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

Future Faces of Physics Award Report

Project Proposal Title	SSU SPS/MESA Skills Lab: Teaching Arduino Based Microcontrollers To Underrepresented Students
Name of School	Sonoma State University
SPS Chapter Number	6474
Project Lead (name and email address)	Kevin Zack - kzackelectric@gmail.com
Additional Project Leads (two lists: names then emails)	Ben Cunningham[1] Hunter Mills[2] Carolyn Peruta, Ph.D. (MESA Program Director)[3] super_neb@hotmail.com[1] huntermills707@gmail.com[2] carolyn@universe.sonoma.edu[3]
SPS Chapter Advisor	Hongtao Shi, Ph.D.
Total Amount Received from SPS	$300.00
Total Amount Expended from SPS	$300.00

Summary of Award Activity

Sonoma State University's SPS (Society of Physics Students) chapter in partnership with MESA (Mathematics, Engineering, Science Achievement) at SSU hosted an introduction to microcontrollers and their scientific applications funded by the Future Faces of Physics Award granted by the Society of Physics National Organization. SSU's SPS chapter intends to continue helping combat the technological divide that many underrepresented students face in their pursuit of a science education.

Statement of Activity

Overview of Award Activity

During the Fall 2013 semester, SSU's SPS members Benjamin Cunningham, Hunter Mills, and Kevin Zack originated a reoccurring event titled Skills Lab. It was designed to provide a platform for peer-to-peer instruction in potentially valuable skill sets not normally included in a traditional classroom education. Subjects covered ranged from photometry to proper hand tool use and all topics could be applied to a students capstone project, future grad school work, and future careers. As an extension of the Skills Lab hosted by SSU's SPS Club, and in conjunction with the MESA chapter on the Sonoma State University campus, the SPS/MESA Skills Lab provided an introduction to microcontrollers to underrepresented students.

The Skills lab consisted of two 2-hour sessions with light instruction and a focus on hands-on group work. The topics covered were circuit design and construction, introduction to the programming language C, and both hardware and software troubleshooting. Verbal instruction was kept to a minimum as we believe that hands-on activities would successfully pique the students interest in applied physics and engineering. Overall, the skills introduced and practiced, over the two day skills labs, are skills which will aide the student's future scientific pursuits.

Learning how microprocessors work goes beyond what is taught in the classroom and is fundamental to many types of STEM research. Reaching out to underrepresented students for this project, we looked to combat the misconception that customizable electronic systems are prohibitively expensive and require advanced skills to create successfully functioning designs. For this reason, at the end of the two labs, MESA students were given the option to borrow a Starter Kit so they could continue exploring microcontrollers, on their own, for the duration of the semester. We also attempted to show that these systems are easy to obtain at a low cost, and that they are highly customizable electronic components with a very active and highly supportive online community, to help overcome any obstacles that might occur while starting out.

- Outcomes

The event was a greater success then originally envisioned. In two sessions, we were able to cover a variety of topics such as the basics of microcontrollers (the Arduino platform specifically), programming in C/C++, and introduction to circuit design.Dr. Carolyn Peruta, the MESA Program Director, after giving a brief introduce of the MESA program four students signed up to join the program.

Separate from the development of this event, the Physics and Astronomy department was in the process of including reviewing the topics to be covered in the 300 level physics electronics course. The department was looking at including a microcontroller section. The success of this event has contributed significantly to the direction the department has chosen to take when teaching the topic of microcontrollers.

The process has started to hold another SPS/MESA Skills Lab, in the following year, continue the program on a repeating basis. This wouldn't have been possible without the Future Faces of Physics Grant.

- Audience

From the inception of this project, our target audience has been traditionally underrepresented groups in the STEM fields. Due to this focus, a partnership with MESA was ideal and very natural. As the event was developing, significant interest in participating in the event came from Dr. Jones, a professor who was teaching a 300-level physics course in electronics. With some supplies from the Physics and Astronomy department, additional demonstration were able to be put together. This allowed us to accommodate the electronics class with no impact to the MESA students. A last minute addition, a physics professor who had given his son a microcontroller starter set, asked if it was alright to join the Skills Lab, on the second day. We were happy to accommodate this request. In total, 24 people were strongly influenced by this event, from leading the activities(4), participating in them (16), or lending other types of support (4).

- Context of The Project

SSU's chapter of SPS actively recruits, perform science outreach, and support underclassmen through tutoring. We are also very active in expanding the knowledge and experience base of our members. More than in previous years, we reached out to groups and organizations for partnership in events. Holding this Skills Lab to help demystify microcontrollers and their value to scientific pursuits, in partnership with MESA and with support from the Physics and Astronomy department covered nearly every goal that SSU's SPS had set for itself this school year.

- Highlights and Stories

In the development of the presentation and the activities, we attempted to anticipate what parts the students would be interested in and what parts they may struggle with or have no interest in learning about. The reality during the events couldn't have made those concerns any less relevant. Some students followed the instructions to the letter and asked for more when they came to the end. Other students had a drive to modify all the supplied program code to do something slightly different then what the activity called for. Early on we worried students might get frustrated and board if the exercises didn't run smoothly but they ended up being hyper focused on troubleshooting any errors until they could finish the exercises. Groups that were the first to find solutions were quick to split up and offer their help to any other group that had run into their same issue.

Having the event split into two days was purposefully done in hopes that the students would independently explore the topics and might bring new exercise ideas to due on the second day. We also anticipated a attendance drop off between the first and second days of the Skills Lab. Every student returned for the second day and were over flowing with ideas they they wanted to try out. The engagement was more then we could have hoped for.

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

Goals of the SPS/MESA Skills Lab were to:

- Allowing interested MESA students to take home a Starter Kit, for the duration of the semester.
- Expose to circuit design and construction, a programming language interpretation and creation, and both hardware and software troubleshooting.
- Combat the misconception that customizable electronic systems are prohibitively expensive and require advanced skills to create successfully functioning designs.
- Provide underrepresented students with the opportunity to develop skills that would not otherwise be taught in a classroom, but are necessary for future work in STEM fields.
- Develop an understanding of the possibilities of incorporating microprocessors into their own future projects.
- Pique their interest in lower division physics and engineering while supporting the dedication necessary for upper division classes.
- To show that there is an active and supportive community of like-minded people on and off line to help overcome any obstacles that might occur while starting out.

All of the original goals were not only met, but in some cases surpassed. The addition of an entire undergraduate class was more than we had originally anticipated and the student sign-ups for MESA was a tremendously positive outcome. Every student was undeniably enthusiastic about the event and topics covered. It was clear the student's interest was piqued when it became common for groups to discover new circuits to try out and would teach other interested groups when asked.

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?	Our efforts were in promoting the sciences to traditionally underrepresented groups, such as students of low income house holds, minorities, and women.
How many attendees/participants were directly impacted by your project? **Please describe them (for example "50 third grade students" or "10 high school volunteers").**	3 MESA students (4 students signed up at event) 12 Physics Students (sophomore/juniors) 2 Professors and their young son (not pictured)
How many students from your SPS chapter were involved in the activity, and in what capacity?	6 SPS members where involved. (3 presented / 3 attended)
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?**	The proposed activity was designed for a grant of $300 and therefore the funding was sufficient. We secured additional funds and supplies, post award, and were then able to expand the number of available seats for this event. Any additional grant money would directly result in an increase in the number of students that can be accommodated. A funding level of $1000 would allow the possibility o gifting these microcontroller sets to the student attendies.
Do you anticipate repeating this project/activity/event in the future, or having a follow-up project/activity/event? If yes, please describe.	This event was very well received. Both students and professors expressed an interest in having the event repeated. SSU's SPS and MESA are both excited to repeat this event, mostly identically, in the coming year.
What new relationships did you build through this project?	SSU's SPS and MESA have formed a stronger partnership because of the success of this event.
If you were to do your project again, what would you do differently?	Polling the attendees, prior to the event, would allow the presentation and exercises to be taylored to their interests.

Press Coverage (if applicable)

- Newsletter, Sonoma State University School of Science & Technology, Volume 3, Issue 2, March 19, 2014, Page 8 - http://www.sonoma.edu/scitech/newsletter/spring_2014.pdf

Expenditures

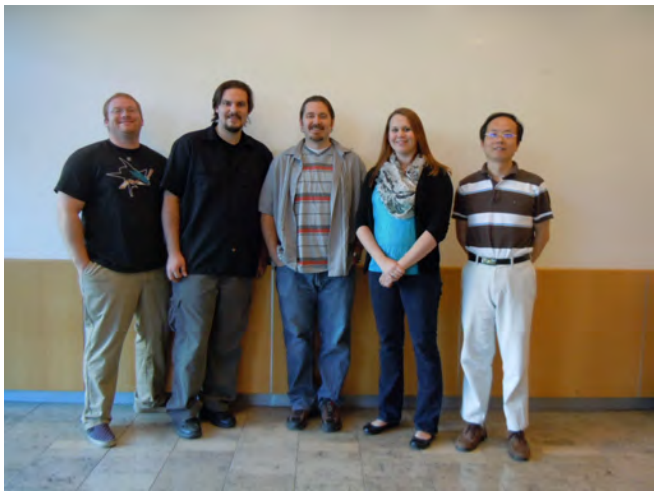
12 SparkFun.com Starter Kits for RedBoard (http://sfe.io/p11930) were purchased. Each kit consists of 1 Red board (Arduino Uno), 1 mini-bread board, a collection of LEDs, select resistors, a flex sensor, a photocell, a thermistor, a buzzer and misc. parts. The Physics and Astronomy department supplied the lab space and any presently owned supplies that were needed. SSU E/PO covered shipping and added their 20% SparkFun.com account discount. MESA donated $150 so that additional kits could be purchased. We saved $5 on each kit with a quantity over 10 units. This project did not have any additional fees associated with it.

Expenditure Table

Item	Cost
SparkFun.com - Starter Kit for RedBoard (Arduino) - x12 units	$557.90
SSU Education And Public Outreach Donated Funds	(107.90)
MESA Donated Funds	(150)
Total of Expenses	$300

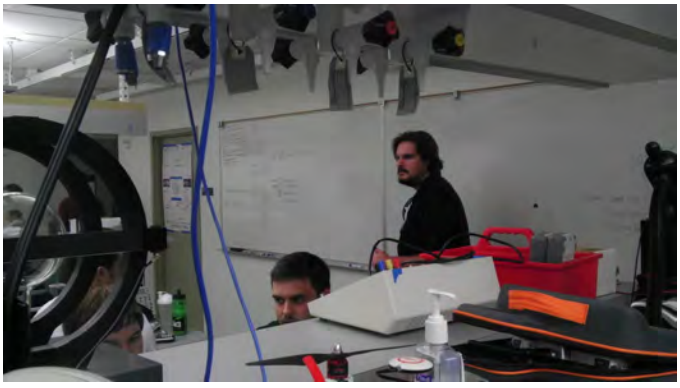
Activity Photos

All Photos by (Sonoma State University Society of Physics Students)

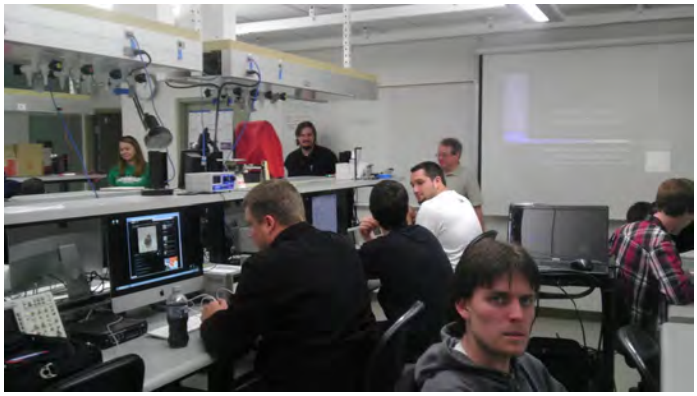


left: Hunter Mills, Kevin Zack, Ben Cunningham, Carolyn Peruta, Ph.D. (MESA Program Director), Hongtao Shi, Ph.D. (Advisor)

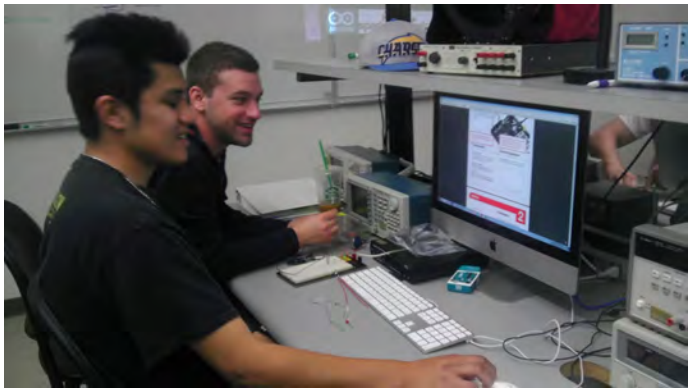
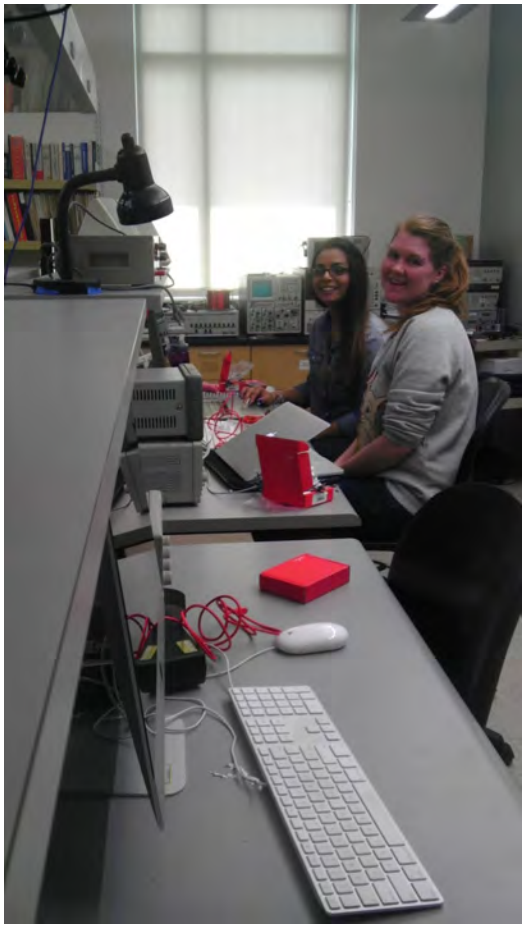
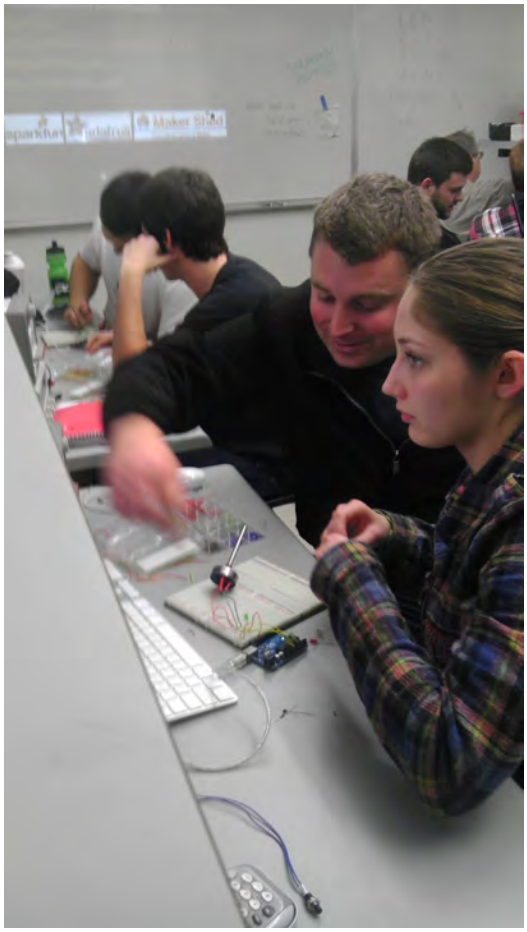
Dr. Peruta kicks off the skills lab with a quick explanation of the MESA program which resulted in four new student sign-ups.



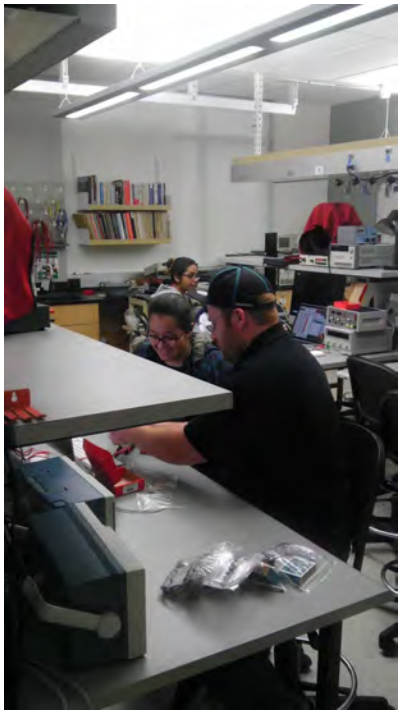
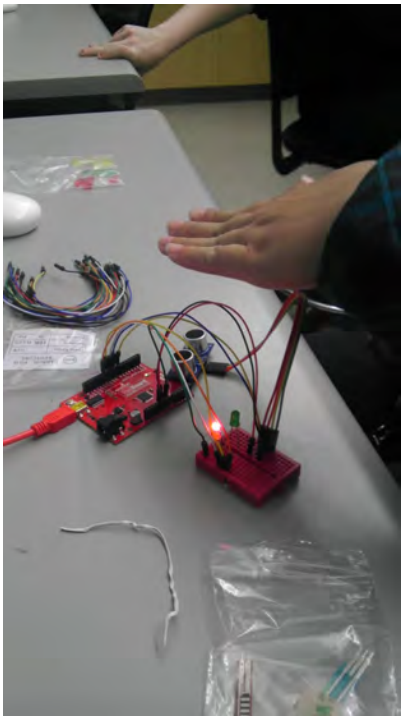
Kevin Zack waits for questions during the hands-on portion of the Skills Lab.



Kevin Zack and Dr. Jones wait for questions after setting the students free to work with their microcontroller kits.

	
Students, completely engrossed in the hands-on process, setting up their first circuit (blinking LED).	Julina (back) and his lab partner use an online resource which was referred to in the exercises.
	
Lauryn (right) and Aman (left - SPS club President) team up and work through the examples - with great success.	Students putting the finishing touches on a voltage divider using a variable resister (potentiometer).

	
Dr. Peruta (front) was able to experience the exercises along with her MESA students.	Engaged students spontaneously assisting each other through the more challenging circuits.
	
Anna McCowan(left) and her lab partner, in great spirits, successfully finish one circuit of the many they completed that afternoon.	

	
Hunter Mills (hat) works with Luisa (left), a MESA student, on an inspired and unplanned project.	Luisa's project was a success. A proximity sensor, was used, by Luisa and Hunter, along with two LEDs to indicated an objects distance within multiple range thresholds.
	
Luisa (front) shows Dr. Peruta (back) the working proximity sensor circuit and program.	