

INNOVATIONS IN HIGH SCHOOL PHYSIOLOGY: THE ARDUINO HEART RATE L.E.D MONITOR

Sowmya Anjur

Illinois Mathematics and Science Academy, Aurora, IL

Program Number 629.8

ABSTRACT:

Physiology and Disease (PAD) is a Biology elective at the Illinois Mathematics and Science Academy, Aurora, Illinois, which is a residential magnet school for students gifted in math and science. My PAD class is based upon student centered learning which has proven to be the best way to challenge students to take responsibility for their own learning. Students spend the most time on the cardiovascular unit, wherein they measure their heart rates, lung capacity and blood pressure before, during and after exercise, correlating their data to their understanding of neuronal controls. Students also build a working model of the mechanical pumping of the human heart. Although several such opportunities are provided in this unit for hands-on experiences in the laboratory and in the classroom, the intrinsic conduction system of the heart has yet to be modeled. Students normally measure their heart rate using carotid pulse or radial pulse while exercising. Digital heart rate monitors are expensive and not very conducive to re-use. Based on my previous experience with the mechanical heart models, requiring students to build models seems to correlate better with their improved understanding of the material. This prompted the creation of the arduino heart rate L.E.D. monitor project. Another factor that strengthened the necessity of an innovative lab that used their programming skills to model the electrical system of the heart, was the mandatory computer science requirement for high school graduation. At this time, students in my classes are currently completing the heart rate model prototypes and I plan to collect their feedback for this project along with any suggestions for improvement or modification. Future research is planned to correlate student understanding to modeling activities in the classroom, based on their work and that of upcoming classes in the course. The main purpose of this assessment is for students to engage their creative skills and take responsibility for their own learning. The evaluation of this assessment includes appraisal of the quality, accuracy and creativity of their monitors and the accuracy of their reflective correlations with the electrical circuit of the human heart. 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 heart rate monitors using arduinos and LED lights that flash during measurements.
- Students are required to work in pairs for ease of collaboration.

- The goal of this activity is to enable students to make interdisciplinary connections and have fun while taking heart rate 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 Grove Ear-Clip Heart Rate sensor 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, (2) Have an LED blink every time a sensor measurement is made (so students can manually calculate BPM) and (3) Calculate and report average BPM on LCD display

MATERIALS AND METHODS:

- Students are provided with Arduino UNO or compatible boards, Grove base shields, Grove ear clip heart rate sensors, Grove universal 4-pin cables and LED and 330 Ohm resistors.
- Students are provided with instructions on how to complete building their project, and are required to modify the instructions provided.
- Students submitted a modified program to activate their heart rate monitor before using it for measurements.
- Students will collect and analyze data from a Grove Ear-Clip Heart Rate sensor 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, (2) Have an LED blink every time a sensor measurement is made (so students can manually calculate BPM) and (3) Calculate and report average BPM 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, Figure 2 shows basic materials used to make the monitors and Figure 3 shows some student comments about this activity .

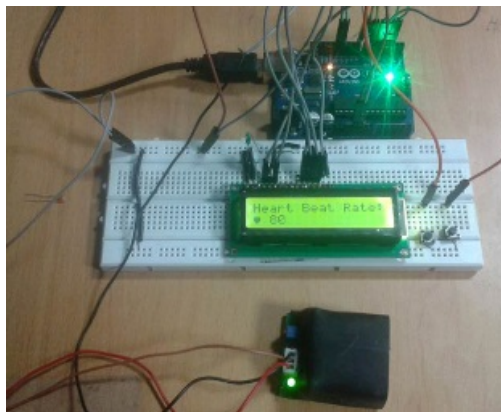


Figure 1: An example of an arduino LED heart rate monitor prototype built by students

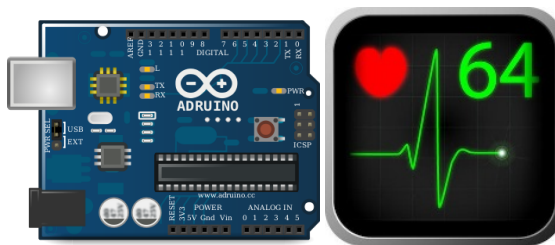


Figure 2: Some basic materials used by students to build the arduino LED heart rate monitor

“RESULTS :

- We are still in the process of implementing this activity.
- Judging from the prototype experiment, student understanding of arduino based heart rate monitors has been enhanced and there seems to be a general atmosphere of increased interest and passion for measuring heart rate using the “cool” monitors that they built.

1. *This is GREAT! I never thought that biology could have any connections to computer science but it does,,,,,*
2. *“A lot of work to build the monitor, but I understand the physiology of heart rate measurement so much better because I had to design the monitor to measure it!”*
3. *“I liked the fact that the teacher brought new things into the classroom. I am good at computer science but not biology so this was a great opportunity for me to do a good job at something I was familiar with.”*
4. *“I am not very good at computer program code but I learned a lot through this activity. I am glad the teacher took the trouble to introduce us to something like this.”*

Figure 3: Student comments for this activity

DISCUSSION:

Having students modify code to make the arduino heart rate LED monitors prototypes turned out to be more time consuming than originally intended.

Plans are under way to implement the arduino heart rate monitor building into the Fall 2018 PAD classes. Next steps involve getting students to write code to integrate Blood Pressure measurements into the arduino monitor

This class is a perfect opportunity to allow students to express their creativity in making the LED heart rate monitors.

PAD has been a great foundation to integrate interdisciplinary learning, and especially to integrate programming, which seems to have become a worldwide necessity, into my classroom.

Students will learn that physiology has many connections to physical sciences such as physics and STEM skills such as computer programming