



Increasing student confidence and enthusiasm in a physiological signals lab: Work in Progress

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Inquiry-based learning followed by peer-teaching in a physiological signals lab: Work in Progress

Introduction

Cooperative, student-centric pedagogical models have been shown extensively to enhance student learning. Not completely unrelated to these models, student attitude and motivation has a significant impact on student learning. Grades make a convenient extrinsic motivator for students to learn but when students are intrinsically motivated the learning occurs at a higher level¹. Along those lines many instructors are exploring how to utilize active learning in laboratory classes^{2,3,4} because cookie-cutter labs do not allow students to practice their creativity or develop critical thinking skills^{5,6,7}. Inquiry-based learning in a laboratory environment develops creativity and critical thinking skills^{8,9}. Peer-teaching has also been shown to increase student learning in a laboratory environment³. This study looks at how inquiry-based learning followed by peer-teaching affects student attitudes toward the subject matter and their overall learning experience.

Methods

Table 1. The five different measurement techniques utilized to complete instructor provided objectives.

Technique	Instructor Provided Objectives
Electromyography (EMG)	<ul style="list-style-type: none"> • Collect signal using National Instruments myDAQ and homemade amplifiers • Analyze the signal using Labview • Compare lifting a variety of weights at a variety of speeds
Electroencephalography (EEG)	<ul style="list-style-type: none"> • Collect alpha waves under two different conditions such as eyes open and eyes closed • Compare the frequencies
Heart Rate Variability (HRV)	<ul style="list-style-type: none"> • Collect 20 minutes of electrocardiography data • Calculate HRV statistics
Electrooculography (EOG)	<ul style="list-style-type: none"> • Determine relationship between voltage and angle of vision • Measure reaction time for moving eyes only • Measure reaction time for maintaining gaze during forced head movement
Earthworm Action Potential Propagation	<ul style="list-style-type: none"> • Record an action potential upon posterior stimulation • Record an action potential upon anterior stimulation • Calculate action potential velocities and compare posterior to anterior • Determine stimulus threshold (i.e. how many action potentials are required to elicit a muscular response)

A brief description of the physiological signal measurement techniques and the objectives to be met is shown in Table 1. These were presented to all of the students before they were asked to complete a survey of their preferred topic to study. Groups of two or three students were then created by the instructor. Groups were given some critical background information to prepare

for lab including references regarding relevant physiology, measurement techniques, and data analysis specific for the acquired signal. The groups were allowed one three hour lab period to learn and practice the measurement and analysis techniques in order to achieve the instructor provided objectives making them the “experts”. During the following week’s three hour lab, all of the groups presented their techniques and how to achieve the objectives. During the next four lab periods, groups rotated through the other four experiments that were presented to them and achieved the instructor provided objectives.

The attitudinal impact of this pedagogy including student-perceived learning gains, confidence in their understanding, and enthusiasm for learning the new material was assessed using an anonymous online survey ‘Student Assessment of their Learning Gains (SALG)’ containing Likert-style and free response questions¹⁰. The Likert-style questions ranged from “no gains” or “no help” scoring a 1 to “great gains” or “great help” scoring a 5. The sample size that completed the survey was 16 out of the 33 enrolled students.

Results

Three of the five techniques had not been performed by the students in the curriculum before: EOG, EEG, earthworm action potential propagation. Students reported an increase in perceived understanding for EEG and EOG receiving scores of 4.0/5.0 with 31% reporting “great gain” in their understanding. The earthworm action potential propagation scored a 3.6/5.0. The techniques that were not completely new scored slightly lower, 3.4/5.0 and 3.2/5.0 for EMG and HRV respectively.

The students reported perceived increase in skills due to “teaching peers how to perform an experiment” (3.9/5.0) but reported a smaller gain in understanding from “preparing and giving oral presentations” (2.9/5.0). Students reported only a moderate gain in “enthusiasm for physiological signals” (3.2/5.0) compared to a larger gain in “confidence that you can analyze physiological signals” (4.0/5.0). The comments about how “class changed your attitudes toward the subject” were overall very positive:

- “I feel more prepared to collect, analyze and explain physiological signals”
- “I was not particularly interested in signal processing before this lab. I now have a better understanding of how to interpret signals along with a marginally increased interest in them.”

Students found “participating in class discussions during class with peers”, “participating in class discussions during class with instructor”, and “participating in group work during class” as helpful (3.9/5.0 each); 25%, 25%, and 31% respectively found these class activities as “great help”. Students found “working with peers during class” and “working with peers outside of class” to be more helpful scoring 4.1/5.0 for both. The comments about how “the support you received from others helped your learning” were overall very positive:

- “It made it much easier to learn the material if I could interact with others to work out the solutions to my problems”
- “Between staff and peers, I asked a lot of questions and got asked plenty of questions as well. The classroom was a cooperative environment”
- “Everyone was willing to help each other out in the group labs and this was really helpful to allow us to learn it better”

When asked to comment on “how the way this section of class was taught helps you remember key ideas,” students gave mixed comments:

- “Having to create a lab for ourselves and teach it to the class helped me to understand the physiology behind the experiment better.”
- “I don’t think this method made me better remember any key ideas. It seemed like such big shifts each week that we didn’t have time to absorb any one thing.”
- “We only covered slightly above the fundamental level of understanding most of the subjects. This helps me to remember these fundamentals.”
- “Learning on my own and then teaching students was probably the best method of learning. I found it easier to sort and organize my thoughts if I knew I would have to repeat them to the class and have a fundamental understanding of each concept in case questions were asked.”

Discussion, Conclusions, and Future Work

Inquiry-based learning was a success. The students were given background information as well as a friendly environment for experimentation which allowed them freedom to apply the understanding they already had and learn new skills. They enjoyed the experience and felt they learned the techniques. Peer-teaching was a success but does show room for improvement. When the students taught each other the technique, they appreciated the process of breaking down the steps and being clear to not just show conceptual knowledge but teach how to perform a task. The students appreciated and utilized the friendly environment to ask each other questions.

In future offerings of the course, each successive week after the initial inquiry-based learning week will be dedicated to a specific experiment. Having all of the presentations in one week and then rotating through the experiments meant that the later weeks were further removed from their presentation and that the “experts” were busy performing their own lab experiment. In future offerings of the course, “experts” will present at the beginning of lab and then act as teaching assistants during lab. Also, some techniques were found to be less suited for this pedagogical style. The HRV lab will be removed from this section of the course. Lastly, the objectives will be evaluated as some were not obtainable or a more challenging objective should be added to elevate the expectations. The course discussed in this study has only been offered this single time so no control group exists which is a limitation concerning analysis. Future analysis will focus on assessing how being the “expert” for a measurement and analysis technique leads to increased knowledge and skills.

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