Use Your Melon: Engaging Undergraduates in the Process of Science by Exploring Beluga Facial Expressions

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Process Skill Development in Undergraduate STEM Education

In undergraduate STEM education, there is a growing emphasis on explicitly training undergraduates the scientific process skills that enable them to "think like a scientist." Engaging students in research experiences is a highly effective way of teaching these skills, which include formulating questions, analyze and interpret data, visually representing data, and communicating scientific results to others (Brownell et al. 2015).

Undergraduates conducting independent research under faculty guidance can develop these skills. However, these students are often trained to contribute to existing programs or to test hypotheses previously developed by the PI, limiting opportunities to develop higher order cognitive skills during their apprenticeship.

These opportunities are intentionally provided to students participating in behavioral research on beluga facial expressions. In a single semester, students learn to conduct the research, formulate their own novel hypothesis, analyze the data to test their hypothesis, and communicate their findings to students and faculty in the form of a conference-style poster.

Bloom’s Taxonomy

The overarching goals of the project are to: 1) demonstrate that the belugas make specified types of melon shapes, 2) that these shapes serve a social function, and 3) that certain shapes are associated with particular behavioral contexts.

Preliminarily, changes in melon “shape,” and other social behavior for 3 belugas was recorded by the PI for 204 hours of video collected at Mystic Aquarium. During the project, students are provided with the video and this raw behavioral data so that they can further evaluate each shape with a refined ethogram and collect additional data on behavioral context to achieve the project goals.

Remember, Understand & Apply

Learning the Ethogram

Students are trained to recognize the different shapes in a training video and are provided with an ethogram that includes written descriptions and images of each shape made by each beluga in the study group. Students are then provided with an hour-long video with 103 shape events, and code each shape with the ethogram.

Interobserver Agreement

Before generating data, students must demonstrate good interobserver agreement with the PI for this video, as assessed by Cohen’s kappa (Kaufman & Rosenthal 2009). To ensure reliability, a screen shot is taken of every shape analyzed so that the PI can test agreement across the entire data set without having to reanalyze the video.

Generate Data

Once trained, students evaluate shapes and record:
• Specific shape identified
• Shape duration
• Actor and Recipient
• Time and identification of behavioral events performed by the actor or recipient ±10 sec from start/end of shape (using previously coded data)

Create, Evaluate & Analyze

Create Hypothesis

Based on their own observations, students are encouraged to create a hypothesis that could be tested using the full data set. During individual meetings, they receive feedback on formulating questions and revise their hypotheses as necessary. For example:

“Melon shapes performed during an open mouth behavior will vary in frequency.”

“Melon shape frequency (per minute of social interaction) will be higher during breeding season than outside of breeding season.”

Analyze & Visualize Data

Students then determine which measure of behavior (frequency, duration, latency, etc.) is most appropriate for their question. Then, they predict what their data might look like in graphical form if their hypothesis is supported or if it is not, challenging them to determine the best way to visually represent their data. Based on these decisions, students manipulate the data spreadsheet so that they can analyze the data of interest.

They are provided with a pre-recorded tutorial on making graphs in Excel, and receive iterative feedback on their graph(s). Advanced students may create graphs in R.

Interpret & Communicate Data

Students then interpret their data in the context of their hypothesis. They propose potential explanations and future research that could help resolve unanswered questions. Finally, students create a poster to communicate their findings. Pre-recorded tutorials and iterative feedback aid the students in this process.

Conclusions

This project is ideal for involving undergraduates in science because the prerequisite skills required are minimal, enabling students with no previous research experience to participate and reach the higher order cognitive skills of evaluate, analyze, and create sooner and with less foundational training than lab-based research.

Students have made meaningful contributions to the project while preparing themselves to succeed in future research opportunities, highlighting the value of collaborations between aquaria and universities for both research and education purposes.

Discussion

Over the last 5 semesters, 10 students have participated in this program for at least one semester, coding 2700 melon shapes in the process. These students have made meaningful contributions to the research, bringing fresh perspectives and generating questions that will be explored further.

The use of video allows students to work independently, broadening participation among students who may not otherwise have time to participate in lab-based research apprenticeships. The rigorous but standardized training process also allows more students per semester to contribute, as many as 4 students have participated simultaneously.

The approach of generating a single data set that can be explored independently in many ways can be readily transferred to other behavioral research projects. In future applications, there will be a greater emphasis on the assessment of the intended learning outcomes to ensure that they are achieved.

This approach formed the basis of a Course-based Undergraduate Research Experience (CURE. Brownell et al. 2015) designed for a course on Advanced Methods in Applied Animal Behavior at URI, further broadening undergraduate participation in novel behavioral research.

References