Learning by Making Newsletter

$4 million Grant to Expand *Learning by Making!*

US Department of Education awards $4 million grant to expand Learning by Making program to Sonoma and Lake counties.

For the past five years, Sonoma State University's Education and Public Outreach Group has been working to create and fine-tune a ninth grade curriculum that rethinks the way STEM courses engage students. The result has been a *Learning by Making (LbyM)* curriculum that trains students to design and construct their own experiments.

Piloted in six Mendocino County high schools during the past three years, the curriculum will now expand to Sonoma and Lake counties thanks to a $3.93 million grant from the U.S. Department of Education.

"We are thrilled that the Department of Education has recognized our work on our innovative 9th grade integrated STEM curriculum by awarding us funding to continue to develop the *LbyM* curriculum for another five years," said Lynn Cominsky, who leads the new project. Cominsky is also Director of SSU's Education and Public Outreach (EPO) Group and chair of the Department of Physics and Astronomy at Sonoma State. "*LbyM* has been our group's most challenging project, but it also has the potential to transform STEM education nationally." Other Co- Principal investigators on the new grant are Dr. Laura Peticolas, Associate Director of the EPO group, and Susan Wandling, Senior Director of SSU's Pre-Collegiate Programs.

The *LbyM* project was specifically designed to benefit rural schools which are typically underserved in STEM education. With many rural schools not having credentialed teachers in each science discipline, teaching an integrated STEM curriculum allows flexibility. The curriculum design also provides advanced students the opportunity to take on more challenging activities, which is important in rural schools where small student populations preclude the ability to offer AP classes.

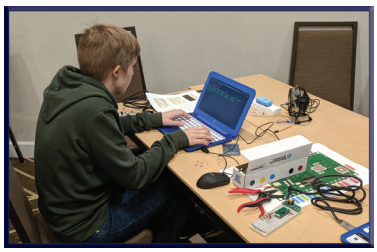
The *LbyM* curriculum was originally supported by a $3 million grant from the Department of Education in 2013, and was taught in six Mendocino County high schools. Susan Wandling directed the 2013 grant with Cominsky serving as STEM curriculum lead. *LbyM* is currently being taught for a fourth year at three different Mendocino County high schools: Ukiah, Point Arena and Round Valley. During the 2016 - 17 school year, external evaluators at WestEd conducted an impact study that compared student learning outcomes using the *LbyM* curriculum to other 9th grade students who were enrolled in traditional courses. According to Wandling, their initial evaluation "demonstrated significant gains in science learning and improvements in mathematics skills." Further explanation of the study can be found on the *LbyM* project's website.

SSU's Education and Public Outreach Group has a goal of having at least 12 schools in the region teaching the *LbyM* curriculum within three years. Although the project is targeting rural schools, the curriculum also will be tested in selected urban schools, including Roseland University Prep and Healdsburg High School, to measure the student learning outcomes in different settings.

> "We have the opportunity to rethink the way that STEM subjects are taught, so that students are more actively engaged in doing science, and not just memorizing facts".
> Dr. Laura Peticolas

Learning by Making into the 2018-2019 School Year

Transitions are always times of change, and our transition from the last 5 years of *Learning by Making* to the next 5 years of *LbyM* is no exception. Of the six schools with which we were working, three are continuing to work with Sonoma State University on *LbyM*: Ukiah, Pt. Arena and Round Valley High Schools. While the program continues to be supported at Pt. Arena and Round Valley High Schools as they were implemented last year, at Ukiah High there are now five Freshman College-Preparatory Elective "STEM Environmental Earth Science" classes, implementing the *LbyM* curriculum together with environmental and earth science content. The five teachers from these four schools, Patty Halpin, Allison Baldwin, Amanda Derby, Anne Marie Bauer and Howard Cole, continue to teach these courses and make changes where needed to iteratively improve the curriculum.



> "The world does not reward you for what you know but instead it rewards you for what you can do with what you know"
> Andreas Schleicher, Director (Organisation for Economic Co-operation and Development)

Learning by Making

Workshops for Teachers

Sonoma State University has continued to, and will continue to, provide professional development opportunities to the teachers engaged in the *LbyM* program. In these workshops, the needs of the teachers are the focus. Specifically, we design the workshops to provide time to deal with logistical and material needs in terms of the "brass tacks" of using the materials necessary for the curriculum, including student computers, the microchip boards and breadboards, and the experiment supplies, as well as the student handouts, teacher guides, and teacher presentation slides.

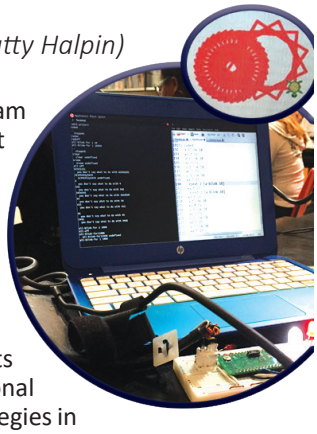
We also design each workshop to provide new content to the attending teachers, tailored to their needs. For example, when we met with the three continuing high schools in the Summer of 2018, we spent some time reviewing the content of the various experiments that are being developed as a part of the curriculum, with time for questions and feedback on the experiment's ability to meet learning objectives for the students. In the November, 2018 workshop, we had two new schools joining our workshop. We thus had multiple sessions throughout the day where the new teachers (fondly called "NTs") were trained on Unit 1, while the original teachers ("OTs") were brought together to provide feedback on Units 1-3 to the curriculum development team.

Because the *LbyM* program is a research endeavor, a part of the professional development is to gather feedback on the effectiveness of the curriculum in the classroom. Not only is the feedback from the original teachers on Units 1-3 incorporated into the development phases of the project, but we also have focus groups around the needs of various experiments in terms of content and scientific practices. Additionally, the next five years allows us time to also gather feedback on the program's ability to consider the effectiveness of increasing high school students' computational thinking.

Finally, we incorporate times into the workshop agendas for community building and reflections.

Featuring Ukiah High School

(Principal Gordon Oslund and science teacher Patty Halpin)



Ukiah High School offers students a *LbyM* STEM program created with Sonoma State University over the past four years. Students recognize and appreciate that this class is taught in a very different format. Using hands-on problem solving strategies our students are consistently engaged and visibly excited in their learning.

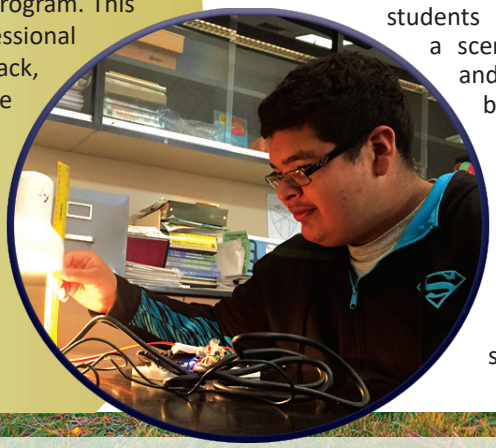
The SSU-UHS program is offered as an Environmental Earth/STEM class. About 120 ninth grade students are enrolled in the course. Students learn traditional environmental concepts. Then they apply *LbyM* strategies in developing their own experiments. The process requires that students use questioning strategies, investigation skills, and problem solving techniques on their own. The teacher serves as a guide While this program is particularly supportive of students that have demonstrated little interest in courses relying on lecture and textbook based instruction, these techniques are clearly beneficial to all students.

A specific curricular example is seen in the electronics field. In this unit students gain hardware and software experience. After wiring circuit boards the students learn coding, or computer programming, to command LED sensor responses. Initially, students are enthusiastic to create a scenario that turns sensors on and off. Students quickly move beyond the introductory level tasks and incorporate these skills into experiments they design and develop.

New Website

In the Spring and Summer of 2018, staff at Sonoma State University worked together to create a new website for the *LbyM* program. This website was tested in a focus group at a summer professional development training, and received overall positive feedback, with some comments that have been incorporated into the design.

The website showcases the current curriculum, the research study results from the first five years of the program, and highlights the high school and teacher involvement in the program. Website updates will be ongoing as the next five years of this program progresses. We welcome additional feedback as we continue to meet the needs of the audiences engaging with *LbyM*.



We look forward to our continued work with Sonoma State University as we expand the program in our science courses and beyond.

Learning by Making: STEM Success for Mendocino County, an "Investing In Innovation" (i3) program, was funded from 2013-2018 by the U.S. Department of Education. Our new grant *Developing a Student-Driven STEM and Computer Science Curriculum for Rural Students* is funded by Ed's Education Innovation and Research (EIR) program (2018-2023).

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To join our LbM group page, send email to
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