**Project Summary:**

Prior to entering college, most science students will have taken separate courses in Biology, Chemistry and Physics. Each of these courses is taught separately and with distinct and defining characteristics that would seem to apply only to the specific field of study. When these students take Freshman physics, that subject too is taught in isolation in a manner that basically emphasis how math (specifically calculus) is used to solve specific problems in physics that have exact solutions. This approach to “learning physics” is strongly reinforced through weekly homework assignments solving narrow textbook-style problems (cylinders rolling down inclined planes; which never occurs in Nature). Nowhere in this process are students ever exposed to a) systems thinking, b) how to think about a problem to being with and c) what assumptions need to made about some physical system (e.g. the Sun) in order to apply known physics to describe its behavior. This pattern of topic isolation and lack of connections between topics continues throughout the physics undergraduate curriculum. **In this project, we propose to engage 16 students selected nationwide amongst physics majors who have just finished a year of freshman physics in a 9-week intensive summer “boot camp” experience in problems-based collaborative learning.** The goal is to expose these students to different learning modalities that facilitate their understanding of systems thinking and to improve their overall data science skills. Combined, these various activities will show the vital role that instrumentation and measurement plays in determining system behavior which, in turn, will demonstrate the interconnectedness of various scientific concepts.

In the summer of 2019 we experimented, using a small number of students, with a physics “lab” class that consisted entirely of hands-on building of novel devices in which to make various kinds of measurements (one being flying a small drone around the Willamette hall atrium to collect temperature and humidity data in a 3D volume) that would then feed into later data analysis and visualization. The class was 50% male and 50% female and the continual engagement with these projects as the exclusive class pedagogy seemed to completely eliminate the gender barrier. Although many physicists see their discipline as a fun-filled, curiosity-driven endeavor, college physics courses are rarely ever taught in that manner, which tends to foster inclusiveness, but instead are taught in a style that rewards students who have good math skills; not necessarily good thinking skills. As those students are generally males, this may well factor into the strong, and well documented, female underrepresentation in physics. Rather than our traditional teaching, where students often see textbook material as disparate entities, our approach through device making by student teams will reintroduce these topics in the context of a common theme provides a conceptual framework that ties these disparate subjects together and promotes better student engagement. This directly has the result of improving the quantitative foundation of their critical thinking skill that will serve their emergence into other disciplines. Instead of learning that physics, is basically applied math (or more crudely, “what formula am I supposed to use to solve this problem”) they instead will use physics as the essence of building predictive models of the world, verifying them, and using them to model reality. Overall, this should a) increase their understanding that science is a process of discovery and b) help with retention is making physics a whole lot more fun than their previous experience has shown.