March 2020

Learning by Making Newsletter

Innovations with *Learning by Making!*

- WestEd

The *Learning by Making* program contains many dimensions—from coding, to professional development, to career pathways—that, together, create a unique and innovative STEM learning experience. With so many components to the curriculum, it can be challenging to identify exactly how *LbyM* innovates upon prior approaches to STEM learning. The following framework, however, does just that. Developed by the *LbyM* team in conjunction with WestEd, it identifies five key innovations that serve to guide ongoing curriculum design and development.

Innovation 1: Helping students to make sense of phenomena and design solutions to problems.

The *LbyM* curriculum innovates upon other science instruction by framing the goals of student activity as tackling engineering design problems or as making sense of phenomena. It seeks to position curriculum content within an overarching sensemaking goal such that students understand the purpose behind each activity. Innovation 1 is successful when students are able to explain why they are performing a task and are able to connect activities to broader science and engineering learning goals.

Innovation 2: Supporting three-dimensional learning.

LbyM seeks to prepare students to meet the performance expectations set forth by the NGSS. In order to be capable of such performances, students need support in all three dimensions of science understanding: Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs). *LbyM* seeks to innovate beyond typical classrooms by putting three-dimensional learning at the forefront of students' experiences.

Innovation 3: Incorporating computational thinking into science classrooms.

LbyM further innovates beyond other NGSS-aligned classrooms in its use of coding and computational thinking as cognitive tools in support of broader science or engineering goals. *LbyM* creates contexts where computational thinking helps advance other learning goals.

Innovation 4: Deepening teacher expertise and agency in STEM.

The interdisciplinary nature of *LbyM* challenges educators to teach across many STEM domains. *LbyM* seeks to support teachers in this challenge in two key ways: (1) by expanding teachers' STEM expertise to help them master as much of the LbyM curriculum content as possible, and (2) by providing teachers with the capacity for teaching STEM content even when it falls outside their area of expertise. Innovation 4 captures this second goal with the term "agency."

Innovation 5: Fostering STEM career pathways.

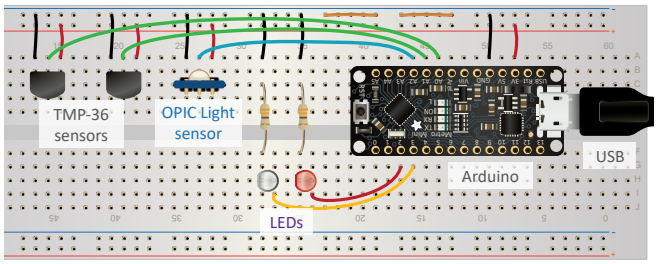
In support of a future STEM workforce, *LbyM* classrooms innovate upon the status quo through CTE events that promote STEM careers as attainable occupations for students. On top of introducing STEM occupations through Career and Technical Education (CTE) field experiences, Innovation 5 entails building connections between what students do in the classroom and what STEM career practitioners do in the field.

New Hardware Platform

With the start of this new phase of the *LbyM* project, we had the opportunity to revisit our hardware implementation. The goal is to drop the cost while improving the reliability of our platform.

In the i3-funded phase of the project, we used a custom microcontroller board ($125) along with expensive FTDI cables ($25) as the basis of all the sensor-based work.

In this new EIR-funded phase, we have switched to a commercially available Arduino-like microcontroller ($12.50) and a standard USB cable ($3). Although our new microcontroller does not have the same resolution as our older, custom solution, it does include both 3.3 and 5 V output power pins, which allows us to widen the variety of sensors that we can use for student experiments. The new platform is also much more tolerant to student errors and abuse, which are additional benefits.

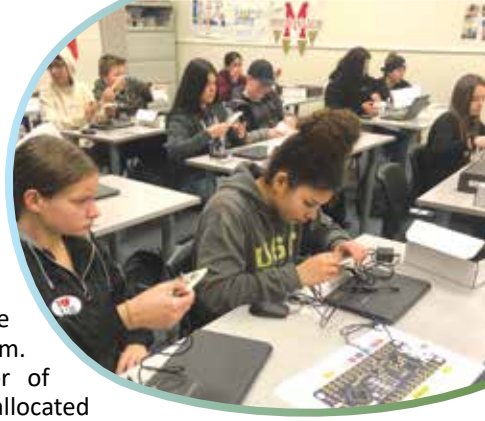


"The world does not reward you for what you know but instead it rewards you for what you can do with what you know"

Andreas Schleicher, Director (Organisation for Economic Co-operation and Development)

Learning by Making

TRIO Programs Try LbyM



A class of 20 Upward Bound ninth graders experienced a *Learning by Making (LbyM)* module on January 10 at Lower Lake High School. The students got a taste of programming by identifying and sending various commands through their Chromebooks to turn on different colored LEDs (as seen on page 1) and make them blink. They debugged problems by determining whether they were having a hardware or software problem.

A proponent of STEM education, Upward Bound teacher Michael (Mac) McMurtrey who welcomed the classroom demo to show his students the value of problem-solving skills said:

> *"The engagement of the young ladies in the class was very encouraging. They were sharing what they had learned and were proud of their troubleshooting abilities."*

Upward Bound, a U.S. Department of Education TRIO program, has served 60 students a year at Lower Lake High School since 2008, with an aim to prepare first-generation and/or low-income students to enroll and succeed in college. The *LbyM* project has partnered with other TRIO Programs at SSU to further develop and disseminate the curriculum in workshop settings outside a regular science classroom. Dr. Carolyn Peruta, Director of *Academic Talent Search*, has allocated supplemental STEM funding to offer *LbyM* workshops to her students in 2019-20. Over the course of three ATS STEM Saturday Academies, 67 students have experienced building circuits, turning on lights and learning to code. Of these students, over 90% could be the first in their family to earn a college degree. The SSU *LbyM* team enjoys these opportunities to partner with educational access programs to inspire underrepresented students to pursue STEM degrees and careers.

The term "TRIO" was coined in the 1960s to refer to the first three federal outreach programs that emerged to develop educational opportunities for disadvantaged populations -- *Upward Bound, Talent Search, and Student Support Services*.

For more information a*bout Upward Bound* and *Academic Talent Search* programs at SSU, visit ***precollegiate.sonoma.edu.***

CTE Foundation and Work-Based Learning (WBL)

(Brandon Jewell, Director of Industry Engagement)

*Learning by Making i*s partnering with *Career Technical Education (CTE)* Foundation to help *LbyM* teachers facilitate the design of authentic WBL activities in alignment with the *LbyM* curriculum objectives and train instructors on how to leverage WBL as an instructional strategy. With such a unique hands-on STEM curriculum, work-based learning and authentic employer engagement is the secret sauce to enhance any project and classroom interaction!

CTE Foundation is an independent 501(c)3 nonprofit organization that leverages public and private funding to incentivize schools to expand and enhance career technical education programs in alignment with economic and workforce development needs. Their mission is to innovate the education to career experience to all students and strengthen economic development and student success. Within this framework, *CTE* Foundation oversees a Sonoma County WBL system designed to enhance career exploration, engage students, and help them develop skills required for success in college and career.

CTE Foundation's Director of Industry Engagement offers workshops and strategic support to help *LbyM* teachers think creatively about how to engage their local employers, community partners, and public utilities to help their students understand the real-world applications to what they are learning.

Though this can be a challenging task, the outcome is an increase in applied learning and student engagement. These engagements can be as simple as a guest-speaking engagement or facility tour that demonstrates how classroom learning ties to the industry partner's day-to-day work, or as in-depth as an employer partner that helps shape class projects to reflect real-world settings, works with students directly, and helps evaluate their work. Whether you are working with local employers, parents, community events, or even doing a video call with someone hundreds of miles away, all of this helps students answer the critical question: Why am I learning this?

SSU's *LbyM* program and *CTE* Foundation will continue to work together to enhance the experience for each student. For direct assistance from the *CTE* Foundation on WBL activities and employer engagement, please contact Brandon Jewell at *bjewell@ctesonomacounty.org.*

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 LbyM group page, send email to
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