Introduction

In an effort to help students become more mathematically fluent there has been a surge in problem-based learning (PBL), a “teacher-facilitated, student-driven approach” [3], since learning through discovery is the way “conversational” math skills are acquired [2, 4, 5]. Although PBL has become more prevalent in elementary and secondary school, in the college classroom it is largely confined to medical and engineering curricula and is far less visible in college mathematics classrooms [1]. When a mathematics course does have an inquiry-based module it often consists of “canned” data for which a predetermined model fits well. This undermines the creative and fluency-building potential of the project.

When students are involved in the data collection process, they have a more intuitive understanding of the mechanisms driving the data [6]. This motivates modeling the data and makes it more clear to students when their models are successful. Generating and describing data gives students a sense of responsibility and produces useful learning lessons, provided
the instructor properly designs the exercise.

We propose that a well-designed activity in which students collect their own data has the following traits:

- **Promote Discovery**—open-ended with ample opportunity to connect concepts and explore
- **Authentic**—an original task driven by student-collected data that uses models/techniques actually used by practitioners
- **Visible Success**—back-story, data and available knowledge make it intuitively (ideally visually) obvious if solution/model is “good”
- **Engaging**—an accessible, original question that fits into a broader storyline

Yeast are an ideal candidate for students to model mathematically. As Gause (1934) states “...yeast cells are sometimes subject to perfectly definite quantitative laws. But it has also been found... their trends often do not harmonize with the predictions of the relatively simple mathematical theory.” These characteristics allow students to initially engage in modeling yeast dynamics with relative confidence but the students must critically and creatively adjust their models in order to get their predictions to better harmonize with yeast data. Here we outline a highly adaptable lab that can be run over several hours using readily-available ingredients. The resulting data can facilitate modeling experiences designed for a wide range of mathematics students. Yeast are grown in a small, capped flask, generating carbon dioxide which is trapped in an inverted jar full of colored water. The volume of carbon dioxide produced can either be measured directly or by using a time-lapse photography application on an iPad or similar. Students are then challenged to model the resulting data. From this exercise students gain greater understanding of the modeling process, parameter estimation, population dynamics and limiting factors.

The Yeast Lab is usually performed with classes comprised of upper-class undergraduates and graduate students from mathematics, statistics, biology, natural resources and biological
engineering. For the Yeast Lab students are divided into teams so that each team has a member with deeper biological background and someone with exposure to nonlinear fitting techniques and numerical methods for solving differential equations.

References


