SOCIETY OF PHYSICS STUDENTS
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Future Faces of Physics Award Proposal

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
Total Amount Requested	$300.00

Abstract

Sonoma State University's SPS chapter in partnership with MESA at SSU will host an introduction to microcontrollers and their scientific applications. SSU's SPS chapter intends to help combat the technological divide that many underrepresented students face in their pursuit of a science education.

Proposal Statement

Overview of Proposed Project/Activity/Event

As an extension of the Skills Lab hosted by the SSU SPS Club, and in conjunction with the MESA (Mathematics, Engineering, Science Achievement) chapter on the Sonoma State University campus, the SPS/MESA Skills Lab will provide an introduction to microcontrollers to underrepresented students. MESA at SSU recruits underrepresented students and provides tutoring, professional development opportunities and support to encourage them to choose and succeed in majors in STEM disciplines. Each week, MESA holds tutoring and study sessions for members: these will be expanded to include these proposed Skills Labs.

During the past semester, SSU SPS members originated Skills Labs to provide a platform for peer-to-peer instruction in potentially valuable skill sets not included in a traditional classroom education. Subjects range from science communications to lab equipment operations and proper tool use, and are applicable to capstone projects, grad school, and future careers. We are currently offering six Skill Labs per semester: this proposal would fund two additional labs for MESA Students that build on the microcontroller Skills Lab already developed by SPS. The first two-hour MESA Skills Lab would introduce students to hardware and pre-written software in order to control sensors in the Starter Kit for RedBoard from SparkFun. The second two-hour lab would provide students with the opportunity to write their own simple software. At the end of the two labs, students would be loaned the Starter Kits to take home so they can continue exploring microcontrollers on their own for the duration of the semester. At the end of the semester, we will retrieve the kits so that they can be reused by subsequent generations of students, thus ensuring the sustainability of the program.

The goal of the SPS/MESA Skills Lab is to provide underrepresented freshman and sophomore MESA 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. Furthermore, if after the lab students have the opportunity to explore the Starter Kit on their own, they are more likely to develop an understanding of the possibilities that microprocessors can provide to their own projects. By bringing hands-on activities to underrepresented lower division students, we hope to pique their interest in lower division physics and engineering while supporting the dedication necessary for upper division classes. Learning how microprocessors work goes beyond what is taught in the classroom and is fundamental to many types of STEM research.

With the funds from the Future Faces of Physics students grant, we will be able to purchase six Starter Kits and MESA will provide two additional kits allowing us to reach a total of eight underrepresented students per semester.

The SSU Skills Lab began with the idea that upperclassmen are a major resource that otherwise goes untapped. When a student graduates, all the knowledge they hold goes with them. However, if that student passes their applied knowledge on to others, they create a self-sustaining system. This concept has evolved into a student-led laboratory session held every two weeks. So far, SSU students have instructed their peers in soldering, the proper use and safe handling of hand and power tools, and Arduino Microprocessors. As an extension of the Arduino Microprocessor Skills Lab, the SPS/MESA Skills Labs will benefit from the prior experiences of the Skills Labs already held at Sonoma State. Because the Skills Labs have been entirely student-

driven and supported, the previous Arduino Microprocessor Lab used borrowed parts. As a result, once the lab had ended, students were not able to continue their work with the microprocessors. Funding for this project will remedy this problem by allowing the students to take home the Starter Kit for the duration of the semester.

How Proposed Activity Promotes Physics Across Cultures

Physics experiments often require the scientist/science student to customize equipment to be able to take the appropriate measurements for their experiment. Prior to coming to SSU, underrepresented students may not have had exposure to specialized laboratory equipment and therefore may be starting their STEM studies with a skills disadvantage. They may never have had the freedom to customize the equipment for a particular experiment. Introducing underrepresented students to the low cost and highly customizable Arduino platform will empower the students to be able to peruse experiments that traditionally they may not have had the opportunity to explore.

Another goal of this project will be to introduce underrepresented students to a skill set that, when pursued, opens up more opportunities for them in the future. Through this workshop, the students will be exposed to circuit design and construction, a programming language interpretation and creation, and both hardware and software troubleshooting. These are all skills which are useful in many aspects of scientific pursuits.

Reaching out to underrepresented students for this project, we hope to combat the misconception that customizable electronic systems are prohibitively expensive and require advanced skills to create successfully functioning designs. We also aim to instill the idea that, it is easy to gain access to low cost, highly customizable electronic components and 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.

Plan for Carrying Out Proposed Project/Activity/Event

- The co-inventors of the Skills Lab, Ben Cunningham and Kevin Zack, will be in charge of planning the event. A prior Skills Lab presenter, Hunter Mills, will help facilitate the event.

- Progress will be monitored by the MESA Director Dr. Carolyn Peruta and chapter advisor Dr. Hongtao Shi based on the time-line provided below.

- Target audience will be reached through both the MESA Director and SSU SPS Club meetings and publications.

- The MESA/SPS Skills Lab will be presented by three SSU SPS Officers; Cunningham, Zack and Mills, along with the support of the members of the SSU SPS chapter.

- Special expertise that will help ensure success will be provided by the three volunteers all who have presented for the Skills Lab before as well as the large support base the SSU SPS chapter provides.

We will start promoting the skills labs in mid-January to get a list of potential MESA students that are interested in the program. A questionnaire sheet will be attached to the sign-up sheet to help us tailor the Skills Lab to the students involved. During this time we will purchase the Starter Kit for RedBoard - Programmed with Arduino. When the questionnaires are returned we will expand the prior presentation on Arduino Microprocessors to match the experience and expectations of the students. The two workshops will be held in February and the final report will be submitted by the end of May.

Project/Activity/Event Timeline

- January 1st - Skills lab presentations will be tentatively finalized and supplies needed for the skills labs will be collected.

- January 13th - 27th: Eligible MESA students will be informed of the skills lab. Both a signup sheet for the workshops and a questionnaire about the students' expectations, for the skills lab, will be handed out and collected.

- February 1st: The presentations for the two skills labs will be modified based on the questionnaire and finalized. Any missing components for the skills labs will be gathered or ordered.

- February 21 - The first skills lab will be held. It will introduce microcontrollers and hands on circuit building.

- February 28 - The second skills lab will be held. It will touch on programming in relation to the Arduino microcontroller, and examples of this system's possible application in scientific endeavors.

- May 31st: The final report will be submitted prior to this date.

Activity Evaluation Plan

A pre-skills lab questionnaire will be passed out to participants asking them for their expectations of the topics, ideas, and concepts that the skills labs might cover. After the second skills lab each participant will be expected to fill out an evaluation form. The evaluation form will entail what they learned and what could have made the experience more fulfilling.

A few examples questions of the pre-questionnaire might be;
- Do you have any programming experience?
- Do you have any electronics experience?
- Do you understand how microcontrollers function?
- What are your future-career plans?

At the end of the semester, we will again survey the participants to determine if their understanding of microcontrollers has improved, and if their future plans have been influenced by this experience. In addition, we will ask the students to report on any self-directed projects that they initiated with the Arduino kits. We will request approval from SSU's Institutional Review Board for both questionnaires.

Budget Justification

All funds requested for this project will be used to purchase six RedBoard Starter Kits which will be loaned to the participants at the end of the Skills Lab series. Additional funding of two Starter Kits will be provided through MESA.

Supporting resources will be obtained at no cost to the project. Computer stations, to work with the Arduinos and lab space in which the workshops will be held, will be provided by the Department of Physics and Astronomy at Sonoma State University. The costs of any paperwork, questionnaires, informational fliers, etc., will be covered by the Department or the club. All software and circuit designs are available for free by the open source and open hardware communities online. The project's presenters and club members will volunteer their time and knowledge to develop and advertise the workshops; to research and test appropriate circuit designs; to run the workshops; and to field any follow up issues the participants may have. The MESA director will locate interested underrepresented students for the workshops. The Chair of the Physics & Astronomy Department will help to develop the evaluation instruments, and assist in getting University IRB approval to administer the questionnaires to the MESA participants.
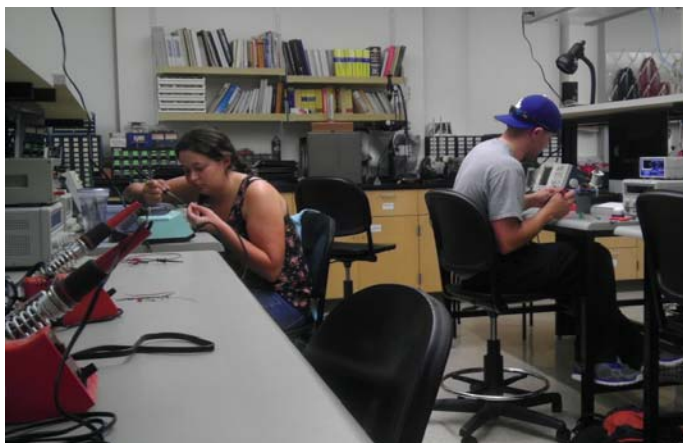
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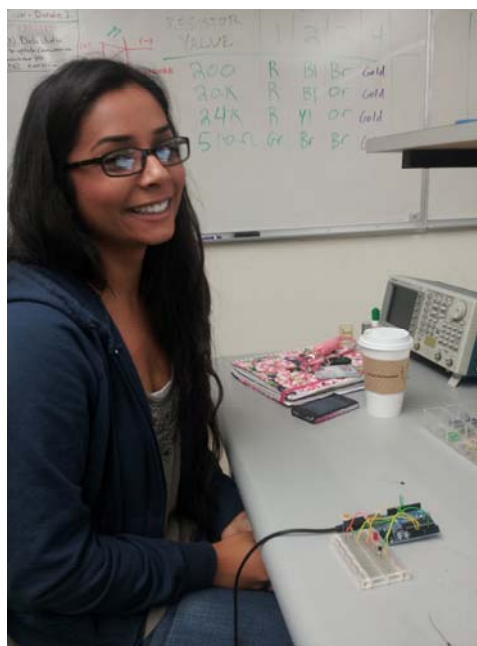
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SPS at SSU Skills Lab

SPS at SSU Skills Lab – Soldering
Kate, Stephan

SPS at SSU Skills Lab – Microcontrollers
Aman

SPS at SSU Skills Lab – Hand Tools
Aman, Hunter, Stephanie, Mike