SOCIETY OF PHYSICS STUDENTS
An organization of the American Institute of Physics

Marsh W. White Award Proposal

Project Proposal Title	Reinventing a bicycle: discovering physics via a common object well known to every kid
Name of School	Cleveland State University
SPS Chapter Number	1247
Total Amount Requested	$300.00

Abstract

SPS chapter of Cleveland State University proposes to continue their outreach program to the afterschool care of the Campus International School (Cleveland K-6 public school) by unifying monthly outreach lessons with a common object that is easily accessible to elementary/middles school kids – a bicycle. The goal of this project is to motivate students using bicycle-related demos that spark their interest in discovering how things work and develop their physics intuition by interactive hands-on activities adjusted to appropriate student level.

Proposal Statement

Overview of Proposed Project/Activity/Event

The outreach program will be based on exploring the physics of a bike and will consist of six content modules centered on a bicycle: 1) Center of Mass and Stability; 2) Wheel Rotation; 3) Driving Forces (Friction and Gravity); 4) Simple Machines and Gears; 5) Energy and Conservation of Energy; 6) Speed and Distance Measurement with a bike.

Each module will be delivered via interactive inquiry based 1.5-2 hour lesson to kids in the afterschool care of Campus International School (CIS) by members of SPS chapter of CSU. CIS is a K-6 public school in Cleveland Municipal School District where CSU's SPS has been conducting outreach since Spring 2011. The afterschool care program at CIS, run by YMCA, has grown recently to 60-70 students covering the wide range of ages from kindergarten to 6th grade. This age range has recently presented our SPS outreach team with an issue of finding a balance for the outreach program to be of interest both to youngest and oldest kids.

The goal of this year's project is to separate kids into at least two age categories (K-3 grade and 4-6 grade) and bring the excitement of physics and science to kids of various ages via different age appropriate activities unified by a common theme that any of the kids can easily relate to – a bicycle.

The common theme, a bicycle, should allow not only to gel the outreach activities designed for various ages together but also serve as an inspiration for kids to discover that an object (bike) common to school children of all ages contains endless layers of curiosity and complexity, than can be revised again and again from grade to grade.

How Proposed Activity Promotes Interest in Physics

The proposed outreach program would expand on our successes of the previous Marsh White award sponsored outreach at K-6 Cleveland public school. The new award would allow to diversify our outreach effort between K-3 grade and 4-6th grade kids while giving all kids another reason to be excited about physics – via focusing outreach on a common object that is easily accessible (and often owed by) all of the kids. The commonality of the focal point of the proposal (a bike) should allow kids to extend their excitement about physics from the "outreach classroom" to their everyday life. The outreach would also allow SPS/outreach team members to try out physics teaching for themselves helping them to deepen their understanding of physics and heighten their own sense of excitement about it.

Plan for Carrying Out Proposed Project/Activity/Event

- Key Personnel – Christian Gunder, CSU CME major/physics minor, SPS outreach coordinator; Janna Mino, physics major, SPS vice president; Grace Gaeckle, CE major, SPS secretary; Marie Blatnik, physics major, SPS outreach veteran (since 2012) (all SPS National members)
- Marketing – Afterschool staff will be notified of events two weeks prior to the event. The staff will communicate the event to parents who can plan to pick up their children later on Physics Days.
- SPS member participation – in addition to key personnel 5-10 other students, physics majors/minors, engineers will participate. Many are national SPS members as our chapter rewards a semester long outreach with paid SPS membership.
- Expertise –
  The current outreach team includes several members of the "original" outreach team from 2011:

- Dr. Kiril Streletzky, advisor to CSU SPS, SPS National Zone Counselor, and CIS Dad
- Krista Freeman, 2011 CSU Physics Graduate, PhD student at Carnegie Mellon University, Outreach Program co-Founder
- Jim Pitchford, 2011 CSU Physics Graduate, science blogger, past Outreach Coordinator

Their experience and familiarity with the after-school students, the after-school program at CIS, and CIS administration are essential for planning smooth lessons.

Project/Activity/Event Timeline

Six bike-based modules have been developed for the proposed Recreating The Bicylce outreach series. These modules would take place once a month at CIS, starting in January and ending in June. Each 2 hour event takes place with students in the after-school program at CIS. For each module, we plan engaging demonstrations and hands-on activities to teach physics concepts related to bicycles and how they work. Most importnatly we plan to inspire student interest in physics/science by engaging them in hands-on exploration of how an object so important in their lives works.

Please see the "Simple Machines and Gears" lesson plan below for a representative sample module.

Simple Machines and Gears.

Demonstrations:

Making simple Machines work for us:

- How can we be stronger?
  - Level arm, door nob/hinges, household items with level arm, model of arm, a leg with a thighbone
  - system of pulleys (lifting heavy objects)
  - catapult demo
- How can we be faster?
  - The role of chain and drives in a bicycle
  - Gears and systems of gears. The benefits of gears
  - Clocks, bikes, typewriters, etc
- How can we slow down?
  - Brakes on a bike
  - Coaster brakes and Caliper brakes

Activities:

- Challenge students to lift objects of various mass using Atwood Machine and least possible applied force
- Level a wooden stick on a system of pulleys. Compare forces applied to different parts of the stick
- Equilibrating popsicle stick on a force table. Finding translational and rotational equilibrium
- Understanding role of gear ratio by using various ratios on various bikes. Comparing different bicycle gears

Outcomes:

Students will learn basics of simple machines and how they help us every day

Activity Evaluation Plan

The set of six modules of bike related outreach activities will be carefully documented via: a) lesson plans created by the entire outreach team; b) photo-reports with multiple pictures from rehearsals at CSU and activities at CIS; c) short video for each module to help dissemination of the lesson plans in the future; d) recorded number of kids and their grade for each activity. Kids (in older grades 3-6) will also be asked to reflect on outreach activities. Outreach team participants will be asked to complete two quick surveys to estimate the impact of the activities on SPS/outreach members.

Budget Justification

The SPS outreach team has a vast variety of demos for the planned activities thanks to the previous Marsh W. White awards and a close collaboration with the Physics Department at CSU. Available equipment includes turn tables, various bike gears, several bike wheels and tires, and a multitude of demos on simple machines, rotation, center of mass, friction force, and types of energy and work. Also, Campus International School has three donated bikes that they are willing to allow our outreach team to use. We request funds for a Mechanic Bicycle Repair Stand, Complete Bicycle Repair tool kit, and Cyclocomputer to allow a successful implementation of this project.