Video Textbooks in the Active Learning Classroom

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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...
History

- Fall 2012 - Hired at Univ. of Minnesota, Lower-Division Coordinator. PreCalc II used standard text and homework. MWF ‘lecture’, Th discussion.

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- Fall 2016 - Version 8.0, more emphasis on communication skills, addition of PreCalc I

- Fall 2017 - Version 11.0, addition of College Algebra

- Fall 2018 - Version 14.0

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open.umn.edu - David Ernst
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\[ \{ \ldots, -270^\circ, 90^\circ, 450^\circ, 810^\circ, \ldots \} \]
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• Textbook costs are high, and as a result, students may not buy the textbook.
• Most students in Pre-Calculus at the U of Minnesota are majoring in health careers, social sciences, economics, not engineering.
• Most students in Pre-Calculus have taken the course before, but did not show understanding of the material on the placement exam.
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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
• 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.
Advantages of Video over Print

- Animation
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- Highlighting is flexible
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\[(x + 3)(x - 2) = x^2 + -2x + 3x + -6\]

\[= x^2 + x - 6\]
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- 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.

![Diagram of a triangle with sides $a$, $b$, and $c$ and angle $A = 35^\circ$.]
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$$\text{Area} = \frac{1}{2} bc \sin A$$
11.2.1 Exercises

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

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

21. Find the area of the triangles given in Exercises 1, 12 and 20 above.
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Traditional Lecture Course approach to formulas:

- The **professor** and/or **text book author** does the generalization and ’proof’ to derive a formula
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- The **professor** and/or **text book author** does the generalization and ’proof’ to derive a formula
- 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’
Worksheet - Area of a Triangle

Assume we know the formula for the area of a triangle

\[ \text{Area} = \frac{1}{2}(\text{base})(\text{height}) \]

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 \( A = 35^\circ \), find \( h \) and the area of the triangle.

(b) Given \( b = 12 \), \( c = 8 \) and \( A = 52^\circ \), find \( h \) and the area of the triangle.
(c) Given \( b = 4 \), \( c = 11 \) and \( A = 83^\circ \), find \( h \) and the area of the triangle.
(d) Given \( b = 10 \), \( c = 9 \) and \( A = 115^\circ \), 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.
Active Learning Course

- **Students** calculate answers to specific problems using whatever tools they have at hand.
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- **Students** develop a process
- **Students** devise an algorithm
- **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.
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.
http://open.lib.umn.edu/probability/
http://open.lib.umn.edu/algebra/
http://open.lib.umn.edu/trigonometry/
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