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Cats Teach Stats: An Interactive Module to Help Reduce Anxiety When Learning Statistics in Biology

RECOMMENDED
FOR AP Biology

SUANN YANG, JENNY HAZLEHURST,
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|=====| 79
I Do you like to watch cat videos?

- 1: Maybe
2: Yes
3: No

Selection: |

ABSTRACT

Tools that teach quantitative skills and foster positive student attitudes toward these skills are important in biology curricula. Math and statistics anxiety is common and can interfere with student learning in biology courses. We describe a new framework for alleviating this anxiety. In our module, students watch a cute internet cat video, which inspires them to ask scientific questions about animal behavior and collect, analyze, and interpret data. We developed two freely available interactive tools to implement our module. We successfully implemented these tools with undergraduate students at two institutions. Based on this experience, we provide ideas for extension along with assessment.

Key Words: animal behavior; math anxiety; scientific inquiry; statistics anxiety.

increased happiness and stress relief (Myrick, 2015). Furthermore, minoritized students in particular may choose to pursue biology careers in part because they wish to help people or animals (Villarejo et al., 2008). Having pets can affect children's understanding of biological concepts (Geerdst et al., 2015; Longbottom & Slaughter, 2016), which they then carry with them into higher education. Our modules build on the informal biology experiences that students have had observing their pets' behavior.

Our module uses a computer-based approach to link a cat video with statistics, providing students with positive associations with math and statistics. Students observe animal behavior in the cat video and use what they observe to engage in scientific inquiry and apply statistical knowledge. Students test if the cat has a preferred "handedness," a characteristic of brain lateralization (Bisazza et al., 1996).

○ Introduction

Publications such as BIO2010 (National Research Council, 2003) and *Vision and Change* (AAAAS, 2011) have urged biology educators to increase our emphasis on quantitative biology skills. However, relatively few provide resources or innovations to teach these skills in biology courses (Aikens & Dolan, 2014). While the number of resources is growing, the need for tools that teach quantitative skills and foster positive student attitudes toward these skills remains. Many undergraduate biology students report feelings of fear and apprehension while doing mathematics and/or statistics, which can lead to physiological manifestations (Lyons & Beilock, 2012) and worsened performance in tasks involving math (Ashcraft & Kirk, 2001).

Our module attempts to reduce statistics anxiety in biology students through the use of an internet cat video in the context of animal behavior and scientific inquiry. Watching cute cat videos online has been associated with emotional benefits such as

“Math and statistics anxiety are common and can interfere with student learning in biology courses.”

○ Module Description

Our module is designed with the BSCS 5E Instructional Model (Bybee et al., 2006). We have created two tools available as Open Educational Resources to implement the module (see “Links to Online Resources” below). One is a web app and the other teaches statistical coding skills in the programming language R through a swirl lesson.

The lesson engages students with an internet video of the “cat-istician” William Plumer Jacobs (WPJ), using a cat toy that consists of a cardboard disk surrounded by a circular track containing a movable ball (Figure 1). The video includes sound effects that are specific to left or right paw use.

Students explore the patterns in paw usage observed in the video, either in groups or as a class. Students propose scientific questions about handedness preference and identify the data they can collect from the video to answer the question. Students (in groups) and/or the instructor decide(s) how to collect the data.

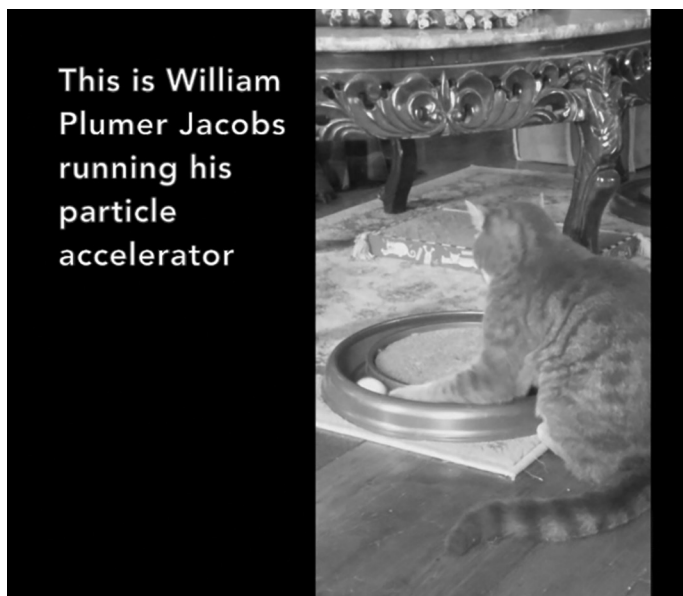


Figure 1. Screenshot of YouTube video of catistician William Plumer Jacobs.

After data collection, the students and/or instructor decide(s) what calculations need to be performed, how the data can be graphed, and the reasoning behind these decisions.

As the lesson moves into explanation and elaboration, student groups create and interpret graphs of the data collected to formulate statistical hypotheses. If students have already been introduced to the relevant statistical methods, they would then run a binomial test. Otherwise, instructors can teach this necessary statistical test. Instructors can also discuss the assumptions of the binomial test and how well it does or does not apply to the collected data.

Finally, students use their statistical results to evaluate their hypotheses. Students share their findings between student groups or with the whole class.

○ Cats Teach Stats Tools

We have developed an interactive web interface (Figure 2) and tutorial (Figure 3) to implement our module. We call the action of pawing the ball a “boop.” After collecting data, students create bar graphs and use a binomial test to analyze handedness preference based on boop counts.

○ Implementation of Web Interface

Our web interface, created using the *shiny* package in R (Chang et al., 2018), allows students to observe the WPJ video and enter the data they collect on paw usage. A bar graph is generated automatically, along with the results of a binomial test from their data (Figure 2).

We implemented the web interface in a first-year seminar for biology students at SUNY Geneseo. We distributed to students a link to the interface. Students immediately engaged with watching the video. The students grouped themselves into teams of three, with members assigned to count left, right, or total boops. Students

Does WPJ have a Paw Preference?

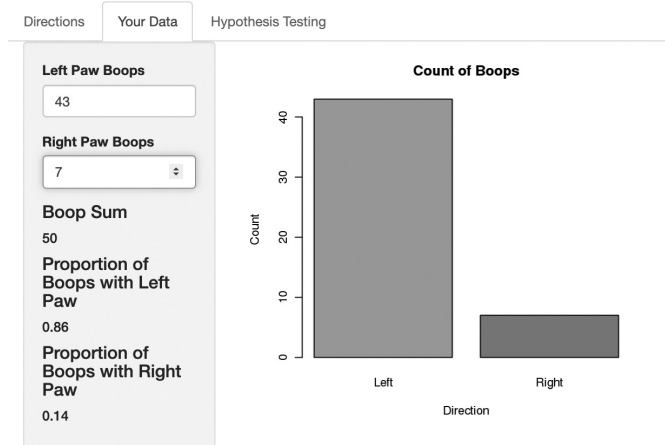


Figure 2. Screenshot of web interface for creating bar graphs from data collected from our cat video. Entered numbers of boops are for illustrative purposes only and are not the actual counts.

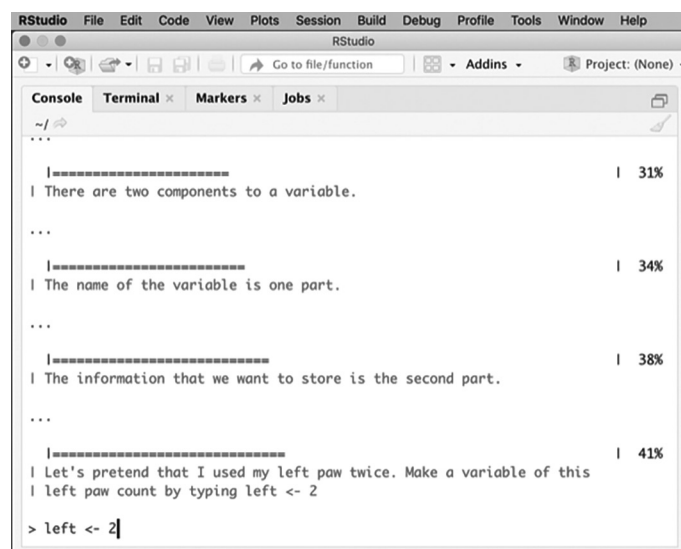


Figure 3. Screenshot of example tutorial questions and prompts.

determined that their counts were accurate when the left and right boop sum was equal to the total boop count. Students then proceeded to the graphing tab and the binomial test results.

○ Interactive Coding Tutorial

Coding skills in the R language are becoming critical for biology research careers. Our interactive tutorial (Figure 3) teaches students the basics of R programming to analyze data from the WPJ video. The tutorial uses “swirl,” created using the *swirlify* package in R (Kross & Carchedi, 2018). The three-part tutorial teaches students about different data types, graphs used for different data types, and how to perform a binomial test in R. Student mastery of the major concepts and programming skills is assessed using quiz-style questions throughout.

○ Implementation of Interactive Tutorial

California State University San Marcos students were recruited to implement the tutorial (approved by CSUSM IRB no. 1316239). We provided students with instructions to open RStudio and access the tutorial (see Supplemental Material available with the online version of this article). Students collected data from the cat video of WPJ twice for accuracy. We also demonstrated how to use the data for statistical analysis. We surveyed students afterward, and the results suggest that the swirl lesson was associated with decreased anxiety about statistics, along with increased ability in statistics (see Supplemental Material).

○ Extensions

Additional videos of other cute animals could increase sampling efforts and provide opportunities for small-group work. Advanced students could make their own lessons using new or existing videos. We suggest that the web interface could be used in person or for distance learning to teach the scientific process in an introductory biology course, and the interactive coding tutorial could be used in biostatistics, animal behavior, or experimental design courses.

○ Links to Online Resources

- *QUBES Hub Group*: https://qubeshub.org/community/groups/cats_teach_stats/projects
- *Paw Preference Video of Catistician WPJ*: <https://youtu.be/IW9Lmh3D4cY>
- *Web Interface Tool*: <https://qubeshub.org/tools/ctsbinetest/>
- *Interactive Coding Tutorial Tool*: <https://qubeshub.org/resources/ctsbinetestswirl>
- *GitHub Code*: https://github.com/CatsTeachStats/shiny_app_and_swirl_lessons

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