Apr 12th, 2:00 PM - 3:00 PM

Creating and Implementing a Teaching Module for the High School Biology Classroom

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Introduction

The implementation of hands-on experiments in the science classroom allows students to actively learn, comprehend, and retain more information by making observations, developing and testing hypotheses, manipulating variables, analyzing data, and coming to their own conclusions based on acquired evidence[1, 2]. As a future high school biology teacher, I created an inquiry-based teaching module that can be implemented into my biology classrooms. Egg masses from *Physa acuta* (Figure 1), a locally common freshwater snail, were utilized as a model to test the effect of rearing temperature on the rate of embryo development and survival. All *Physa acuta* are hermaphroditic; each individual is simultaneously male and female. Each snail lays egg masses; within each egg mass embryos are individually contained within capsules (Figure 2). Materials present within the capsule provide nourishment for the developing embryo prior to hatching from the capsule as a juvenile snail.

Methods

Students in Biology 209, Biostatistics and Experimental Design implemented the protocol. In this protocol, groups of 3-4 students:

•Collected egg masses (<24 hours old) and divided each mass into two pieces with a similar number of egg capsules.

•Photographed and measured each capsule.

•Reared each ½ egg mass at a reference temperature (23 °C) and either a lower (20 °C) or higher (26 °C) temperature.

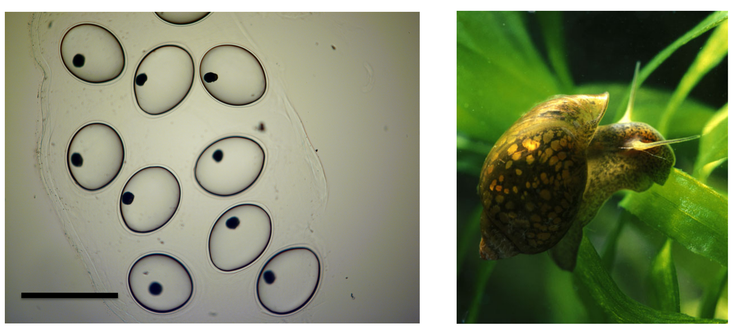

Figure 1. Images of *Physa acuta*. **1a.** An intact egg mass. Within this egg mass are nine egg capsules each of which contains a single embryo. Scale bar: 1mm. **1b.** An adult *Physa acuta.* Image from http://www.fwgna.org.

- Examined all ½ egg masses until all embryos hatched as juvenile snails or died; the date and time of each examination was recorded.

Each group examined the complete development of 5 separate egg masses.

At the end of the experiment, students completed a survey assessing the value of the project to enhance their understanding of experimental design, statistical analyses, and the scientific process.

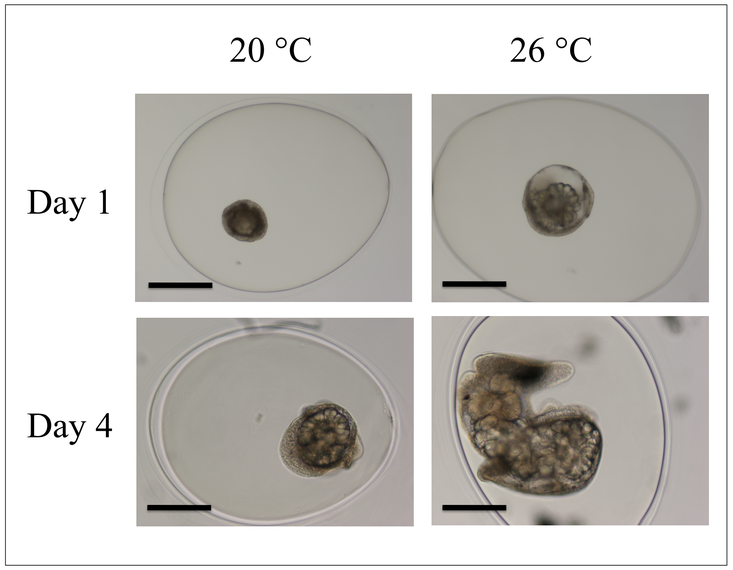

Figure 2. Testing the effects of temperature on the development of egg masses. Day 1 images show developing embryos (<24 hours old) that were reared at 20 °C or 26 °C. After four days, the individuals at 26 °C were larger and had developed faster than individuals reared at 20 °C. Scale bar: 200μm.

Results

86.7% (13 of 15) of students in Biology 209 completed the survey. The majority of students reported that through this exercise they learned more about the components of the scientific method (Table 1). However, the completion of this protocol did not significantly improve students' understanding of the value of experimental replication and sampling frequency.

Free Responses

46.2% of students support the inclusion of a class project in future Biology 209 classes, 38.5% of students would not support a project, and 7.7% of students would support the project only if there was a required laboratory session.

Table 1. Summary of results of student survey. Each value represents the percent of students who agreed, disagreed, or neither agreed nor disagreed.

	Agree	Neither Agree nor Disagree	Disagree
The expectations of the protocol were clear	**92.3**	**7.7**	**0**
Completing this project increased my understanding of:			
the importance of the scientific process	**61.5**	**30.8**	**7.7**
the importance of experimental design	**69.2**	**23.1**	**7.7**
the importance of standardizing methods	**84.6**	**0**	**15.4**
the importance of replication	**46.2**	**35.8**	**15.4**
the importance of sampling frequency	**38.5**	**53.8**	**7.7**
the importance of sample size	**61.5**	**23.1**	**15.4**
the appropriate selection and use of statistical tests	**61.5**	**38.5**	**0**

Conclusions

The findings suggest that completion of this project aids in student understanding of the process of science. This protocol, with appropriate modifications, could be used as a teaching module in a high school biology classroom.

For future versions of this protocol, at either the collegiate or high school level, our survey results indicate that:

•More emphasis should be stressed on the importance of replication and sampling frequency. A summary at the beginning of the protocol can be added to emphasize these concepts.

•More information should be added on how to work the microscope camera. Pictures and detailed descriptions can be added to increase understanding.

References

[1]Handler, A., & Duncan, K. (2006). Hammerhead shark research immersion program: Experiential learning leads to lasting educational benefits. *J. Sci. Educ. Technol.*, *15*(1), 9-16.

[2]Mulkerrin, E. A., & Hill, J.W. (2013). Relevance, rigor, and relationships: Student perceptions following participation in an integrated experiential zoo-based academic high school science program. *Creative Ed.*, *4*(4), 287-297.

Acknowledgments

I would like to thank the Biology 209 class for participating in this experiment.