SOCIETY OF PHYSICS STUDENTS
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Marsh White Award Report

Project Proposal Title	Lunchtime Physics Club for True Inquirers
Name of School	Cleveland State University
SPS Chapter Number	1247
Project Lead (name then email address)	Samantha Tietjen (stietjen.2015@gmail.com) Jim Pitchford (j.e.pitchford@gmail.com)
Total Amount Received from SPS	$250.00 out of granted $500.00
Total Amount Expended from SPS	*$621.12

*See "Expenditures" section for explanation

Summary of Award Activities

Cleveland State University's SPS chapter partnered with Campus International School (CIS), a K-8 school located in downtown Cleveland, to develop a set of lessons to be used as both in-school, lunchtime interactive lessons and with its after school program. These lessons were based around CIS's Programme of Inquiry, "How the World Works," an exploration-based STEM program for K-5 students.

Statement of Activity

Overview of Award Activity

For this year, Cleveland State University's chapter of SPS sought to adapt our well-loved "Physics Friday" afterschool program into a monthly in-school science club for the students at Campus International School (CIS), a public K-8 school located in downtown Cleveland. This program was designed to go along with the school's Programme of Inquiry, a K-5 educational structure focusing on globally-minded, investigation based lessons and learning. The program features tiered topics (by grade level) through which students progress, and has lessons for every core subject. The science portion of the Programme, "How the World Works," spans a wide variety of topics, including how an object's properties effect its behavior, mechanics, states of matter, environmental sciences, and optics. The lessons were designed so as to be possible for both the in-school an afterschool programs.

These outreach lessons were delivered over the course of three afterschool visits, and one in-school visit: occurring after school on March 23, April 20 and May 11, and in-school on May 18. These lessons were designed and delivered as closely to the progression of the Programme of Inquiry as possible; in order, the lessons were Center of Mass/Intro to Simple Machines, Density/Phase Changes, and Light/Optics. These three lessons were done with the afterschool program due to scheduling conflicts for the in-school club. Done in our standard outreach format, four stations included hands-on activities relating to the days topic. Unlike previous outreach "sessions", since these lessons didn't build on each other over the course of the semester, each station had a very basic demo and activities that built up in complexity. This played out well for student interaction in that the aftercare program caters to a large range of ages, so where younger students could focus mostly on the basic activities, older students were often asked to build on what they had already learned from the Programme and apply it to the more advanced activities.

The first visit featured lessons on density and Newtonian forces as demonstrated by simple machines. Highlights for students on this visit included the aquarium, which was purchased to allow for simple density demos that could easily be seen by groups of students. Here students were presented with objects of varying densities and allowed to investigate how they'd behave in water (Sink or float? Why?). Two separate stations focused on simple machines, on the small scale where students were given parts and allowed to construct their own machines to test, and another with large simple machines, including the pulley system (Can students lift heavy objects? Is it easier with or without the pulley?) and the lever system (How can one student lift a full-grown adult?). This lesson was designed largely around the K-2 tiers of the Programme, but stations such as the small simple machines were a favorite amongst the older kids, as it allowed them to create their own setups and test their own ideas.

The second visit focused on the tiers on the 3-4 grade tiers, and since it involved repeat concepts from a somewhat recent lesson, these activities allowed for the students to demonstrate what they had previously learned and then build up these concepts. Dry ice was a big hit, allowing students to learn not only about the standard phase changes, but also concepts like sublimation. These changes were compared to that of normal (wet) ice, as well as investigating the mystery of the "instant freezing water bottle". The vacuum chamber was an excellent addition to our catalogue of demos, especially after becoming one of the favorite demos during our 2017 Astronaut Day event with NASA. Items used in the chamber included "boiling" soda, marshmallows/balloons, and dry ice, where students were prompted to decide which were and weren't examples of phase change, and why. This visit included a take home gift, where students got to make their own shrinky dinks.

The last afterschool visit was all about optics and light, for the 5th grade tier. The previous Physics Fridays theme involved waves as they relate to sound, so this lesson was a smooth transition from that. Students were asked to recall what they knew about waves, and then asked if they knew how this related to light. Th demos for this visit included stations such as dispersion of light (including prisms, diffraction gratings), geometrical optics (with white board lenses, mirrors, and a laser box; How do eyes work?), light and energy (What are photons? How does glow in the dark work? What is "solid energy"?), and reflection/refraction (How do fiber optics work? What is an endoscope?). Students stated that this was by far one of their favorite visits, as getting to use lasers was a big deal for all of them.

One topic that we weren't initially sure how to incorporate into our lessons was environmental science and biological process. The answer came to us in the form of the Foldscopes, a high-powered paper microscope that is assembled origami-style and able to view things very clearly on the scale of nanometers. After being walked through the process of building them and seeing all the possibilities that they now had, the students were thrilled to be able to take one home with them. During the lesson, students once again got to play with the laser box and lenses, compare a foldscope to a standard microscope, and build one of the foldscopes. Students were also shown some of the attachments that can go with the scopes, including a projector and a camera mount for a phone or tablet. We chose to do this for the in-class visit since we could work closely with small groups of students to make the Foldscopes there and speak about microscopy. This was a perfect close to our Outreach program for the semester.

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

The goal this time around was to expand our audience from just the afterschool program by starting an in-school science club for students. The format of the lessons remined founded on the concept of inquiry-based discovery and the development of a scientific intuition. While we had hoped to get to more in-school visits this time around, there were several issues with scheduling that kept us from going as often as we'd like, due to security measures and other pre-planned school day programs. Still, now that program has made its initial push within the school, several other teachers have reached out to us to start scheduling similar lessons for next year.

It was clear that our in-school visit made a great impact on the students who do not regularly, or ever, get to attend the Physics Fridays events. Many asking if we really did this all the time and if we'd be able to come back and do it again. This bodes well for the program, and hopefully after several classroom visits we will be able to transfer it to a full on science club like originally intended!

Key Metrics and Reflection

Who was the target audience of your project?	The K-5 students of CIS
How many attendees/participants were directly impacted by your project? Please describe them (for example "50 third grade students" or "25 families").	For the afterschool program, 15 – 35 students ages K-7; number fluctuated based on day and time. For the in school program, 24 fourth grade students.
How many students from your SPS chapter were involved in the activity, and in what capacity?	One CSU student and one alumni planned and scheduled the visit to CIS about a week in advance with the aid of Dr. Streletzky. Four to six SPS members and Dr. Streletzky (with the occasional CSU alumni) were involved in specific lesson

	planning, rehearsing, and delivery of the outreach event.
Was the amount of money you received from SPS sufficient to carry out the activities outlined in your proposal? Could you have used additional funding? If yes, how much would you have liked and how would the additional funding have augmented your activity?	The amount awarded was sufficient for the project as proposed, some changes in pricing allowed for some extra funds to be left, which was put towards the purchase of the foldscopes for the in school lesson. If any additional funding were to have been granted, it likely would be used for purchasing more foldscopes as well as some of the various kits/accessories that go along with them as these kits lend for very strong hands-on activities while encouraging kids to investigate the environment around them with "pocket microscopy".
Do you anticipate repeating this project/activity/event in the future, or having a follow-up project/activity/event? If yes, please describe.	Yes, this year allowed for the first "dry run" of the in-school program. Now that the first lesson has been completed, several other teachers in the school have already asked to plan a similar sort of program for their classrooms. This will likely be done in conjunction with CSU's already established "Physics Fridays" afterschool program.
What new relationships did you build through this project?	Doing lessons in-school allowed for the Outreach team to interact with kids who would not usually get to participate in the program during the regular afterschool time. Also, the program has now raised the interest of several of the school's teachers, allowing for an even broader impact within CIS.
If you were to do your project again, what would you do differently?	We would like to do more in-school lessons next year; hopefully as consistantly as the afterschool program is done. Now that the initial contact has been made for this project, this should be much easier to accomplish.

Press Coverage (if applicable)

N/A

Expenditures

While out SPS Outreach team has a rather vast array of demos now to pick from, many of these are directly physics related. The Programme of Inquiry as designed by CIS expands across many disciplines of science, and thus we needed to start developing demos that would cater to these needs. Purchasing some of the "big ticket" items, such as the vacuum chamber and the foldscopes, will allow us to starting creating demos that will expand beyond just the physics discipline.

Expenditure Table

Item	Please explain how this expense relates to your project as outlined in your proposal.	Cost
Cooler	Used to transport the dry ice safely	$20.38
Aquarium/ Golf Balls/Ping-Pong Balls	Basic density demo	$25.98
*Foldscopes	In-class visit demo and take-home gift for students	$149.44
LaserClassroom Optics Outreach Kit	Built onto our optical demos, and expanded on the wave demos from the previous Marsh White award	$199.00
Vacuum Chamber	Was the favorite of the NASA demos, purchased as the basis of a new demo set, will vastly expand our demos for future visits	$174.75
Vacuum Chamber Pump		$51.75
Total of Expenses (w/o Foldscopes)		$471.68
***Total of Expenses (w/ Foldscopes)**		$621.12

*We decided to purchase the foldscopes after attending the Kavli Foundation Symposium at APS March Meeting 2018 and hearing the talk given by Dr. Manu Prakash of Stanford, which featured the devices heavily. Being underbudget due to price changes in items since the time of the initial proposal, we were able to use the remaining Marsh White funds in conjucntion with some internal SPS funding to get the scopes.

Activity Photos

Highlights from the Density and Simple Machines visit. Students investigate the density of things such as peeled and unpeeled oranges, diet versus normal soda, and tin foil boats (**TOP LEFT**). Students learn about balancing forces using the pendulum and the swinging balance (**TOP RIGHT**)**.** Students help the CSU Outreach team build and test simple machines (**BOTTOM**).

A student lifts part of CSU's Outreach team using a large-scale lever system.

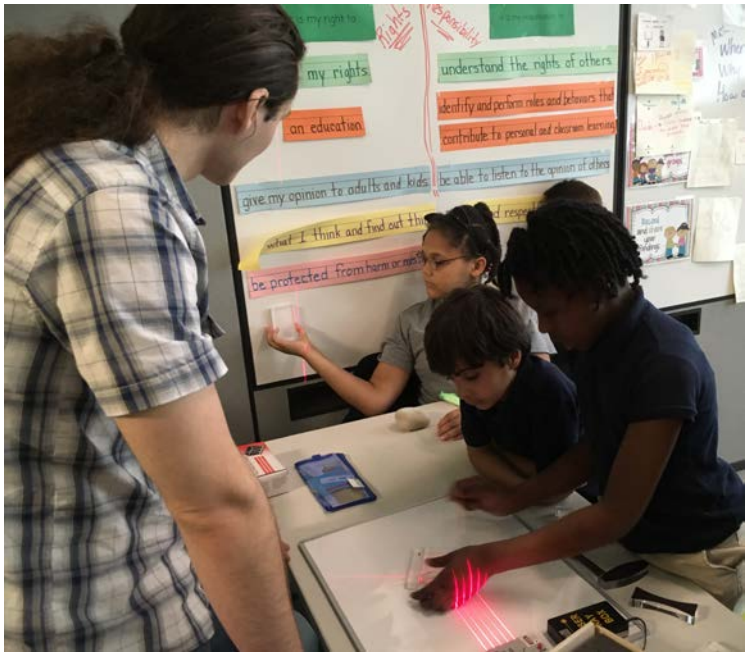
Highlights from the Phase Change visit. Students help the Outreach Team to investigate materials and objects when subject to vacuum, and determine what is and isn't a phase change (**TOP**). Students make shrinky dinks with the Outreach team (**BOTTOM**).

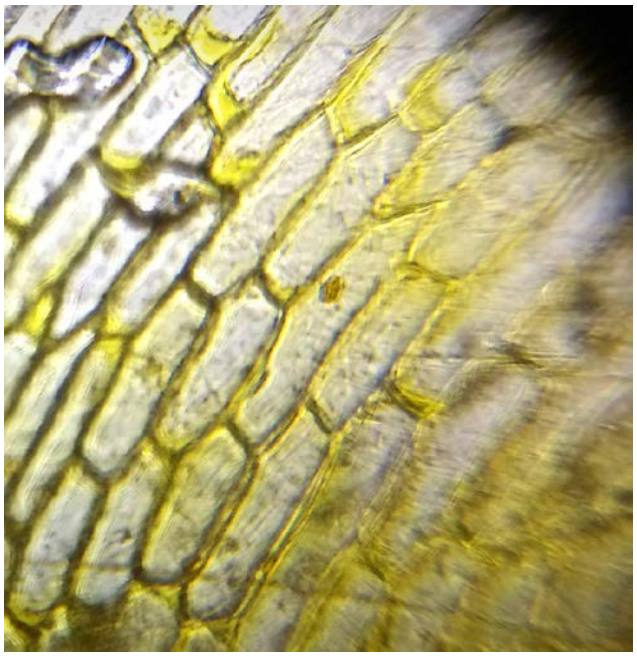
(**ABOVE**) Students use dry ice to learn about the progression of phase changes and sublimation during the Phase Change visit.

(**BELOW**) Students learn about waves as light, including dispersion (**LEFT**) and reflection (**RIGHT**).

(**ABOVE**) Students learn about lenses and how they interact with light.

(**BELOW**) Students during the in-school visit learn about reflection and refraction with a laser box kit while waiting for their turn to build a foldscope (**LEFT**). An onion cell viewed through the foldscope camera mount, students had fun trying to locate a nucleus (**RIGHT**).





(**ABOVE**) A group photo with the 4th grade students who participated in the in-school outreach session.


NASA
THIS
IS HOW
I ROLL


NASA

(**ABOVE**) Group photos from the after school visits to CIS for the Programme of Inquiry outreach sessions.

If you have any questions, please contact the SPS National Office Staff
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