An Active, Adaptive Approach to Teaching and Learning College Algebra

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Project Outline
Opportunity

APLU Grant (2016-19)
Accelerating the Adoption of Adaptive Courseware
at Public Research Universities
Task

Re-design College Algebra

Incorporate adaptive courseware

Increase & improve active learning—*not* emporium model

Blended course
Team

7 Math instructors
1 Instructional designer
2 Instructional technologists
1 Blended learning & faculty development specialist
Goal

Create the best College Algebra course ever!
Think – Pair – Share

Consider issues that might affect your College Algebra students’ ability to succeed in the course.
Issues we identified

• Irregular/low attendance
• Low level of engagement with content
• A preference/expectation for rules and procedures

• Unrealistic assessment of their own understanding
• Over-reliance on the instructor
• Rarely electing to use multiple function representations to aid in problem-solving
Course Elements

Active Learning
• Course Notebook
• Student response system
• GTAs/LAs

Adaptive Online Homework

Coordination
• Weekly meetings
• Common LMS site, syllabus, & exams
• Online grading

Our NEW story of College Algebra!
Designing Our Blended Course
When designing or re-designing a course, what is usually your first step?
Backward Design

1. Identify Desired Results.
   - Big Ideas and Skills
2. Determine acceptable evidence.
   - Culminating Assessment Task
3. Plan learning experiences and instruction.
   - Learning Events

Example (see handout):

**MAA Guidelines**
Determine the appropriateness of a model via scientific reasoning

**Bacc Core Outcome**
Identify situations that can be modeled mathematically

**Course Level Outcome**
Fit an appropriate curve to a scatter plot and use the resulting function for prediction and analysis.

**Weekly Learning Objective**
Use the best-fit model from Excel to model a real-world data set and use it to predict values not in the data set

**Student Tasks**
Gender Wage Gap analysis
Modeling Gender Wage Gap

U.S. Gender Wage Gap 1973 to 2016

\[
y = -0.556x + 38.755 \\
R^2 = 0.947
\]

U.S. Gender Wage Gap 1973 to 2016

\[
y = 0.008x^2 - 0.910x + 41.233 \\
R^2 = 0.973
\]

U.S. Gender Wage Gap 1973 to 2016

\[
y = 40.382e^{-0.021x} \\
R^2 = 0.966
\]
Process: Blending

What would blended College Algebra look like?

• Elements?
• What do students do in class? In lab/recitation?
• What do they do outside of class?
• How are these two connected?
Adaptive Enables Active Classes
“The prep assignments...allowed me to understand topics more clearly. I knew what I was getting myself into before class which made the learning process...much easier.”

A College Algebra Student from Spring 2018
A week in the life of a MTH 111 student
(other side of handout)
Adapting in Class

Question: Sketch a graph of a function $f$ with the following end behavior

As $x \to -\infty$, $f(x) \to 0$
As $x \to \infty$, $f(x) \to \infty$
Focus on the BIG Ideas
Think – Pair – Share

What are the Major Themes in College Algebra?
7) (5 points) Which of the parent functions have even symmetry (symmetric about the y-axis)? Bubble all that apply.

- $f(x) = \frac{1}{x}$
- $f(x) = x^2$
- $f(x) = \sqrt[3]{x}$
- $f(x) = x$
- $f(x) = |x|$
- $f(x) = e^x$
- $f(x) = \sqrt{x}$
- $f(x) = \frac{1}{x^2}$
- $f(x) = x^3$
- $f(x) = \ln(x)$
Connections Between Function Representations

Function Family: Logarithmic
Sub-family: \( y = \log_2(x) \)

Parent Function: \( y = \log_b(x) \), with \( b > 0 \) and \( b \neq 1 \)

- Shape: ____________
- Domain of \( y = \log_2(x) \): ____________
- Range of \( y = \log_2(x) \): ____________
- Equation of asymptote: ____________

Verbal description:

Table of values for \( y = \log_2(x) \):

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y = \log_2(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>undefined</td>
</tr>
<tr>
<td>0</td>
<td>undefined</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>
1) You serve as the Health and Safety Engineer during the New Year's Eve celebration in Mt. Hood, Oregon and must make sure to meet city fire safety regulations.

- Fire safety regulations require a firework shell to explode at a height greater than 75 feet above the ground.
- The fireworks will be launched from the available 4-foot platform.
- The height, $W$ (in feet), of the Willow Firework shell $t$ seconds after it is launched is given by the firework manufacturer to be:

$$W(t) = -16t^2 + 80t + 4$$
2) Omar was asked to find the domain and range of \( f(x) = \frac{2}{x+3} - 4 \) so, he sketched a “good enough” graph.

a) Do you think Omar’s graph is “good enough” for his task? Why or why not?
“...we are talking about whether or not certain functions are differentiable and/or continuous at different locations and I’m one of the few folks in the class who doesn’t have to graph them out to make that determination.”

A former College Algebra student, currently in Business Calculus
New

Story of College Algebra
The Big Questions

• What are Some Fundamental Functions?
• What Can We Learn from a Graph?
• How Do We Transform a Given Function?
• What Can We Learn from an Equation?
• How are Different Representations of Functions Connected?
• How Do We Combine Functions?
• How Do We Solve Equations and Inequalities?
What are Some Fundamental Functions?

Reference Guide: Families of Functions
Functions, Domain and Range
Function Notation and Average Rate of Change
Introduction to Exponential and Logarithmic Functions
Introduction to Polynomial Functions
Introduction to Rational Functions
Why Re-Order the Content?

• Shakes things up
• Common themes versus memorizing rules
• More time for difficult concepts
• Address issues with diverse students
Results
Recall...

- Irregular/low attendance
- Low level engagement with content
- A preference/expectation for rules and procedures
- Unrealistic assessment of their own understanding
- Over-reliance on the instructor
- Rarely electing to use multiple function representations to aid in problem-solving
Student Response

• Consistent attendance
• Engage with course content at higher levels
• Use multiple representations
• Use tools like DESMOS to check their understanding
• Report enjoying the class
Improvements in Withdrawal Rates

Withdrawals in MTH 111 Fall Terms

Year | 2013 | 2014 | 2015 | 2016 | 2017
--- | --- | --- | --- | --- | ---
% W | 8.0 | 7.5 | 7.0 | 5.0 | 4.0

Withdrawals in MTH 111 Winter Terms

Year | 2014 | 2015 | 2016 | 2017 | 2018
--- | --- | --- | --- | --- | ---
% W | 15.0 | 10.0 | 10.0 | 5.0 | 4.0

Withdrawals in MTH 111 Spring Terms

Year | 2014 | 2015 | 2016 | 2017 | 2018
--- | --- | --- | --- | --- | ---
% W | 15.0 | 10.0 | 15.0 | 4.0 | 2.0
Improvements in DFW Rates
Questions?
Thank You!

Our free and open materials coming soon!
www.open.oregonstate.edu
The Speakers

Sara.Clark@oregonstate.edu, Elizabeth.Jones@oregonstate.edu, Lyn.Riverstone@oregonstate.edu, and Katy.Williams@oregonstate.edu
Sara Clark

• Mathematics Instructor for Oregon State University Mathematics Department.

• 20 years experience teaching Mathematics at the community college and university level.

• Dedicated to creating active learning mathematics courses in traditional courses and in online courses.
Dr. Elizabeth Jones

• Mathematics Instructor for the Educational Opportunities Program at Oregon State University.
• 25 years experience teaching Mathematics at the university level and in designing curriculum.
• Inspired by my students, from traditionally underserved populations, to find ways to help them build the big ideas in College Algebra.
Lyn Riverstone

• Senior Instructor in the Oregon State University Mathematics Department.
• 20 years experience teaching introductory college mathematics
• Passion for team course development.
• Extensive training in the implementation of evidence-based teaching practices.
• Coordinated instructional team that worked to extend this story of Algebra from EOP to all College Algebra courses at OSU.
Katy Williams

• Instructor in the Oregon State University Mathematics Department.

• Masters of Science, Statistics

• Involved in the intense redevelopment of three courses implementing adaptive course ware and increasing active learning

• Re-developed online College Algebra to increase student engagement