

Flipping science lab courses with portable sensors

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Despite over a century of emphasis and prioritized funding, science lab courses often fail to deliver their objectives. The pedagogical literature is full of contradictory claims, and recent research has shown that typical university level physics lab courses are not effective in teaching disciplinary concepts. Even worse, when following prescribed recipes to reproduce expected results, students' understanding and appreciation of the scientific method have been shown to actually deteriorate!

In contrast, open-ended lab assignments require students to define their own goals and experimental methods. These "design labs" engage students in scientific inquiries, while dispensing with the goal of teaching a set of concepts. With traditional tools, however, practicing the full research cycle requires significant time with expensive laboratory facilities – exacerbating financial and logistical problems that lab courses already struggle with.

As an alternative, we are developing and will implement and evaluate a new type of inquiry-based laboratory course. The expensive and space-intensive lab facilities are to be replaced by ubiquitous solid-state sensors, e.g. in mobile phones or controlled by microcontrollers, which are matched with apps and open-source code for data analysis. With powerful detectors in their pockets, the world offers itself as the students' laboratory, yielding unlimited data and unfiltered feedback to steer their investigations. Students' projects are supported by (and participate in) the "maker" movement's resources of open-source software and hardware. As a bonus, students acquire transferable 21st century skills for their later careers, as more sectors are transformed by data analytics, remote sensing, and IoT devices.

This presentation will describe some initial findings from a pilot of this idea within another lab course and discuss plans for full implementation in spring 2020. Extra emphasis will be given to how to most effectively guide students in designing and carrying out their own empirical research projects.