Program No.

Integrating Quantitative Experiments into the Physiology Classroom

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Abstract:
Physiology and Disease is a student led inquiry based class at the Illinois Mathematics and Science Academy, where students design and execute their own experiments and analyze their data based on the evidence they have gathered. Student surveys have also indicated the need for more quantitation in lab experiments. To accommodate all these issues, several changes are being implemented into the course in an effort to allow students to identify the role of the neuronal controls for parameters such as blood pressure and heart rate, and to understand better how they work in concert. A new project (construction of a heart model project) was also included in the curriculum.

Introduction:

- Physiology and Disease is a one semester Biology elective for juniors and seniors at IMSA, and although the curriculum has been gradually changed, based on student surveys, from partly student centered to completely student centered, students have brought up the need for more quantitation in experimentation to help them tie in their Biology experiences with their Physical Science courses.
- The objective of this experiment was to implement electronic automation into the Physiology curriculum to help augment student understanding.
- Students can continuously record their blood pressure using Vernier logger pro software while exercising and doing other activities, and use this as a hands on approach to study the cardiovascular system rather than the traditional bookish approach.
- Depending on the success of the BP probes, heart rate monitors will be purchased to supplement student exercise data.

Materials and methods:

- Students have traditionally worked in small groups of 3-4 and designed an experiment to measure blood pressure before and after exercise (increase through exercise or decrease through meditation, etc.) and then measure their BP using the traditional sphygmomanometer method. Heart rate is also measured simultaneously.
- Blood pressure sensors from Vernier (BPS-BTA, $105 each) will be used to supplement student data using the sphygmomanometer. The Blood Pressure Sensor is a non-invasive sensor designed to measure human blood pressure. It measures systolic, diastolic and mean arterial pressure utilizing the oscillometric technique. Pulse rate is also reported.

Figure 1:Vernier blood pressure sensor cuffs (BPS-BTA) http://www.vernier.com/products/sensors/bps-bta/

- The experiment will be repeated three times by each group for consistency and the data will be analyzed using two-way factorial ANOVA for independent samples (Vassar stats, http://vassarstats.net/)
- The results of the analysis will be used by students to build a model for the understanding the neuronal controls that are responsible for heart rate and blood pressure. As part of this journey, students will construct accurate life size heart models after getting approval for precise measurements and will have 4 weeks to build the model. Student understanding or the enhancement thereof will be measured through periodic assessments until a correlation can be made between the merits of quantitation and the enhancement of student understanding.

Projected Outcomes:

- This project will advance teaching and learning by stimulating students to understand basic principles of physiology and explore various other options in their quest to be innovative leaders. Currently students are having trouble using sphygmomanometers to measure blood pressure. They have difficulty listening for the sounds of Korotkoff which indicate the highest and lowest arterial pressure in the arteries. Using sensors to sense changes in blood pressure will take the frustration out of this experiment and allow students to design applications of the experiment, as well as enable them to continuously record their readings using Vernier loggerpro software.
- Correlations can then be made with the lung lab and the heart lab and eventually a model can be constructed based on the data
- Further research is planned with incoming PAD classes to reinforce these preliminary results.
- The project will be evaluated by consolidating data from students at the end of the semester and surveying students to quantitate their liking for the sensors as opposed to the traditional sphygmomanometer method.

Figure 2: Some examples of heart models constructed by students as part of the heart unit. Students were given 4 weeks and had to get their project design approved before construction. All models were life sized.