Future Faces of Physics Award Report

Project Proposal Title	After-School Activity Series
Name of School	William Jewell College
SPS Chapter Number	8235
Project Lead (name and email address)	Megan Anderson (canvasmeg@gmail.com)
Total Amount Received from SPS	$291.90 (half has been sent to us so far)
Total Amount Expended from SPS	$291.90

Summary of Award Activity

During spring 2019, the William Jewell College SPS chapter engaged with an urban school to offer after-school science activities on waves and energy. As part of our interactions, elementary-school students did several hands-on learning activities, one of which involved assembling, operating, and performing experiments on solar-powered toy cars. Students learned principles associated with waves, concepts of energy, and energy transformations. Each student participating in the after-school program took home several items to continue doing various science projects with their families. Such items included: SPS diffraction glasses, solar-powered toy cars, and ultraviolet bead bracelets.

Statement of Activity

Overview of Award Activity

In spring 2019, the William Jewell College SPS chapter engaged with an urban school to offer after-school science activities on waves and energy. Two faculty members and two SPS students developed activities for students in grades 3-5; activities were administered over two sessions. In general, interactions with students initially focused on brief discussions of physics concepts and principles. Once students understood basic concepts, activities moved to hands-on demonstrations, experimentation, and simple building (construction) projects.

In the first session, students learned some basic concepts associated with transverse and longitudinal waves. Then we did several projects with Slinky's: we produced different kinds of waves, showed what happens when waves overlap (interference), and asked students to make observations of waves when faster and slower motions (frequencies) were used to generate the waves.

To demonstrate other wave effects, students viewed light sources through diffraction gratings and were asked to describe what they saw. Students responded that light from the different sources has multiple colors, which they could see separately through glasses supplied by SPS. Students also experimented with fiber optic and prism materials to show the bending of light rays via refraction. Very low power light sources were used here so that students could do additional experiments on their own.

Students learned more about mechanical waves by producing various sounds using tuning forks and Whirly sound tubes. As students experimented, we asked them questions such as: Can you make different frequencies with the tubes? How soft can you make the sound?

We concluded the first session by observing what happens when ultraviolet beads are exposed to violet versus red light. (We did not go outside that day due to bad weather.) Students noted that beads absorbing violet light produced various colors including yellow, red, and blue; whereas, the ones absorbing red light did not produce any (visible) light. Mentors then helped students make bracelets or necklaces using the beads. We finished the afternoon by coloring rainbow pictures.

In the second session, we focused on showing students how energy can be transformed. Transformations of energy are especially important for understanding how solar panels work. Our first experiment involved cranking generators connected to a light bulb to show that mechanical energy (human motion) can be transformed to electrical energy, and, ultimately, to radiant (light) energy. Each student turned a generator in order to see for herself how these motions result in light being produced.

Next, the "world's simplest motor" was demonstrated using a commercial device consisting of a coil of wire, magnet, and battery. An energized coil within a magnetic field experiences a turning force (torque), causing the coil to rotate. Students recognized the connection between electricity (electrical current here) and magnetic fields to produce rotation.

Another experiment done as a group was to shine light onto a small solar panel connected to a fan. Students observed that when energy from a light source was present, such energy could be converted into motion of the fan. We also experimented with blocking part of the light and observing less motion of the fan. Students suggested that we move the light source closer and farther away to observe variations in the rotational motion of the fan.

As our final project, students and mentors worked together to assemble commercially-available, solar-powered toy cars. Assembly required several steps so that students needed to listen carefully to instructions and to help each other (if needed). All students were able to put together a car and make it work. We tested the cars indoors (due to rainy weather again) by shining lights onto the small solar panels on the cars. We encouraged students to experiment with variations of light; they enjoyed seeing how light intensity changed the motion of the cars. They also enjoyed seeing how fast the cars would go. Before leaving we asked students several questions related to how the cars work. Students responded to our questions, and said that they really enjoyed all the projects.

The primary audience for the wave and energy activities described here are third through fifth grade elementary school students from an urban school (Primitivo Garcia School) in Kansas City, MO. This particular school has very little funding for science education. As a result, William Jewell College has made a long-term commitment to partner with teachers and administrators at this school to help provide science activities for students.

Two years ago, the college worked with teachers to develop an aquaponics system for one of the classrooms. Now, students are able to use the system to learn principles associated with water quality, plant and fish symbiosis, and the influence of light energy on plant and fish growth. The college with associated grants supplied approximately 90% of the funding for the aquaponics project. Over the past several years, the college also has participated in science nights held at the school. These usually consist of students and their parents coming to the school for about 2 hours to observe scientific demonstrations and to participate in various activities.

The projects described here are part of ongoing efforts by William Jewell College to help improve science education in an urban community in Kansas City, MO. In particular, our efforts in spring 2019 focused on working with 15 third through fifth grade students as part of an established after-school program. The after-school program is especially important for these kids, because their parents often work long hours. Providing these kinds of opportunities helps to bridge the gap between the time that kids are dismissed from school and when their parents get home from work.

Over the past 3 years, our SPS chapter has focused on outreach to elementary school kids in our community. In fall 2018, our SPS group offered after-school activities in waves and optics to students at Schumacher Elementary School in our hometown of Liberty, MO. The year before, several SPS students helped faculty to develop projects on fiber optics to use in outreach to the Liberty, MO school district. We have already been asked to offer additional activities at various schools next year, and we have agreed to continue our efforts.

Our efforts at Primitivo Garcia School in spring 2019 had several positive effects. Most importantly, students were engaged and attentive, and they expressed joy in learning new things about the world around them. Due to lack of funding for their school, most of these students had little experience in hands-on science activities. They readily engaged in the activities and developed more confidence as they progressed. At first, several students said, "I'm not sure if I can do this!" Through encouragement and support, however, students expressed more and more confidence. By the end several said, "I like science." "I might want to work in science." "I really enjoyed learning about science."

Another important part of our engagement with students in the urban core involves opportunities for these kids to interact with adults from a suburban liberal arts college. The students were very receptive to the activities that we planned for them. They interacted with us immediately; they also showed interest in the topics and enjoyed their time with us. These kinds of collaborations, we believe, are important for encouraging students who do not have the advantages of well-funded schools. They also help to encourage students from underrepresented groups to pursue scientific endeavors.

Impact Assement: How the Project/Activity/Event Promoted Physics across Cultures

Goals for the projects and activities described in this report include:

1. Engage third through fifth grade students in introductory physics topics associated with energy and waves.
2. Help students to understand concepts and principles associated with energy and waves.
3. Show how these concepts apply to our everyday lives.
4. Demonstrate to students how science is done in current-day society.
5. Show how people from all cultures can engage in science.

SPS faculty and students from William Jewell College developed a variety of activities to engage elementary school students from an urban school with few resources for hands-on science projects and experiments. Activities here focused on waves and energy, two of the main topics covered in elementary schools across the US. Students learned basic concepts via discussions and demonstrations. Once students learned basic concepts, activities then centered around investigations of concepts through demonstrations and experimentation. Ultimately, students assembled, operated, and performed experiments on solar-powered toy cars.

Activities developed here focused on investigations and experimentation. As a result, students gained experience and confidence in doing science in a hands-on environment. From our observations, students readily engaged in all the activities and asked relevant and insightful questions. They also participated in figuring out what happens when parameters vary and how variations in a physical quantity impacts another. They enjoyed investigating scientific questions and expressed to us their interest in learning more.

In addition to learning basic science, students observed how scientific theories and concepts apply to our everyday lives. For example, when we discussed solar energy, we showed how devices such as lights and motors can be operated using energy produced by solar panels. After showing students these kinds of examples, they often suggested other ways to use solar panels in practical settings.

By engaging students in interactive, hands-on, and investigative projects, they learned how the enterprise of science is done. They saw the value of working together and pursuing questions by experimentation. In addition, they began to see how diverse perspectives lead to more viable solutions to problems. Finally, students experienced how science is done so that they can envision themselves as working scientists.

Finally, through engagement with SPS, urban students saw that science cuts across all boundaries, including gender, race, and culture. They gained experience in working with people outside their own culture. They also observed how talking to different people gave new insights and provided deeper understanding.

Our overall plan did not have a formal survey for assessment. However, we did engage students in informal interviews. Questions focused on giving impressions of the projects. Responses included: “I like science.” “I might want to work in science.” “I enjoyed learning about science.” From these responses, we determined that students here enjoyed learning about science, and they gained greater appreciation for how science is done.

We also sought to determine how levels of confidence changed as the students engaged in more and more activities. One student, in particular, had little confidence when she began. Later that student was able to assemble the car and do several experiments using the car that she had put together. Overall, her confidence increased as she gained new skills and applied those skills over time.

Finally, we gauged knowledge acquired by students as they progressed through the activities and finished the final project. By the end, each student could explain in basic scientific terms how the toy solar-powered cars work. They also were more inquisitive and were not afraid to try experiments on their own. Many told us, “We would like to do more of these projects.”

Impact Assement: How the Project/Activity/Event Influenced your Chapter

This project involved two students and two advisors in a crucial part of SPS: outreach to the general community. While many opportunities exist for students and advisors to share science with others on campus, it is much more difficult to find time and funding for activities beyond the college. Through the support we received for this after-school activity series, we were able to continue our relationship with Primitivo Garcia while promoting science to kids who might not know to even be interested.

Going into the project, we believed that the children in this school would be excited about the activities once we demonstrated them. While this was largely the case, we noticed that a couple of kids in each group needed a little extra encouragement in order to finish their projects. When you see how much perseverance is required to complete activities such as stringing together solar beads, the need for encouraging and affirming young scientists — particularly those from minority backgrounds — is especially clear. We left the school feeling a renewed passion for the work that is being done there and a renewed commitment to helping continue that work in whatever ways we can.

Thus, though our activities involved plenty of physics, we came away with a lesson in the benefit of collaborating and the practice of empathy. We plan on continuing to grow our relationship with the school, hopefully involving younger SPS students in our department in future outreach initiatives. When one project like this succeeds, it is much more likely that more projects like it will be explored in the future.

Key Metrics and Reflection

The Future Faces of Physics Award is designed to promote projects that cross cultures. What cultures did your project attempt to bring together? (Please be as specific as possible.)	Urban, Hispanic elementary students engaged with SPS faculty and students from a suburban liberal arts college
How many attendees/participants were directly impacted by your project? Please describe them (for example "50 third grade students" or "10 high school volunteers").	15 2 SPS student members 2 faculty
How many students from your SPS chapter were involved in the activity, and in what capacity?	Two SPS students were involved in planning and facilitating the activities.
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? How would the additional funding have augmented your activity?	Yes, the amount of money we received from SPS was sufficient to carry out the activities.
Do you anticipate repeating this project/activity/event in the future, or having a follow-up project/activity/event? If yes, please describe.	Yes, the college has made a long-term commitment to engage teachers and students at an urban elementary school. Our SPS group plans to continue these projects.
What new relationships did you build through this project?	Direct relationship with teachers and administrators
If you were to do your project again, what would you do differently?	Offer additional sessions to incorporate more topics in energy.

Press Coverage (if applicable)

N/A

Expenditures

The below expenditures went toward supplies for our outreach activities as well as gas for getting to the school where we did outreach. The solar beads, activity sheets, and miscellaneous supply costs went toward our first outreach activity day while the solar powered car kit costs went toward our second outreach activity day. Bad road conditions kept us from a third outreach activity day. Finally, our physics department covered the cost of demos and all additional supplies (such as scissors and other tools).

The children were encouraged to take their solar powered cars, solar bead bracelets, and worksheets home.

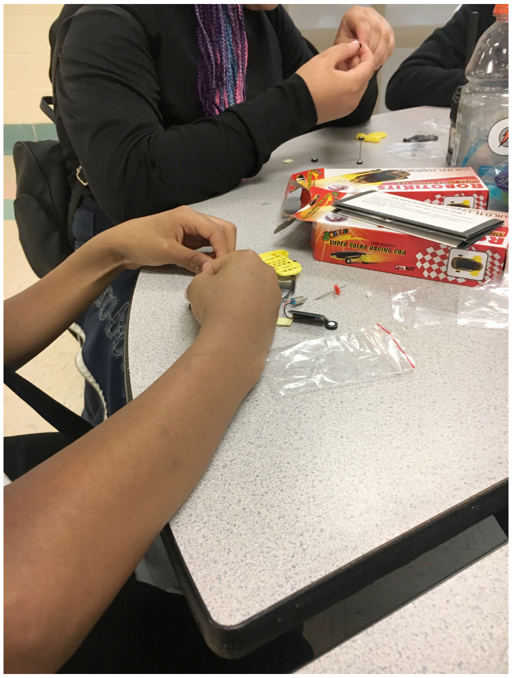
Expenditure Table

Item	Please explain how this expense relates to your project as outlined in your proposal.	Cost
Solar powered cars	Students assembled these cars as their final project on waves and energy	226.20
Solar beads	Students used these to make bracelets	20.70
Printing costs	Students completed activity sheets	10.00
Gas	Covering transportation to and from the school	30.00
Miscellaneous	Covering string and crayons	5.00
	Total of Expenses	291.90

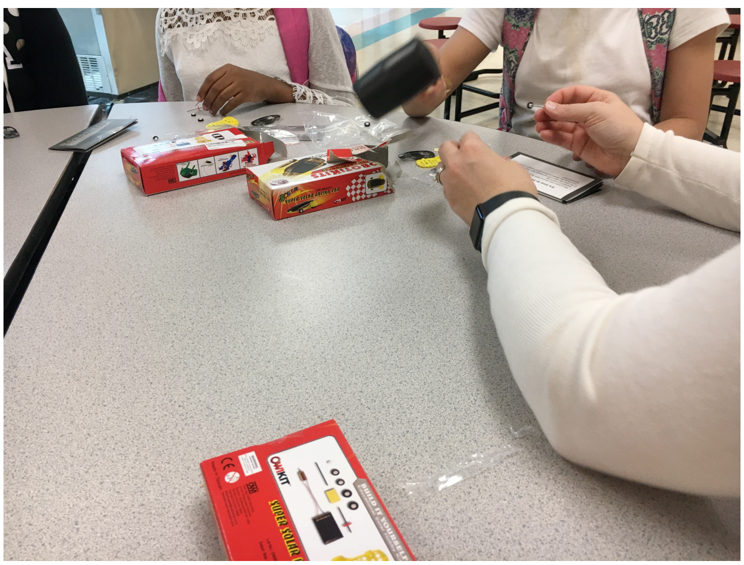
Activity Photos

All photos were taken by Megan Anderson.

Students demonstrating transverse waves with a Slinky.



Students assembling solar-powered toy cars.



Students and mentors assembling solar-powered toy cars.

A completed solar-powered toy car ready for testing.

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