# Teaching the Scientific Method in Core Curricula Through Practical Lab Assignments

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## ABSTRACT

Most core curricula at liberal arts schools require a science component to their undergraduate education for non-science majors. It is possible to meet these requirements with modified forms of normal science classes. However, for many students these classes can be a monotonous throwaway more than meaningful learning. At Lynn University, the core classes in "Dialogues of Scientific Literacy" incorporate opportunities for students to learn the scientific process via simple lab exercises without burdensome prerequisites. In one iteration, we implement a 3-part lab series meant to take students from observation to hypothesis formulation, to experimental design. The starting point is a simple animal observation experiment where data is collected and combined on an ongoing basis from each class. The final lab is a multistep experiment where they perform the scientific method start to finish using their phones as instruments for collecting quantitative sound data.

## BACKGROUND

- **Scientific Process** – Teaching the scientific process to non-science majors is imperative to ensure a society composed of scientifically literate individuals[1]. At the core of a scientific education is the undertaking of experimentation. However, basic scientific equipment can be limited when teaching core curriculum courses. In addition, the required skillsets for handling such equipment are rarely present. For this reason, it is often easier to rely on methods that can be performed without the aid of anything other than the students' five senses and a computer or smartphone.
- **Citizen Science** – Citizen science has become a powerful tool for outsourcing data collection, especially for field-based or ecological science disciplines[2]. The required input of the citizen researcher often involves something as simple as recording observations of animal behavior or geographical inputs such as where a certain species has been sighted. Applied to a college course setting, it is easily conceivable that a large quantity of this type of data can be acquired over the course of multiple semesters.
- **Biodiversity** – Oftentimes, traditional scientific themes need to be introduced to emphasize and illustrate the importance of the scientific process. One which is relatively easy to grasp is biodiversity. Coupled with the human impacts outlined below for South Florida, this concept is readily integrated into the experiments described.
- **Human Impacts to the Local Environment** – South Florida is particularly interesting from an ecological perspective because of the extent of human impacts not only in terms of the urban development but also because of the introduced species[3]. These include both plant and animal species that, in an undergraduate science course, can be used to connect science to everyday life.

## STUDENT LEARNING OBJECTIVES

- The lab series of assignments are assessed at the college level in order to accomplish the following learning objectives for students

1. To be able to identify the different components of the **scientific method**
2. To apply the scientific method to an **observation** or research **question**
3. To describe how scientific understanding of **natural phenomena** is open to **revision** based on new evidence

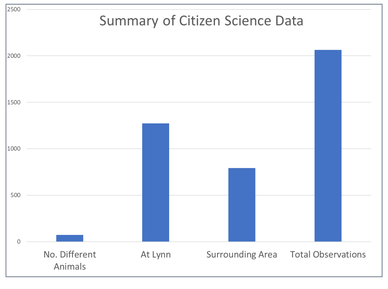
## METHODS

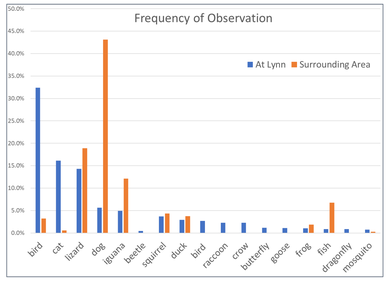
The demonstration of the scientific process and experimental methods is broken up into 3 individual laboratory assignments. Each is designed to take the students through different stages of the scientific method, but the focus point changes to emphasize different components and thereby different learning objectives.

- **Laboratory Exercise 1** – In the first assignment, students are tasked with a keeping a log of animal observations. The assignment has twofold purpose – the first is to allow for students to become acquainted with the importance of observation informing the researcher, and the second is to gather data that will be utilized for the next exercise.
- **Laboratory Exercise 2** – The second lab requires students to look at the data collected by them and their peers over the course of multiple semesters in a little bit more detail, introducing the use of graphical visualization to make conclusions (with Excel tutorial included).
- **Laboratory Exercise 3** – Finally, students are tasked with completing the whole process by themselves, this time with the focus on how sound changes in our local environment. To measure this, they are introduced to another concept – **scientific instrumentation** – by using a "decibel meter" application on their smartphones.

## EXAMPLE RESULTS: LAB 1 & 2

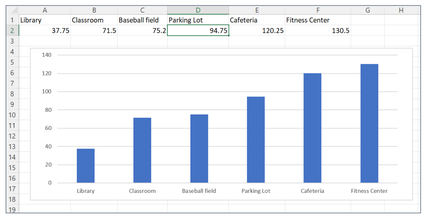
- The basic results for labs 1 and 2 include a breakdown of how frequently different types of animals are scene either on Lynn University campus or the surrounding areas. Students can graph the accumulated data to evaluate various hypotheses




## EXAMPLE RESULTS: LAB 3

- In the final "Lab", students take measurement of noise levels around campus using freely available **decibel meter** apps on their smartphones. The quantitative data allows for graphical visualization and rigorous testing of the hypothesis – "What location on campus is likely to be the loudest?" A minimum of six locations (of the 31 listed on the map below) to be sampled is required.




## CONCLUSIONS

With a mixture of simple observation-based laboratory exercises and Microsoft Excel® data workup, along with exploitation of basic citizen science concepts, a valuable introduction to the experimental side of science education can be had in course meant for non-science majors. As a valuable side effect, students are exposed to concepts that connect them to the region – like the South Florida invasive species problem – and skills that they may be able to carry forward in their respective majors.

## REFERENCES

1. Pain, E. (2010). Teaching Science to Nonscience Majors. *Science,* doi:10.1126/science.caredit.a1000043
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3. Briggs-Gonzalez, V., Allen, K., Harvey, R.G., Mazzotti, F.J. (2019). *Ecological Risk Assessment for Invasive Wildlife in Florida*. Ask IFAS, https://edis.ifas.ufl.edu/publication/UW419.