



Transforming Precalculus Instruction: Evidenced Based Course Design



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The Department of Mathematics has sought to significantly improve student success rates in Math 101 & 103 through the implementation of Active Learning Mathematics. We are now experiencing greatly improved student outcomes.

Other changes to courses also had positive impacts on student success. Overall, we found higher student passing rates if their class met in Brace (where classrooms have been renovated to support active learning), if their instructor participated in a new pedagogy course, and if their course had a learning assistant assigned to support student engagement and learning.

	2007	2008	2009	2010	2011	07-11 Ave.	2012	2013	2014
101	63%	61%	60%	68%	60%	62.4%	59%	80%	80%
103	66%	65%	68%	65%	70%	66.8%	77%	78%	

	LA	No LA	Total
Passed	335	120	455
Failed	76	35	111
Total	411	155	566
Pass Rate	82%	77%	

	In Pedegogy Course	Not In Pedegogy Course	Total
Passed	299	127	426
Failed	64	43	107
Total	363	170	533
Pass Rate	82%	75%	

	In Brace Labs	Not In Brace Labs	Total
Passed	416	39	455
Failed	98	13	111
Total	514	52	566
Pass Rate	81%	75%	

Sample In-class worksheet & Sample Team quiz

Worksheet 2.1: Input and Output Math 101 Spring 2015

Problem 1 (Warm-up). Let $C(x) = 0.08x + 7.50$ be the cost of a road trip in dollars, where x is the number of miles you travel. Give a possible interpretation for the slope and y -intercept.

Problem 2 (Warm-up, §2.1, #2). If $g(x) = x^2 - 5x + 6$, find $g(0)$ and solve $g(x) = 0$.

Problem 3 (Ex. 1). Let $f(t)$ be the total number of reported flu cases at UNL by the t th day of the semester. Answer the following with complete sentences.

What does $f(103)$ mean?
 What does $f(50)$ mean?
 What does $f(15) = 73$ mean?

Team Quiz 1: January 28, 2015 Math 101 Spring 2015

Names: _____

Directions: You may work with the people at your table, but you must turn in team quizzes in groups of two or three. You may not use your notes, worksheets, or other resources on this team quiz.

Be sure to show work and/or explain your reasoning.

Problem 1. The following tables represent the relationship between the button number, N , that you push, and the snack, S , delivered by three different vending machines.

Vending Machine #1		Vending Machine #2		Vending Machine #3	
N	S	N	S	N	S
1	M&M's	1	M&M's or dried fruit	1	M&M's
2	pretzels	2	pretzels or Hersheys	2	M&M's
3	dried fruit	3	pretzels or Hersheys	3	pretzels
4	Hersheys	4	Snickers or fat-free cookies	4	dried fruit
5	fat-free cookies	5	fat-free cookies	5	Hersheys
6	Snickers	6	fat-free cookies	6	Hersheys
		7	fat-free cookies	7	fat-free cookies
		8	Snickers	8	Snickers
		9	Snickers	9	Snickers

a) To have a useful vending machine, must S be a function of N or N a function of S ? Explain.
 b) For which vending machine(s) is S a function of N ?
 c) For which vending machine(s) is N not a function of S ?

Graduate Teaching Assistant Training

Goals:
 Teach GTAs elements of effective instruction
 Gain buy-in for Active Learning philosophy

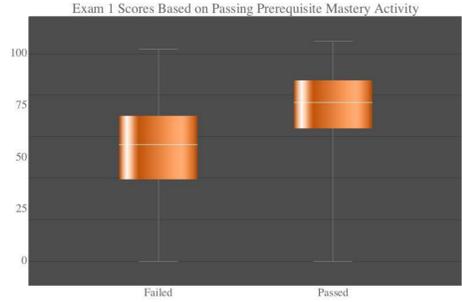
Strategies:
 Pre-semester training workshop
 Year-long course for first-time GTAs
 Mentoring

First Year Mathematics Task Force

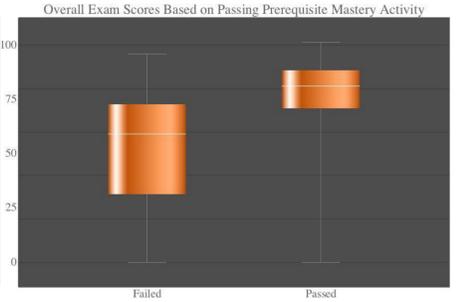
Goals:
 Faculty support for high-quality GTA instruction
 Maintain high standards for learning

Strategies:
 Faculty mentor GTAs
 Faculty review syllabi & exams for rigor, content, goals

"We run into problems that individually we would probably get stuck on, but instead of working it out of the books ourselves or trying to get lined up with the professor, we can group together and try and get it done. We've even gone as far as get together to get the homework done and branching out into other problems and not just the team quiz."
 -Math 101 Student



Results



The Prerequisite Mastery Activity was a strong predictor of student success. Students who passed the Prerequisite Mastery Activity passed both Exam 1 (upper left graph) and ultimately all the Exams (upper right graph) at statistically significantly higher rates than those who did not pass.

Active Learning Mathematics

Goals:
 Teaching methods & classroom norms: engage students in sense-making activities
 Students develop *habits of mind of mathematical thinkers*: solve problems, conjecture, experiment, explore, create, communicate reasoning

Strategies:
 Cooperative learning (group work)
 In-class worksheets to direct focus of group work to meet math objectives
 Team quizzes

Learning Environment

Goal:
 Make group work easy and natural for students

Strategies:
 Classroom tables/chairs for group work
 Classroom whiteboard, document camera
 Extended time

Early Formative Assessment

Goals:
 Engage students at start of course
 Provide students opportunity to demonstrate mastery of prerequisite knowledge

Strategies:
 Prerequisite Mastery Activity-material a "B" high school Algebra 2 student would know & be able to do

Close Coordination

Goals:
 Build out effective practices
 Have GTAs focus on students, not material

Strategies:
 Director of First Year Mathematics Programs
 Assistant conveners
 Common lesson plans
 Common exams
 Weekly coordination meetings

Learning Assistants

Goal:
 Support group work & student engagement

Strategies:
 Hire undergraduates to assist with course instruction
 Recruit from majors, "A" students
 Can support larger class sizes



Sample Common Lesson Plan

Week 3: Section 2.1 Input and Output Math 101 Spring 2015

Objectives (Students will be able to...):

- identify the input and output of a given function,
- evaluate a function to find an output value,
- solve an equation to find an input value,
- interpret input and output pairs as points on a graph.

Relevant exercises & problems: 3.8,13-14,16b,18,20-22,29-31

[5 mins] Warm-up: Exercise 2, p. 72

Allow students to work alone or in groups. Go over answers on the board, highlighting the input/output pairs in each part.

[15 mins] Interpreting Inputs and Outputs

This problem incorporates a function given in words that does not have a formula. You may want to remind your students that this is still a valid function, and you will certainly want to model correct language for them. (That is, both write and say $y = f(t)$.)

(The following problem is on Worksheet 2.1.) Let $f(t)$ be the total number of reported flu cases at UNL by the t th day of the semester. Discuss the following questions with your class, asking them to explain with complete sentences. You may want to write these sentences on the board.

- What does $f(103)$ mean?
- What does $f(50)$ mean?
- What does $f(15) = 73$ mean?

Some questions to ask students in your discussion include: Is $f(103)$ a function or a number? What does $f(15) = 73$ mean on a graph? Would we expect this function to be increasing or decreasing? (You may want to mention to your students that we will ask them to interpret functions in complete sentences on exams.)

[10 mins] Interpreting inputs and outputs for a function with a formula

"I love my group... We're teaching our groups, like to the people who don't understand it."
 -Math 103 student

Data Collection:

- Instructor survey & interviews
- Student attitude survey pre/post
- Student exam & course grades
- Student focus group interviews
- Interview involved faculty
- Analyze exams
- Document GTA training & teaching seminar

Future Goals:

- Extend precalculus efforts to calculus I & II
- Wide dissemination of Active Learning Mathematics

External Support & Connections:

- Grant from Association of Public & Land-grant Universities
- Grant from Mathematical Association of America
- Mathematics Teacher Education Partnership
- Ongoing collaboration with University of Colorado Boulder, Auburn University, University of West Virginia, University of Nebraska at Omaha

More information on our webpage:
www.math.unl.edu/first-year-math-initiative

