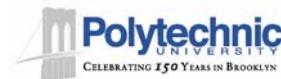


Revitalizing Achievement by using Instrumentation in Science and Engineering



RAISE: A GK-12 Project (URL: raise.poly.edu), Grant# DGE-337668

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PARTNERSHIPS

- Polytechnic University
- George Westinghouse HS
- Marta Valle HS
- Paul Robeson HS
- HS for Technology, Arts, and Telecommunication

INDUSTRY PARTNERS

- American Museum of Natural History
- Con Edison
- FIRST
- Honeybee Robotics
- Symbol Technologies

PEOPLE

- Two engineering faculty and one faculty with extensive experience in secondary education
- 13 RAISE fellows
- Nine high school teachers
- ≈ 400 high school students

COURSES AFFECTED

- Active Physics
- Marine Science
- Regents Living Environment
- Regents Physics
- Math A (Algebra)

OVERVIEW

- 13 RAISE Fellows deployed in four NYC high schools and paired with teachers
- Fellows develop sensor-based lab experiments and demos to illustrate scientific phenomena
- Lab modules are designed so that every member in a group has an active role in the experiment
 - Team members must constantly interact with one another to complete lab assignments
- Experiments demonstrate connections between real-world applications and high school science
 - In some cases, sensor-based experiments illustrate concepts that would be difficult to illustrate in the absence of sensors

OBJECTIVES

- Elevate academic achievement of students in STEM disciplines
- Prepare students to succeed on standardized exams (tutoring)
- Inspire an underserved student population for higher education and productive career opportunities in STEM disciplines
- Provide technology literacy to students and teachers
- Reinforce science and math skills of students
- Provide unique professional development opportunities for NYC teachers
- Build lab infrastructure for sensor-based STEM curriculum and instruction
- Advance discovery and learning through technology-enhanced STEM curriculum and instruction

TRAINING FOR RAISE FELLOWS

- RAISE fellows are provided extensive hands on training in mechatronics using Parallax Inc.'s "STAMPS in Class" educator's program
- Education/pedagogy workshops for RAISE fellows
 - Lesson planning and effective questioning techniques (pedagogical skills)
 - Student behavior and cognition
 - Learning theory and styles
 - Classroom/group management skills
 - Effective communication/presentation skills

DAMPED VIBRATIONS

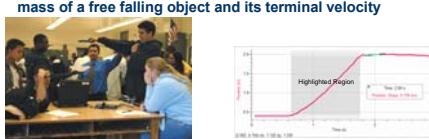
- Damped vibrations occur naturally in numerous natural and engineered systems
- No material is ideal and thus all oscillating systems experience damping
- Accelerometer is used to observe the exponentially decreasing acceleration of a mass-spring system
- After recording the acceleration time history, system parameters (e.g. frequency and damping ratio) are obtained



Students performing the experiment

DRAG

- Object passing through a fluid experiences a resistance (drag)
- At low speeds, drag is proportional to the object's velocity
- Ultrasonic sensor records the position-time history of a free falling coffee filter
- Linear displacement in the highlighted region suggests constant velocity (terminal velocity)
- Increase number of coffee filters to find a correlation between mass of a free falling object and its terminal velocity



Experiment	Description
Conservation of Mechanical Energy	A force sensor is used to measure the buoyant force of an object immersed in a liquid. Knowing the autogenous volume of the object the density of the liquid is determined.
Electromagnet	An ultrasonic sensor is used to measure the position and velocity of a free fall. Using the position and velocity at various locations, the acceleration of the free fall is calculated.
Freefall Acceleration	Using a proximity sensor to measure the position of a falling mass. Knowing the initial position and time of the free fall, the acceleration of the free fall is calculated.
Heat Transfer	Using a temperature probe, the rate of cooling and heating of water is measured. Knowing the mass of the water, the heat transfer coefficient is calculated.
Projectile Motion	Two ultrasonic sensors are used to measure the horizontal component of the initial velocity of an object being rolled off a table. Using this value, the range of the horizontal motion is calculated.
Simple Harmonic Motion	An ultrasonic sensor is used to measure the amplitude and frequency of a mass-spring system. The angular frequency, velocity and acceleration are calculated and the mathematical model of harmonic motion is calculated.
Stability	A force sensor is used to pull a block up until the block tips or slides. The angle of the block when it tips is then mathematically calculated with the sensor measurements.
Static and Kinetic Friction	A force sensor is used to pull a block over a surface until the block begins to move. The coefficient of friction is determined using an ultrasonic sensor that measures the displacement of a block when it begins to roll.

Other Physics Experiments Developed



Experiment on Stability



Students performing Light, Brightness, Distance experiment

IMPACT ON FELLOWS

- Exercised and honed technical and non-technical skills that will undoubtedly play a pivotal role in their careers as scientists and engineers
- Afforded the opportunity to conduct cutting edge research in their disciplines and share results with a non-technical audience
- Sharpened communication and public speaking skills through classroom presentations and demonstrations. Improved ability to describe scientific and engineering concepts in layman's terms has been the greatest benefit to the Fellows
- Improved management skills as a result of managing a classroom full of teenagers
- Emergence of new leadership skills since most high school students admire the Fellows and consider them role models
- Networking with professionals and other students by presenting conference papers and by organizing and attending professional events
- Exposure to and sensitization toward the community for which they will develop products/services and make technical/business decisions in their professional careers

IMPACT ON HIGH SCHOOL TEACHERS

- Professional development and expansion of technological literacy
- Acquired the ability to integrate sensor-based demonstrations in classroom lessons and modernize labs with hands-on experiments

IMPACT ON HIGH SCHOOL STUDENTS

- Students see the sensor-based labs and the presence of Fellows as the areas expected to yield the greatest educational value
- Students are receptive and appreciative of the new sensor-based activities in their classrooms and have reported that the lab component is their favorite and most helpful aspect of the science course
- Many students have expressed interest in continuing their education in STEM disciplines
- Benefits due to the RAISE Fellows include
 - helping to explain science concepts
 - providing useful lab exercises
 - presenting positive role models for their students
 - helping to improve lab attendance
 - engaging students' attention
 - providing information on what is involved in working in science/engineering professions

QUOTES FROM HIGH SCHOOL STUDENTS

- "I like having them here because they help me understand the material. The sensor labs make things more interesting and understandable."
- "Our fellows are great help for our class. They help us out whenever we need it. The sensor labs are fun too. Good technology."
- "I think the guys from Poly are great. They help us one by one. The sensor labs are better because we experience better skills like working together."
- "The sensor labs are very knowledgeable. We get to test things and calculate stuff we ordinarily wouldn't do."

PUBLICATIONS

M. Walia, E. Yu, V. Kapila, M. Iskander, and N. Kriftcher, "Using Real-Time Sensors in High School Living Environment Labs: A GK-12 Project," *Proc. Amer. Soc. Eng. Ed.*, Chicago, IL, June 2006, to appear.

S. Sobhan, N. Yakubov, V. Kapila, M. Iskander, and N. Kriftcher, "Modern Sensing and Computerized Data Acquisition Technology in High School Physics Labs," *International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering*, E-Conference, December 2005.

M. Walia, E. Yu, M. Iskander, V. Kapila, and N. Kriftcher, "The Modern Science Lab: Integrating Technology into the Classroom is the Solution," *International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering*, E-Conference, December 2005.

N. Yakubov, S. Sobhan, M. Iskander, V. Kapila, N. Kriftcher, and A. Kadashev, "Integration of Real-Time Sensor Based Experiments in High School Science Labs: A GK-12 Project," *Proc. Amer. Soc. Eng. Ed.*, Session 1510, Portland, OR, June 2005.