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

Marsh White Award Report

Project Proposal Title	Engaging High Schoolers in Electromagnetism
Name of School	Stony Brook University
SPS Chapter Number	#6786
Project Lead (name then email address)	Christopher Siebor, christopher.siebor@stonybrook.edu
Total Amount Received from SPS	$498.22
Total Amount Expended from SPS	$500.00

Summary of Award Activities

Stony Brook University's SPS chapter organized a two-day hands-on electromagnetism lab activity in which local high school students were given specially designed kits and guidance to build their own motor, generator, and AM receiver. As students built these devices, SPS members delivered lectures on the underlying physical principles and provided individualized assistance. We also arranged a trip for high school students to see real physics la Brook University and take part in physics of sports lab activities.

Statement of Activity

Overview of Award Activity

Members of the Stony Brook SPS general body and executive board collaborated with Longwood High to organize a two-day physics outreach event, consisting of a two-part instructional lab activity and a tour of Stony Brook University's Physics Department. Our primary aim was to engage students with limited extracurricular physi opportunities and expose them to physics outside the classroom to develop their interest in STEM fields and encourage them to pursue physics-related fields in their collegiate studies.

For the first day of the lab, students were provided with kits and detailed instructions to construct their functional motors and hand-crank generators. These hands-on activities demonstrated the fundamental principles of electromagnetism and conversion between mechanical and electrical energy. Additionally, a Gauss gun demons was conducted to show how magnetic potential energy can be used to propel a ball bearing at high velocity. I second day, students were led through the process of constructing their own AM radio receivers using comprehensiv circuit kits designed and assembled by SPS chapter executive board member Will Daniels. This activity emph importance of the physical phenomena that underlie everyday electronics. Lab activities were run by SPS club members, who guided students through the construction process and complemented the hands-on component with age-appropriate prepared mini-lectures about the relevant scientific principles. On the first day, mini-lectures were delivered about DC motors, electromagnetic induction, and Lenz's law; the second day covered AM broadcas resonance circuits, diodes, low-pass filtering, op-amp basics, and sound generation with the piezoelectric effect.

Besides the lab kits, we also organized a trip to Stony Brook University for students to see large-scale physics and understand the college experience. This included a visit inside a retired Van de Graaff accelerator, a phy sports lab activity, and a tour of the university's campus to demystify the undergraduate experience by answering students' inquiries and reassuring them about their worries. The trip concluded with the first day of our lab kits conducted in a college instructional lab, with which students each built their own motor and generator to take home. Students were particularly excited about the physics of sports lab activities, which involved using sensors suc photodetectors and force meters to calculate athletic metrics such as jump height or ball speed. This opened students' eyes to the physics behind familiar physical activities. In the execution of this trip, we were supporte Technical Staff Richard Lefferts, who facilitated access to the instructional labs and the Van de Graaff genera shared captivating historical information about the generator and the physics facilities to ease students in.

This project took physics outside the classroom and related it to familiar parts of everyday life, showing innumerable possibilities that physics offers and demonstrating its practical applications. Building their own de allowed students to personally experience how physics underlies all aspects of their lives, which was an eye-opening experience for many.

Impact Assessment: How the Project/Activity/Event Promoted Interest in Physics

Our project aimed to promote interest in and understanding of electromagnetism among high school st through a unique hands-on activity. More specifically, our goals were to have an event that is both informative, teaching students the ubiquity of physics and the specific scientific principles that underlie everyday electronics, a fun, keeping students engaged with an achievable hands-on building project and fascinating them with the wonderful devices that can be made with an understanding of electromagnetism. Towards the end of promoting interest in physics more generally, our event also included a tour of a retired Van de Graaff accelerator and a physics of activity.

Through feedback that SPS volunteers heard from students during and immediately after the lab activities, it is evident that we successfully generated interest in physics among the participants. Students were engaged and enthusiastic throughout the event. They each eagerly participated in the hands-on building activities, showed curiosity in understanding how the devices they built worked, and even responded to our Socratic questions during the mini-lectures. We attribute this to the hands-on nature of the project, which gave students independence in approaching problems while also being steered in the right direction by our SPS volunteers. In particular, students were very excited about our physics of sports lab, which incorporated fun physical activities and described how comprehension of physics leads to a deeper understanding of athletics. Students were also entertained by the Gauss gun demonstration and enjoyed theorizing how it worked and attempting different configurations of magnets to make it work themselves.

We also aimed to design lab builds that were both enjoyable and within the reach of high school students. The lab kits were made enjoyable by including a tangible output that students could be proud of and celebrate when their peers achieved. Each output relied on the scientific principles covered in our mini-lectures. Successful completion of the motor led to a wire coil spinning seemingly of its own accord; a working motor led to an LED lighting up; and, a working radio receiver allowed students to listen to our AM radio transmitter broadcasting Rick Astley's "*Never Gonna Give You Up*" through their piezoelectric speakers. Positive feedback from students indicated that they certainly found the kits enjoyable.

However, we had more difficulty in making the lab sufficiently accessible for the high school students. S
lab techniques, such as coiling copper wire for their motor shaft/rotors and their radio receiver inductors, were
difficult for students to master. We had to resort to coiling and bending the copper wire ourselves for some stu
to help students lagging behind and keep everyone at the same pace. We also generally had to steer students m
we had hoped, as they had no prior experience in building their own devices. For the more difficult steps, we
complete the steps on our demonstration kit in view of everyone for them to understand how to continue.
Happily, according to student feedback, the assistance we provided did not diminish their sense of accomplis
building their own devices.

Another minor shortfall in our goals was the AM radio receiver. We originally intended for students to build a
tunable radio receiver powerful enough to pick up transmissions from AM radio stations, as a commercial rad
receiver can. However, after significant development and troubleshooting, we were unable to get our breadboard-based receiver design to be sufficiently powerful and tunable. We adapted by purchasing our own FCC-compliant AM radio transmitter, which we set to play a familiar song and tuned to reach the resonant frequen
students' coarsely tunable receivers. While this was not our original goal, it still successfully contributed to the ov
goal of promoting interest in the electromagnetic principles of radios.

In the future, if we repeat a similar project, we hope to improve in planning and logistics and to have a
event attendance. We originally planned to have three days of lab activities, but had to reduce this to two day
combining the motor and generator into a single day due to scheduling difficulties with Longwood High School.
This reduced the time we could allocate to our mini-lectures, and we were thus unable to cover as much content as
had planned. We also originally hoped to have 20–30 students at our events but ended up with 10 students. The
attendance shortfall was also due to logistical difficulties, as we only had students from a single one of the hig
physics classes. However, the small group size facilitated more personal interaction, allowing us to
engage with each student personally, address their individual questions, and keep everyone involved. These
were primarily due to communication difficulties with the high school, which can be reasonably expected when first
working with a new institution. Now that we have established firm relationships with several Longwood educa
and a vice principal, we expect any future scheduling to be far smoother. If this project is continued next year
expand the audience to interested students from all physics courses at the school.

Our original assessment plan was to work and discuss with students during the event, review how each day went with the educator chaperoning students, and provide exit surveys to students. However, because there were only 10 students and we had enough volunteers to hear from each one, we forwent the exit survey and had our volunteers personally ask each student for feedback. With the feedback from the students, we determined that students found certain lab steps difficult and a few students were disappointed that they weren't able to get their devices to work, but overall students were excited at seeing themselves or their peers spin a wire, illuminate an LED, or pick up wireless transmissions with something they built themselves. Students also indicated their especial enthusiasm for the physics of sports lab and the Gauss gun demonstration. Our discussions with educators provided a professional perspective of how engaged students were with our mini-lectures. They also provided suggestions to keep students actively interested and learning. In particular, they suggested that we further simplify some of the content, intersperse the mini-lectures throughout the building process, and introduce and familiarize ourselves with the students at the beginning of the activity to make them more comfortable asking questions. These suggestions were all adopted for our second day, building the radio receivers.

Overall, despite some shortfalls in logistics, attendance, and difficulty level, our project successfully promoted interest in physics by keeping students thoroughly engaged and enthusiastic about the physical phenomena behind everyday electronic devices.

Key Metrics and Reflection

Who was the target audience of your proj	Longwood High School students
How many attendees/participants were directly impacted by your project?	10 high school juniors and seniors currently taking a physic
How many students from your SPS chapt were involved in the activity, and in what capacity?	7 undergraduate students were involved in designing and b the lab kits, leading the tours, running lab activities, and teachin mini-lectures
Was the amount of money you received f SPS sufficient to carry out the activities outlined in your proposal?	The money received from SPS was sufficient to purchase components of the lab kits. However, the radios were not se enough to pick up AM radio stations, so we had to purchase FCC-compliant AM radio transmitter with petty funds.
Do you anticipate repeating this project/activity/event in the future, or havi a follow-up project/activity/event? If yes, please describe.	In light of the success of this project, we anticipate repeating the same lab activities and reusing some components with anothe group of high school students in the future. We will use t connections we have established with Longwood educato organize lab events for interested students from any of the physics courses. We successfully designed kits that are complicated enough to mimic everyday electronic devices ye enough to be constructed by high school students, and we share them with more students.
What new relationships did you build thro this project?	The project established a firm connection between our chapte Longwood High School. Several educators from the schoo stated their desire to work with us again next year.
If you were to do your project again, what would you do differently?	Primarily, we would extend this project to students in more phy classes. We would also discuss our lab manuals and lesson high school educators *before* the lab activities. In terms of logisti

	we would put more effort into coordinating dates with the h school such that we could spread the lab activities across three days instead of two, giving us more time for providing understandable mini-lectures. With the benefit of this experience, we will better tailor our mini-lectures to be completely accessible to high school students.

Expenditures

Expenditure Table

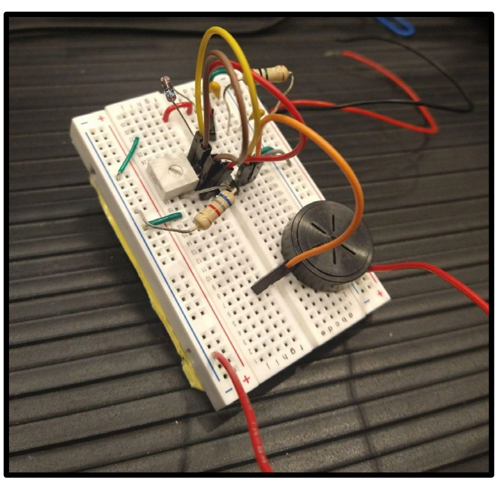
Item	Please explain how this expense relates to you project as outlined in your proposal.	Cost
1 x 16pc 400 Tie Breadboard	Radio lab kit component	$19.99
2 x 120pc 10cm Jumper Wires	Radio lab kit component	$13.96
16 x 1N34A Germanium Diode	Radio lab kit component	$31.20
16 x 1/4" 1MΩ 500mW Potentiometer	Radio lab kit component	$5.62
20 x 0.001µF Ceramic Capacitor	Radio lab kit component	$2.70
20 x 1MΩ 1W Resistor	Radio lab kit component	$5.20
16 x TLC271 8-pin Op Amp	Radio lab kit component	$11.38
20 x 6.8 kΩ 1W Resistor	Radio lab kit component	$2.70
16 x 3/8" Square Cermet Potentiometer	Radio lab kit component	$6.12
16 x Piezo Speaker 3V 80dB 400Hz 14mA	Radio lab kit component	$18.40
1 x 24pc AAA Battery	Radio lab kit component	$30.99
20 x 0.15µF Monolithic Radial Capacitor	Radio lab kit component	$3.80
1 x Digital Multimeter	Radio lab equipment	$17.95
1 x AM Radio Transmitter ST1009	Radio lab equipment	$39.99
1 x 4oz Wood Glue	Demo component	$2.48
1 x 25pc 1/2" Steel Bearing Balls	Demo component	$9.16
4 x 3/7" x 36" Oak Dowel	Demo component	$8.96
10 x 1/2"x1/2" Neodymium Disc Magnet	Demo component	$14.90
1 x 100pc LED Diode Assortment	Motor/generator lab kit component	$7.99
2 x 18pc DC Motor + Rotor	Motor/generator lab kit component	$59.98
1 x 8pc C Cell Battery	Motor/generator lab kit component	$11.84
1 x 24pc C Cell Battery	Motor/generator lab kit component	$19.93
1 x 0.94" x 60yd Masking Tape	Motor/generator lab kit component	$3.49
1 x 100pc 1/4"x1/16" Nd Disc Magnet	Motor/generator lab kit component	$21.99
3 x 20pc 21.5" Alligator Clips	Motor/generator lab kit component	$17.97
1 x 200pc 2" Paper Clips	Motor/generator lab kit component	$6.99

2 x 507' 22AWG Enameled Copper Wire	Motor/ generator lab kit component	$39.88
1 x 25pc 6mmx2mm Nd Disc Magnet	Motor/ generator lab kit component	$4.99
1 x 25pc 220 Grit 5.5"x9" Sandpaper	Motor/ generator lab kit component	$8.99
1 x 328' 2mm Twine	Motor/ generator lab kit component	$4.99
1 x 48pc 16oz Deli Containers w/ Lids	Motor/ generator lab kit component	$17.50
Total fees: Tax + Shipping + Discounts		$49.77
	Total Expenses	$521.79

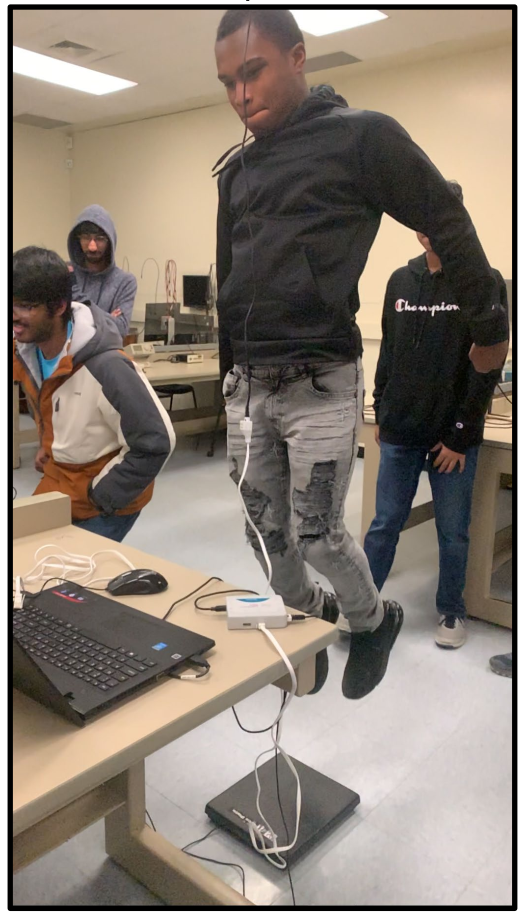
Activity Photos

Richard Lefferts (tech. staff) shows students the Van de Graaff accelerator.

High school students and SPS members celebrate after building generators and motors.



An almost-complete radio receiver.



A student uses a force sensor to measure his jum height in our physics of sports lab.

SPS delivers mini-lectures during the radio receiver lab.

SPS