DR K-12: Teaching STEM with Robotics

Design, Development, and Testing of a Research-based Professional Development Program for Teachers

PI: Prof. Vikram Kapila
Mech. & Aerospace Engineering
Tandon School of Engineering
New York University
Email: vkapila@nyu.edu
Co-PIs: M. Iskander, J. Ma, C. Milne

Award #: 1417769

This project implemented authentic, hands-on, robotics-based STEM lessons to aid middle-school students develop cognitive, collaborative, and conceptual skills, and to enhance interest in STEM-based careers. Teachers implementing robotics-based lessons and activities were provided with effective professional development opportunities to deepen their technological, pedagogical, and content knowledge, and to guide a transition towards successfully implementing the three-dimensional (3D) learning of the Next Generation Science Standards (NGSS).

RESEARCH GOALS

- To study teachers' various pedagogical techniques for presenting robotics-related content and observe their effects on student perceptions and attitudes
- To examine the alignment between the 3D NGSS, 5E instructional model, and robotics-based STEM lessons and factors that can improve it

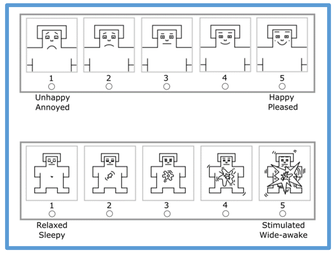
RESEARCH DESIGN

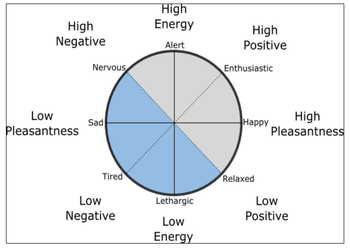
Participants:

- Teachers who participated in three-weeklong summer workshops infused with the model of ***social capital***
  - Received introduction to LEGO Mindstorms EV3 robotics kit hardware and software
  - Afforded opportunities to participate in hands-on programming challenges and lesson tryouts
  - Engaged in examining pedagogically challenging math and science concepts and their representations using robotics
  - Developed robotics-enhanced science and math lessons, collaboratively
- Middle school students from NYC public schools

Data Collection using Mixed Methods Research:

- Qualitative:
  - Classroom observations (field notes, recordings, interviews)
  - Response to questions (Would you like other classes in school to use robots? Why?)
- Quantitative data collection using validated instruments (pre-/post-tests)
  - Self-Assessment Manikin (SAM), Qualitative Question, Test of Science Related Attitude (TOSRA)— Robotics Enjoyment, Evaluating the Quality of Instructional Products (EQuIP) Rubric, 5E Inquiry Lesson Plan (ILP) Rubric





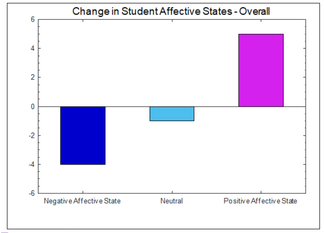
Data Analysis:

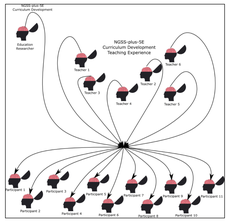
- Transcribed narratives
- Anonymized data using aliases
- Created code book: Systematic Characterization of Inquiry Instruction in Early LearNing Classroom Environments (SCIIENCE)—33 codes
- Utilized two coders for coding and used a dichotomous scale for the presence or absence of each code, cross-verified the results with two experts
- Conducted thematic analysis and content analysis

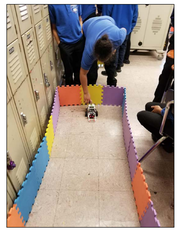
RESULTS and IMPACTS

Results:

- **Perceptions:** Mood of students improved in all the participating classrooms, a majority (58.44%) of students surveyed responded positively
- **Standards-alignment***: Teacher resistance* and *challenges to NGSS-plus-5E implementation* were revealed
  - Difficulty in identifying appropriate performance expectation (PE)
  - Challenging to create lessons with robotics activities that meet the 3D model
  - Rigor and time required to create 5E lessons prohibitive







Impacts:

- Formulated recommendations to improve adoption of robots as educational tools, with a special focus on improving alignment with standards and student perceptions
- Identified a 7-step process for NGSS-plus-5E curriculum development, co-conceptualized and created robotics-enhanced science and math lessons that are being disseminated online
- Developed and validated a three-phase model of professional development that exploits social capital to build trust and create channels for mutual recognition and acknowledgement