

# Building a successful project-based mathematical modeling course

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# Why projects?

- ▶ More realistic work/working conditions
- ▶ Integration of knowledge across disciplines
- ▶ No test anxiety

Start with what you want your students to be able to do.

## Main learning goals

- ▶ Understand the process of mathematical modeling, in particular the role of assumptions
- ▶ Familiarity with example models and standard tools
- ▶ Ability to use software (MATLAB ,  $\text{\LaTeX}$ )
- ▶ Ability to explain their understanding to others

## Where to go from here?

- ▶ What would show you that students had achieved that goal?

# First assignment: What is Mathematical Modeling

- ▶ Students given an outline of main points in class
- ▶ Get students using  $\text{\LaTeX}$ , with minimal formatting and formulas

**Genius moment:** write this as a 2-person dialog.

- ▶ Students were immediately integrating knowledge

# Why do students struggle with projects?

Projects involve large-scale integration of knowledge.

- ▶ Mathematics
- ▶ Programming
- ▶ Communication and writing
- ▶ Justifying decisions
- ▶ Project management

This is a **high cognitive load** for a beginner.

Scaffold the tasks; choose easier rather than harder material.

# What motivates students?

- ▶ We wish: Interest in learning/understanding material

## **Reality:**

- ▶ Grades
- ▶ Look good for classmates
- ▶ Material might be relevant to landing a job someday

## **Instructors can**

- ▶ Tie material in with students' prior knowledge and experience
- ▶ Let students make choices
- ▶ Make clear how the class teaches employable skills

# Demonstrating Chaos in the Lorenz Attractor

- ▶ Chaos is cool
- ▶ Relates to weather prediction
- ▶ Used successfully in prerequisite course (easy)
- ▶ List of new vocabulary and ideas to organize
- ▶ Think about how graphs convey information.

# Why do students hate group work?

- ▶ Freeloading
- ▶ Grade dependent on others work

Students can accomplish more and perform at a higher level when they work well with others.

## **Instructors can**

- ▶ Create systems for individual accountability
- ▶ Explicitly teach group work values and skills

# Models for population growth

- ▶ Data easily available for human populations
- ▶ Population growth is a familiar idea
- ▶ Growth models aside from exponential are not: logistic, Gompertz
- ▶ Students can choose a population to model
- ▶ Allows for compare/contrast
- ▶ Fits in with what students expect to learn in the course

# Final project

- ▶ Student finds own project
- ▶ Efficient Portfolio Frontier – investing money
- ▶ Phytoplankton modeling – environmental issues
- ▶ Mathematical models for a Zombie Outbreak

# Advice

- ▶ Teach skills for doing projects a little bit at a time, along with with easy content goals.
- ▶ Make initial project subject matter easy, at least at first. The difficulty will come from the integration.
- ▶ Create projects that tie in to prior knowledge and build on prior knowledge.
- ▶ Create projects where students can choose and customize to their interests and strengths.
- ▶ Manage group work actively (group work assessment) so everyone pulls his or her weight.
- ▶ Make truly difficult pieces a group responsibility and help them to learn to work together to conquer the challenge.

## Suggested Resources

- ▶ *How to Model It: Problem Solving for the Computer Age* by Anthony Starfield, Karl Smith, Andrew Bleloch. This is out of print, but easy to find used copies on Amazon.
- ▶ *How Learning Works: 7 Research-Based Principles for Smart Teaching* by Susan A. Ambrose, et. al.

**Thanks for listening!**