachers' capacity to effectively utilize robotics to teach middle school science and math and (2) positively impact student learning, beliefs, attitudes, perceptions, and motivation in STEM. The PIs will draw relevant lessons from their prior experience and literature to effectively address issues related to the use of robotics in STEM education, e.g., teacher challenges, gender differences, robot-kit management, and age appropriate, ready to use curricula.

Intellectual Merit :

1. Use design-based research to iteratively develop and refine a generalizable curriculum model that employs robotics as a pedagogical tool to support active, collaborative learning for standards-aligned, middle school physical science and math courses.
2. Design, conduct, and refine a research-based, generalizable PD model to deepen middle school teachers' TPACK, contextualized in and reinforced through robotics design experiences, which will foster skills and attitudes for integrating robotics-based learning in science and math classes.
3. Contribute to our knowledge about how teachers create new representations of science and math content by using their robotics experiences.
4. Evaluate the robotics-based curricula and PD model on teacher practices and student outcomes to validate our hypothesis about the potential of these approaches and measure efficacy.

Broader Impacts :

1. Develop and deploy curricula, human resources, and technical infrastructure in 22 NYC middle schools to enhance the learning of over 2,000 students in science and math through robotics.
2. Provide PD to teachers from primarily urban, inner-city schools, with socially diverse, economically disadvantaged, and underrepresented student bodies, to address the STEM workforce diversity issue.
3. The project's research results will help shape future PD programs that seek to infuse modern tools and techniques of engineering into K-12 science and math teaching.
4. The project's PD and curriculum models and best practices will be widely disseminated for adoption.
5. The project team's past performance and an array of strategies will ensure project sustainability.
6. The project will broaden the education of student researchers.
7. The project will strengthen ties between engineering and education researchers and NYC middle schools.