

**ABSTRACT:**

Students in my Physiology and Disease (PAD) which is a Biology elective at the Illinois Mathematics and Science Academy (IMSA), Aurora, Illinois, measure heart rates and blood pressure to study the correlation between these parameters. IMSA is a residential magnet school for students gifted in math and science. I have evolved my PAD class to be based upon student centered learning, which has proven to be the best way to challenge students to take responsibility for their own learning. Several opportunities are provided to students for hands-on experiences, such as building a working model of the pumping heart and measuring body parameters such as heart rate, lung capacity and blood pressure before and after exercise. Students normally measure their blood pressure using sphygmomanometers while exercising. To enhance student learning and improve integration between different disciplines, an interdisciplinary and collaborative project was introduced where students will modify the previously introduced Arduino heart rate monitor to make the Arduino blood pressure monitor. This will help them understand the connections between programming and measurement. This project build upon previous integration of different disciplines such as biology, computer science and physics, encouraging collaboration between students proficient in any or all of these disciplines. It is hoped that students will understand the working of the heart better by creating the Arduino blood pressure monitors.

Student understanding of material as evidenced by their assessment scores improved significantly with the introduction of the mechanical heart model building assignment. At this time, students in my classes are currently completing the blood pressure model prototypes and their feedback for this project will be collected along with any suggestions for improvement or modification. Evaluation of this assessment includes appraisal of the quality, accuracy and creativity of student monitors. It is hoped to continue building upon this non-traditional method of modeling for other physiology concepts next semester, to further enhance student learning.

**INTRODUCTION:**

- Students integrate computer programming into their learning by building blood pressure monitors using arduinos to record their blood pressure measurements during the cardiac unit.
- Students are required to work in groups of two or three for collaboration and peer review.
- The goal of this activity is to enable students to make interdisciplinary connections and have fun while taking blood pressure measurements. This activity will also encourage integration of computer science and physics into the biology classroom, and will impact about 40-60 students this Fall semester.
- Students will learn how to collect and analyze data from a pressure transducer and air pump using a blood pressure cuff and an Arduino UNO. Similar to the Arduino heart rate monitor, students will learn (1)The basic input and output data flow with the UNO and (2)How to connect wires between devices for reading, processing, and writing from the UNO
- Students will analyze code to accomplish three different tasks: (1) Read in input data from the blood pressure cuff transducer, and (2) Calculate and report average Blood Pressure on LCD display

**MATERIALS AND METHODS:**

- Students are provided with Arduino UNO or compatible boards, Pressure Transducer, Voltage controlled valve, air pumps, 4-pin cables and 100 and 1 KOhm resistors.
- Students are provided with instructions on how to complete building their project, and are required to modify the instructions provided.
- Students will collect and analyze data from their transducers using an Arduino UNO.
- Students will learn (1)The basic input and output data flow with the UNO and (2)How to connect wires between devices for reading, processing, and writing from the UNO
- Students will analyze code to accomplish three different tasks: (1) Read in input data from the Grove Ear-Clip Heart Rate sensor, and (2) Calculate and report average BP on LCD display
- Students are required to write a reflection on their work, correlating the working of the model to their understanding of the intrinsic conduction system of the heart.

Figure 1 represents student work and Figures 2 and 3 show basic materials used to make the monitors.

# HIGH SCHOOL PHYSIOLOGY INNOVATIONS: THE ARDUINO BLOOD PRESSURE MONITOR

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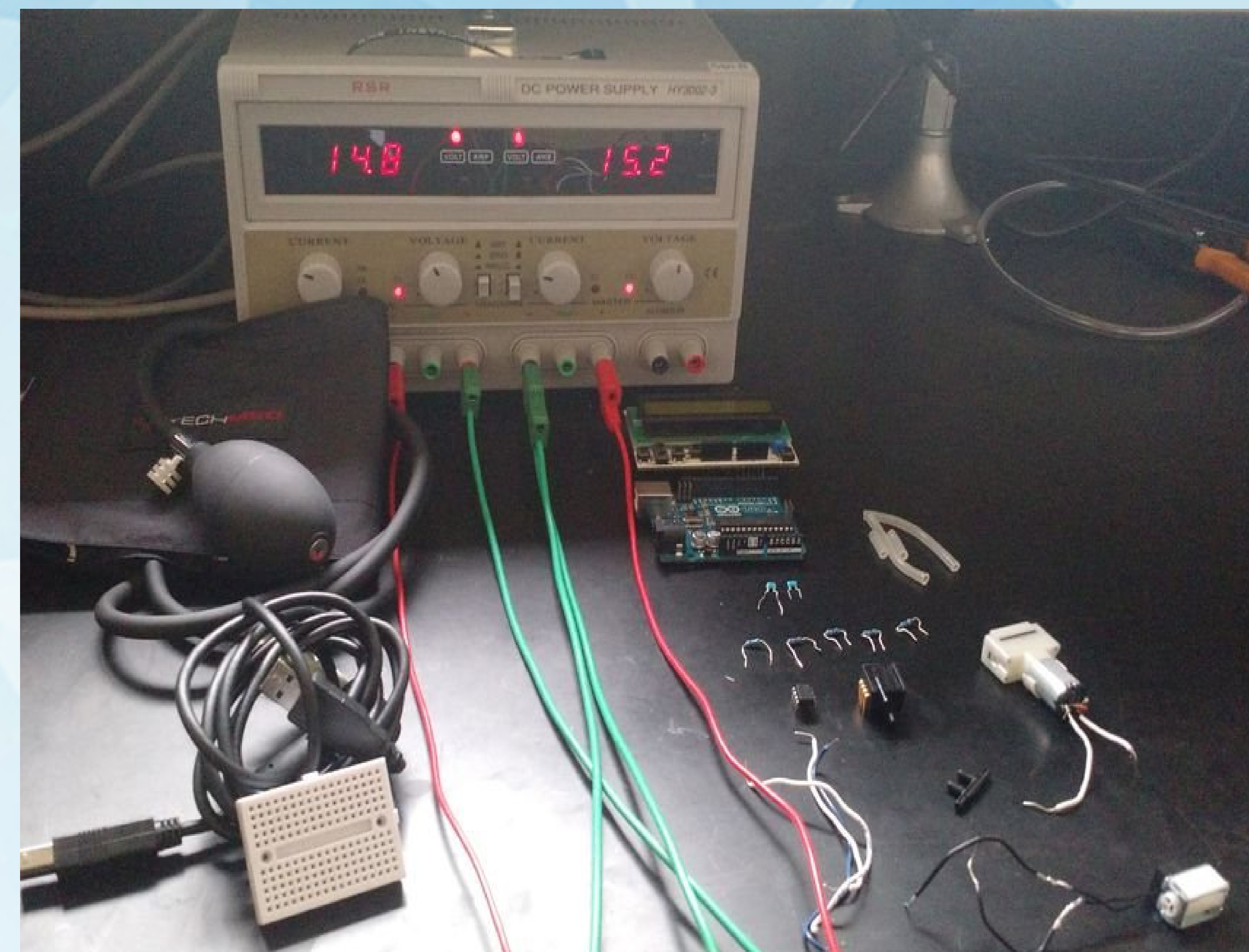


Figure 1: An example of an arduino LED heart rate monitor prototype built by students

<http://www.instructables.com/id/Blood-Pressure-Monitor/>

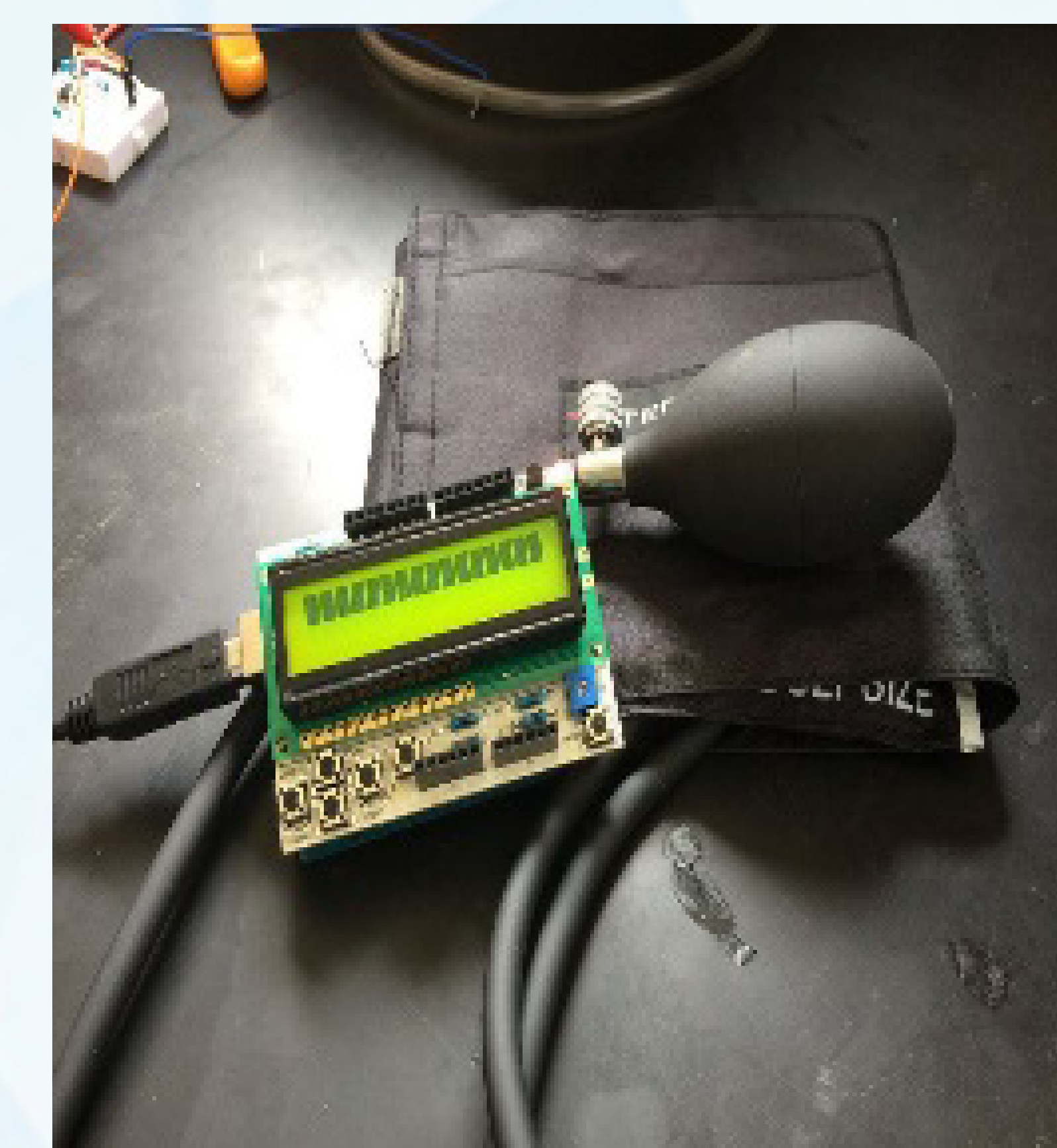
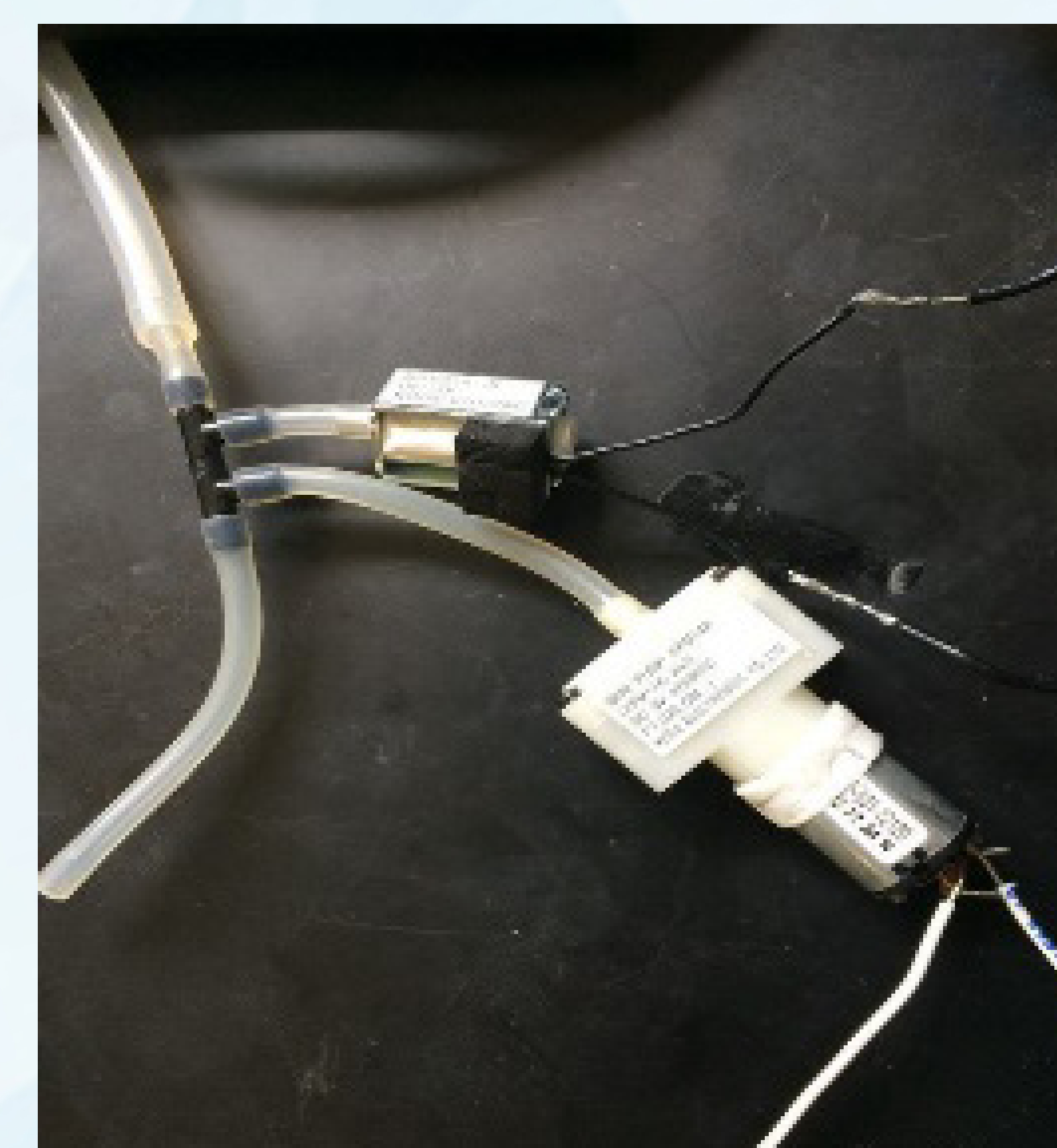


Figure 2: Basic materials used by students to build the arduino LED heart rate monitor

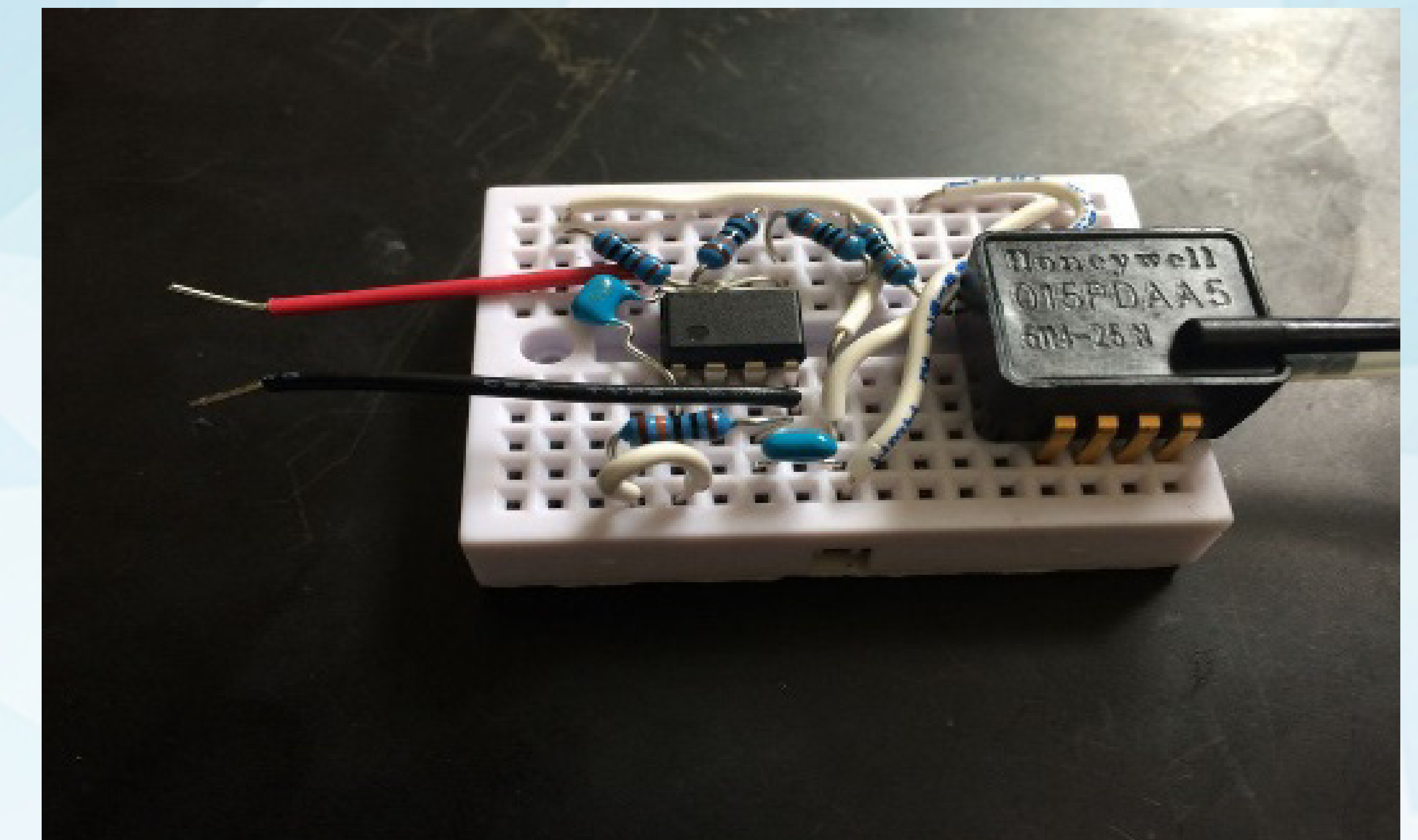


Figure 2: Basic materials used by students to build the arduino blood pressure monitor

**RESULTS:**

- We are still in the process of implementing this activity.
- Students are working on making prototypes and are excited about learning about how computer science integrates with biological measurements.

**DISCUSSION:**

- Similar to the Arduino heart rate monitor project, having students modify code to make the arduino blood pressure monitor prototypes has turned out to be more time consuming than originally intended.
- Plans are under way to implement the arduino blood pressure monitor building into the Fall 2019 PAD classes.
- Next steps involve getting students to work on building additional applications of Arduino based measurements.