

# Hands-On Precalculus: Modeling and More!

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# The School: Glendale Community College

- ▶ 15,843 Full Time Equivalent Students
- ▶ 17% Caucasian/European/Anglo
- ▶ 32% Caucasian/Armenian
- ▶ 31% Latino/Hispanic
- ▶ 9% Asian/Pacific Islander
- ▶ 5% Filipino
- ▶ 3% Black/African American



Math 101  
(Intermediate Algebra)



Math 110  
(Precalculus)



Math 110A (Precalculus I)

Math 110B (Precalculus II)



Math 103  
(Calculus I)

# Math 110: Precalculus

- ▶ 6 lecture units
- ▶ Meets 6 hours per week
- ▶ Success Rate: 50.1%
- ▶ Retention Rate: 69.3%
- ▶ Prerequisite: Intermediate Algebra

# Math 110A: Precalculus I

- ▶ 3 lecture units and 0.5 lab unit (lab units are 1:3 :: units:hours)
- ▶ Meets 4.5 hours per week
- ▶ Success Rate: 54.8%
- ▶ Retention Rate: 72.9%
- ▶ Prerequisite: Intermediate Algebra

# Old Sequence

- ▶ Math 100 - College Algebra
  - 3 units, meets 4 hours per week
- ▶ Math 102 - Trigonometry
  - 3 units, meets 4 hours per week
  - Non-transferable
- ▶ Math 103 - Calculus I

# Why the need for the lab component?

- ▶ CA required units and hours to match (i.e. 3 unit lecture class should meet 3 hours per week)
- ▶ Saw an opportunity to have students explore concepts using active and cooperative learning without adding significantly more units and cost.
- ▶ To keep Math 110A at 4.5 hours per week with 3.5 total units, we needed to utilize lab units

# What do we do with the extra time?

- ▶ More in-depth explanations and examples
- ▶ Active Learning
- ▶ Mathematical Modeling: through lab activities

“ ...we call on institutions of higher education, mathematics departments and the mathematics faculty, public policy-makers, and funding agencies to invest time and resources to ensure that effective active learning is incorporated into post-secondary mathematics classrooms. ”

- CBMS Statement, July 2016

Conference Board of the Mathematical Sciences made this statement and is signed by a multitude of professional math organizations including AMATYC, AMS, ASA, MAA, NCTM, SIAM.

# Math Research Project

- ▶ Funded by Title V
- ▶ 12 labs for Math 110A
- ▶ 8 labs for Math 110B
- ▶ Quasi-experimental study in Fall 2017 to measure effectiveness of lab activities
  - 4 Math 110A courses are being offered; 2 control and 2 treatment
  - Both treatment classes are held in computer classrooms
- ▶ Data Collection:
  - Pre/Post Tests
  - Qualitative Survey
  - Success Rates
  - Retention Rates
- ▶ The collection of labs will be made available to all math faculty with training provided.

# Time Line:

- ▶ Summer 2016 - Researched mathematical modeling and active learning
- ▶ Fall 2016/Spring 2017 - Discussed which topics would benefit from increased exploration by students and started writing labs/rubrics/evaluation techniques
- ▶ Summer 2017 - Agreed on measurable goals for treatment classes vs control classes
- ▶ Fall 2017 - Implementation of labs into treatment classes

# Table of Contents:

Lab 1: An Introduction to Mathematical Modeling

Lab 2: How do Phones Charge?

Lab 3: Absolute Value Equations and Inequalities

Lab 4: Quadratic Functions in Real Life

Lab 5: Polynomial Functions

Lab 6: Modeling with Rational Functions

Lab 7: Polynomial Function Graphing

Lab 8: How to Phones Charge (Revisited)

Lab 9: Dissolving the Taj Mahal in Acid Rain

Lab 10: What is a Radian?

Lab 11: Law of Sines/Cosines

Lab 12: Unit Circle

Lab 13: Final Mathematical Modeling Project

# Lab 1: An Introduction to Mathematical Modeling

When is using Uber or Lyft less expensive than owning a car?

**Motivation:**

Mathematical modeling is often a messy and iterative process. Usually a simple model is developed with clearly stated assumptions and then more complexity can be added into the model.

**Students:**

- come up with assumptions
- decide what the variables are
- research what it costs to own a car

“  
...despite the usefulness and value in demonstrating how mathematics can help analyze and guide decision making for real world messy problems, many people have limited experience with math modeling.”

GAIMME - Guidelines for Assessment & Instruction in Mathematical Modeling Education

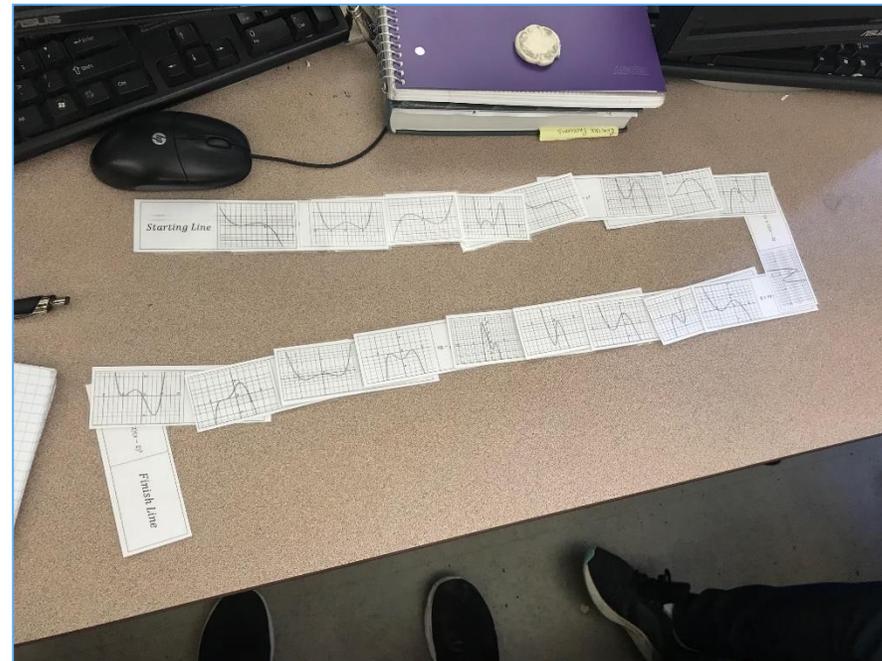
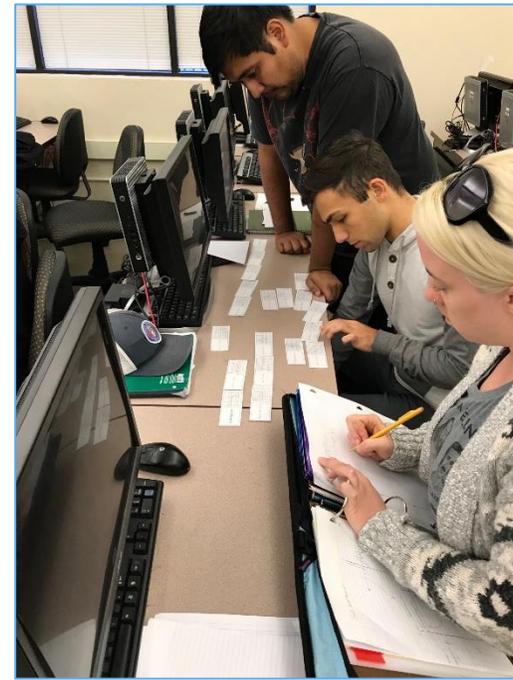
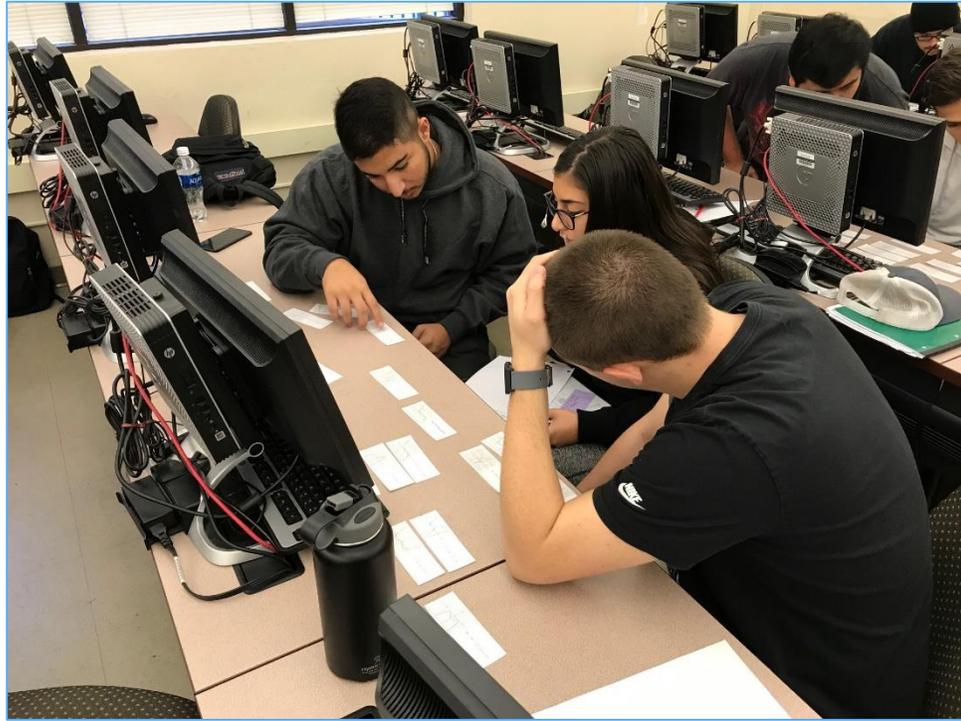
Joint publication from the Consortium for Mathematics and its Applications (COMAP) and the Society for Industrial and Applied Mathematics (SIAM)

# Lab 3: Absolute Value Equations and Inequalities

## **Motivation:**

There are several methods to solve solutions absolute value inequalities. By “seeing” the interval(s) containing solutions to inequalities of the form  $|x| \leq a$  and  $|x| \geq a$ , translations can be used to easily solve inequalities of the form  $|x-c| \leq a$  and  $|x-c| \geq a$ .

# Lab 7: Polynomial Function Graphing

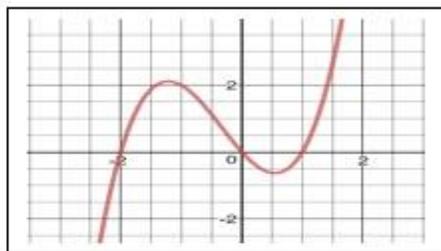


## Polynomial Function Graphing Math 110A Lab – Student Worksheet

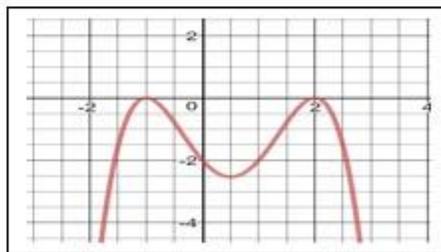
Name \_\_\_\_\_

**Directions:** For each graph, write a function for the given graph in both factored and expanded form.

1. Factored form:  $f(x) =$  \_\_\_\_\_  
Expanded form:  $f(x) =$  \_\_\_\_\_



2. Factored form:  $f(x) =$  \_\_\_\_\_  
Expanded form:  $f(x) =$  \_\_\_\_\_



“ To ensure students graduate with skill sets to match expectations of prospective employers, our community must modernize curricula with input from representatives in partner disciplines, business, industry, and government. ”

A Common Vision for Undergraduate Mathematical Sciences Programs in 2025

*A Common Vision* is a joint effort, focused on modernizing undergraduate programs in the mathematical sciences.

Signed by AMATYC, AMS, ASA, MAA, and SIAM.

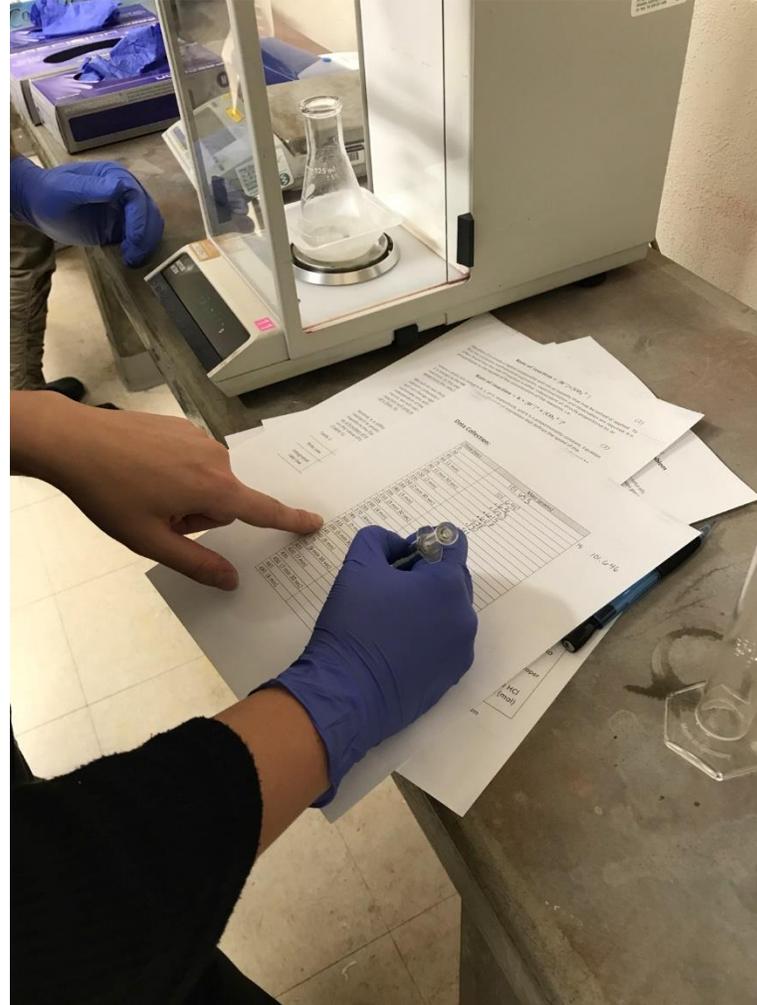
# Lab 9: Dissolving the Taj Mahal in Acid Rain

- ▶ Collaborated with a chemistry instructor from Glendale College
  - You'd be surprised about how willing instructors are to collaborate about math topics. Ask around your campus!
- ▶ Students performed an experiment to determine the rate law for a chemical reaction.
- ▶ It took some coordination with our chemistry department to find a suitable day to borrow a lab classroom.
- ▶ Equipment needed:
  - Analytical scales (accurate to three decimal places)
  - Marble chips and HCl acid
  - Glassware
  - Goggles and gloves

# Lab 9: Dissolving the Taj Mahal in Acid Rain

- ▶ The experiment consisted of dissolving marble chips in hydrochloric acid and measuring the mass loss over time.
  - Students do the experiment in a chemistry lab (30 minutes)
- ▶ The analysis and mathematical modeling were done in class during the next session. (90 minutes)
  - Took some time in class to teach some basic MS Excel skills
- ▶ In small groups, students determined the order of the reaction and found that it was most appropriate to use an exponential decay model.
- ▶ Once students had their model, had to answer a follow-up question for homework:
  - **How long would it take for the Taj Mahal to dissolve in acid rain?**





# What's next?

- ▶ Plan for Math 110B, pilot in the Spring semester
- ▶ Possibly write more labs connected to different partner disciplines
  - Biology
  - Physics
  - Engineering
- ▶ Make labs available to all instructors
- ▶ Instructor training
- ▶ AMATYC 2018 Orlando - quasi-experimental study results

# Digital/Editable Copies:

[www.glendale.edu/precalculuslabs](http://www.glendale.edu/precalculuslabs)

# Questions?

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