# **Teaching Tech Lesson Design Template**

Adapted from: Greg Wilson (ed.): *Teaching Tech Together*. Lulu.com, 2018, 978-0-9881137-0-1,<http://teachtogether.tech/>.

# **Step 1: Brainstorming**

1. What problem(s) will student learn how to solve?

* Students will have to learn how to translate graphical outputs to learn basic ecological principles.
* Students will have to learn how to develop code in the R statistical program.

1. What concepts and techniques will students learn?

* How population growth changes with different values for the rate of growth and carrying capacity.
* How to program R.
* How to think about ecological modelling using a simple example.

1. What technologies, packages, or functions will students use?

The base package in R (although, the program uses functions that draw from ggplot2 even though the students do not program functions from this package).

1. What terms or jargon will you define?

* Carrying capacity
* Logistic growth
* Exponential growth
* Parameter (and variable)
* Vector
* NOTE: Many of these topics are defined in the lecture for the main course that is the precursor for this lecture.

1. What analogies will you use to explain concepts?

* No analogies are used in the lesson.
* The idea of limited resources controlling population growth typically can be explained without analogies.

1. What heuristics will help students understand things?

Students will be allowed to change parameters in the model and observe how the model changes (within boundaries to guide students away from nonsensical examples).

1. What approach will you use to help students implement the lesson?

* Relevant lecture material will proceed the lesson.
* When implemented, the class size was 7 students – thus, the lesson was implemented in a computer lab with each student programming on their own within 2 self-assembled groups supplemented by in-lesson mini-lectures as needed.

1. How will you scaffold the lesson in to your course?

* Use an existing SWIRL lesson that introduces students to R as an in-class assignment to familiarize students with R
* Lecture material presented in order:
  + Basic ecology taught over several lessons
  + A general introduction to exponential functions
  + Explain how exponential growth ‘works’
  + Extend the topic to logistic growth
  + Work through the math
  + Explain the ecological implications of the processes the model demonstrates
* Review prior to the the programming:
  + Review the lecture material
  + Review the R introduction
* Implement the lesson

1. What mistakes or misconceptions do you expect?

* Students will have a difficult time programming.
* Students will not have remembered the term ‘parameter’ from class and what it means.
* Students will have a difficult time conceptualizing the range of values examined for different parameters (r and k).
* Students will likely not be able to conceptualize the ecological meaning of the model even though we discuss it in class (having class notes during the exercise will help).
* Students will not know how to interpret the differences among graphs without prompting and subsequent discussion.

1. What datasets will you use?

No data is used in this exercise. The values for population growth are generated from the values chosen for model parameters.

1. How much time will be devoted to this lesson?

This lesson was run as a 1.5hr portion of a 2hr50min lab paired with 1hr of instruction on scientific writing. It likely would be better run as a 2hr lab with additional learning components (possibly doing the background lecture in the lab prior to the coding to better join the material together). Students in more rigorous undergraduate programs or are taking ecology classes that teach more about R may be able to complete the exercise in a 50min or 1hr15min standard class period.

## **Step 2: Who Is This Course For?**

Provide a summary describing who your learners are. In your summary, address the following:

* what class you are implementing this lesson in:

This lesson is design for a general ecology class for undergraduates.

* the level of the students (e.g. upper division biology students, students meeting a general education requirement, etc.)

Students are generally a mix of junior/senior biology students with the majority being from the Ecology track for the Biology major (some sophomores may be in the class too, but no freshman). Some students majoring in biology are taking the course as a biology elective for programs in anatomy and physiology and cell and molecular tracks. Non-science students are generally not taking this class as a general education requirement, but non-science majors minoring in environmental biology may be in this class.

* whether students have any prior programming and/or statistics experience.

Some students will have prior statistical experience (through an introductory or upper level statistics course taught by the math department). A small percentage of students will have some coding experience in programs other than R. They will have used functions in MS Excel at this point of the semester, and students will have run through a SWIRL course (or similar) demonstrating the basic functionality of R.

Following your summary, address the following questions:

1. How will this lesson help these students?

* It will provide students some exposure to R for a use other than for statistical tests; the specific goal is to expose students to the concepts of ecological modelling, quantitative thinking in ecology, and theoretical ecology (they are taught how basic, applied, and theoretical ecology differ earlier in the semester).
* It will help the students more concretely understand how growth rate and carrying capacity affect population growth.

1. What specific prerequisite skills or knowledge do you expect students to have?

* No prerequisite skills or knowledge other than what was presented in previous lectures is required (See details above about the scaffolding).

## **Step 3: What Will Learners Do Along the Way?**

The best way to make the goals in Step 1 firmer is to write full descriptions of a couple of specific activities that students will do during the lesson. These activities may include an introduction to the swirl lesson, an in-class activity to demonstrate concepts that will be addressed by the swirl lesson, specific analyses to be performed within the swirl lesson, an assessment following the swirl lesson, etc. Use the table below to provide a brief description of each activity and explain which component of the brainstorming step each activity addresses (the “Goal” column, or what the activity will accomplish). Add additional rows to the table as necessary

|  |  |
| --- | --- |
| **Activity** | **Goal** |
| 1. Students are instructed in lecture on the basic concepts of of population growth, competition, and resource limitation. Students are also presented the mathematical structure of the logistic growth equation (including how exponential functions work). | To be sure students have a sound understanding of the foundational ecological and mathematical concepts underpinning logistic population growth. |
| 2. Students will be given instruction on how to begin working through the SWIRL lesson. Students will be asked to develop the code for the growth equation, but a mid-lab explanation/refresher should be anticipated. Students will mostly work on their own at their own pace. | To have students practice using R. Coding the growth equation requires an application of basic algebra to coding. |
| 3. Students will have to visualize how varying different parameters can affect the logistic growth curve by examining and interpreting the graphical outputs generated during the SWIRL lesson (this may be implemented as a formal assignment requiring a written interpretation of the results). | To have students translate and related quantitative concepts with basic ecological concepts. |

## **Step 4: How Are Concepts Connected?**

In this stage, put the activities in a logical order then derive a point-form lesson outline from them. You can accomplish this by re-organizing the activities outlined above into a numbered list (below) that corresponds with the planned sequence of activities.

**Lesson sequence:**

1. (Prior to the lesson) Complete a SWIRL lesson (or similar exercise) introducing students to the R statistical program.
2. Lecture on basic biology/ecology of population growth (and specifically logistic population growth) and the algebra used to create the logistic growth equation.
3. Basic review of lecture material prior to the SWIRL lesson (unless lecture is combined with the lab in which this lesson will be implemented).
4. Students work through the SWIRL lesson for examining logistic population growth.
5. Students must interpret the output graphs created throughout the lecture (as a formal assignment or informal discussion during the lesson/lab; the professor may suggest that students output image files of the graphs as they work through the lesson for review after class if necessary).

## **Step 5: Lesson Overview**

You can now write a lesson overview consisting of:

* a one-paragraph description

The lesson is designed to 1) teach students about the concept of logistic population growth, growth rates, and carrying capacity and 2) provide a very basic introduction to ecological modeling and quantitative thinking in ecology (i.e., theoretical ecology). The 1st objective aligns with material presented in lecture and fits within a general ecology course’s overall structure. This specific lesson is structured to infuse quantitative concepts into the course as a means to understand basic concepts in ecology. The 2nd objective is designed to help students experience an aspect of ecology rarely covered in undergraduate courses (i.e., modelling and quantitative thinking within a framework that could be considered an introduction to theoretical ecology). The lesson will require student to perform basic coding and critical thinking when describing the different graphical outputs based on different parameter values. This lesson is designed to be a guided, inquiry-based approach with multiple educational objectives for the students.

* learning objectives (taken from steps 1 and 3)

The objectives can be broken down into specific components:

Concept of logistic growth:

* Understand how growth rate affects patterns of logistic growth.
* Understand how carrying capacity affects patterns of logistic growth.
* In a general sense, understand what growth rate and carrying capacity represent for population growth (reinforced from lecture).
* In a general sense, understand how to interpret graphical representations of population growth (requires critical thinking).

Ecological modelling

* In a general sense, understand how ecological principles can be investigated without an underlying field-collected dataset (i.e., that models can be used for hypothesis testing in ecology).
* Understand how varying model parameters within a modelling framework can be used to investigate ecological patterns and principles.
* Practice interpreting graphical representations of data from models (from a technical/quantitative perspective).
* Generate a general appreciation for modelling in ecology.