Video Textbooks in the Active Learning Classroom

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Alternate Title

Video Textbooks, Flipped Classrooms, Mastery Learning, Active Learning, Appropriate Physical Structure of Classrooms, Use of Technology, Promoting Higher-Order Thinking Skills, Online Resources, Open Educational Resources, Automated Homework Systems, Cooperative Learning, Writing-Enriched Curriculum, Evaluation of Student Writing...

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- Fall 2018 - Version 14.0
- Fall 2019 - Version 17.0, MF active learning, 50% of course online

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open.umn.edu - David Ernst

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- Most students in Pre-Calculus have taken the course before, but did not show understanding of the material on the placement exam.

Course Structure

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Two goals

- Mastering Basic Skills
- Develop Higher-Order Thinking Skills

Basic Skills

- To a great extent, basic skills can be learned without interaction between the students and the instructor.

- Can be learned from a 'text' (book or video)

- Students practice problems, which can be done through an automated homework system that gives instant feedback.

- Problems are typically multiple choice, calculated numerical answers, or functions.

Mastery Learning

- Online Homework
- Online Quizzes
- In-class Quizzes
- Must have 100% completion to pass the course
- Covers only the half of the course which covers basic skills

Video Textbook Design

- Don't merely record a lecture based on a printed text. Start the instruction from video, and support with written text and exercises, rather than the other way around.
- Keep videos short (5-7 minutes)
- Rely on the pause button, give students problems to work after examples.

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$$
\begin{aligned}
(x+3)(x-2) &= x^2 + -2x + 3x + -6 \\
&= x^2 + x - 6
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- Connections between concepts can be illustrated visually
- Slideshow provides basis for note taking

Active Learning

- Organization
- Written Communication
- Decision Making
- Developing Algorithms
- Generalization

Group Activity Worksheets

- Conceptual Objective
- Components
- Issues
- Questions/Hints
- Synthesis

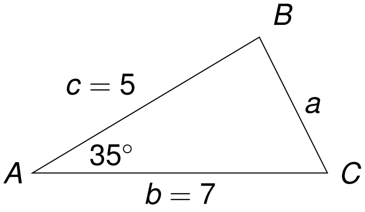
126 students vs. me + 2 TAs + 4 ULAs, 18:1 ratio. Active learning requires frequent interaction between student and instructor.

Flipping the formula

Traditional Lecture Course approach to formulas:

Sample Problem:

Given $b = 7$, $c = 5$ and $A = 35^\circ$, find the area of the triangle.



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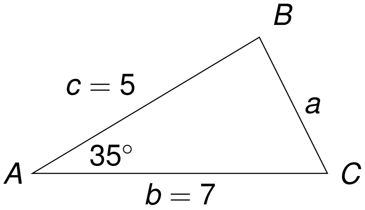

$$\text{Area} = \tfrac{1}{2} bc \sin A$$

Flipping the formula

From **PreCalculus** by *Stitz and Zeager*

11.2.1 Exercises

In Exercises 1 - 20, solve for the remaining side(s) and angle(s) if possible. As in the text, (α, a), (β, b) and (γ, c) are angle-side opposite pairs.

1. $\alpha = 13°,\ \beta = 17°,\ a = 5$
2. $\alpha = 73.2°,\ \beta = 54.1°,\ a = 117$
3. $\alpha = 95°,\ \beta = 85°,\ a = 33.33$
4. $\alpha = 95°,\ \beta = 62°,\ a = 33.33$
5. $\alpha = 117°,\ a = 35,\ b = 42$
6. $\alpha = 117°,\ a = 45,\ b = 42$
7. $\alpha = 68.7°,\ a = 88,\ b = 92$
8. $\alpha = 42°,\ a = 17,\ b = 23.5$
9. $\alpha = 68.7°,\ a = 70,\ b = 90$
10. $\alpha = 30°,\ a = 7,\ b = 14$
11. $\alpha = 42°,\ a = 39,\ b = 23.5$
12. $\gamma = 53°,\ \alpha = 53°,\ c = 28.01$
13. $\alpha = 6°,\ a = 57,\ b = 100$
14. $\gamma = 74.6°,\ c = 3,\ a = 3.05$
15. $\beta = 102°,\ b = 16.75,\ c = 13$
16. $\beta = 102°,\ b = 16.75,\ c = 18$
17. $\beta = 102°,\ \gamma = 35°,\ b = 16.75$
18. $\beta = 29.13°,\ \gamma = 83.95°,\ b = 314.15$
19. $\gamma = 120°,\ \beta = 61°,\ c = 4$
20. $\alpha = 50°,\ a = 25,\ b = 12.5$

21. Find the area of the triangles given in Exercises 1, 12 and 20 above.

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- The **students** calculate answers to specific problems using the formula
- Process goes from general to specific and students only do the machine-like calculation process

Flipping the formula

Problems with this approach:

- Formula is isolated from the concept
- Students don't engage in the problem-solving process
- Students are burdened with a long list of formulas that may or may not have meaning to them
- Students act only as 'calculators'

Flipping the formula

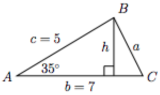
Worksheet - Area of a Triangle

Assume we know the formula for the area of a triangle

$$Area = \frac{1}{2}(base)(height)$$

1. (SAS) Do as many of the following problems as are necessary for you to develop a process that you can describe in question 2. In each case, find h and the area of the triangle. Note that b is the entire length from A to C, not just the portion that would be the adjacent side to angle A in the right triangle.

   (a) Given $b = 7$, $c = 5$ and $A = 35°$, find h and the area of the triangle.

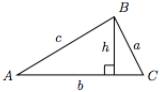
   (b) Given $b = 12$, $c = 8$ and $A = 52°$, find h and the area of the triangle.

   (c) Given $b = 4$, $c = 11$ and $A = 83°$, find h and the area of the triangle.

   (d) Given $b = 10$, $c = 9$ and $A = 115°$, find h and the area of the triangle.

2. Describe, in words, the steps needed to find the area of a triangle, given A, b, and c. (You may also use mathematical expressions in your description.)

3. Using c and A, write a formula for h. Then write a formula for the area of the triangle.

4. Repeat using a and C. That is, using a and C, write a formula for h. Then write a formula for the area of the triangle.

Flipping the formula

Active Learning Course

- **Students** calculate answers to specific problems using whatever tools they have at hand.

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- **Students** solve the generalized problem to create formula
- Process goes from specific to general and students use problem-solving skills throughout the process, with the aid of the instructors.

Mathematical Communication in the Curriculum

Students demonstrate (and are graded on their) communication skills

- while working with and talking to their peers to develop the process
- written write-ups that are follow-ups to the in-class activities
- written answers to questions that appear on exams

Results

- Withdrawal rate is one-third of what is was historically (3% vs. 9.2%)
- Retention rates are up (57.6% of students in hybrid courses enroll in Calculus compared to 50.6% of students lecture courses)
- Withdrawal rates from Calculus are higher among hybrid students (bad news)
- Overall, hybrid students successfully complete Calculus at a high rate that standard lecture students. (39.3% vs. 38.4%)

Challenges

- How do we effectively evaluate student writing?
- How do we effectively evaluate student work in groups?
- How do we encourage creativity and exploration and not penalize productive failure?
- Classroom space appropriate for active learning.
- Training instructors in active learning.

Links

http://open.lib.umn.edu/probability/
http://open.lib.umn.edu/algebra/
http://open.lib.umn.edu/trigonometry/

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Contact Info

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