Dr. Lee Singleton

Grasp the Math: Using 3D-Printing & Active Learning in Trigonometry

Whatcom Community College
EAGER: MAKER: Engaging Math Students with 3D-Printing for STEM Success (DRL #1623405)

- Improve Success Rates of Students in Precalculus II (Math& 142)
- Improve Retention of students in STEM
- Improve Retention of Precalculus information through Calculus

* https://atecentral.net/r32228
Engaging Math Students with 3D-Printing

Dr. Lee Singleton
Whatcom Community College

https://youtu.be/UK5FxETSq9A
Sample Activities

Demonstration:
Linear & Angular Speed

Active Learning:
Graphing Sine & Cosine
A Tale of Two (Types of) Classes

3D-Printed Active Learning Classes:
- Q&A over homework at the beginning of class
- Mini-Lecture after Q&A
- Groupwork Handouts with 3D-Printed manipulatives
- Online & Textbook Homework
- Predator/Prey Modeling group assignment before Exam 2

Interactive Lecture Classes:
- Q&A over homework at the beginning of class
- Full-Lecture after Q&A
- Whole-group feedback and interaction during lecture
- Online & Textbook Homework
- Predator/Prey Modeling group assignment before Exam 2
Test 1 Topics

- Right Triangle Trig
- Coterminal and Reference Angles (degrees)
- Trig functions of any angle (degrees)
- Law of Sines
- Law of Cosines
Test 2 Topics

• Radians, Arclength, Linear & Angular Speed
• Unit Circle
• Coterminal and Reference Angles (radians)
• Trig functions of any angle (radians)
• Trig Graphs
• Inverse Trig Functions
Test 1 Means and Medians

- **M142 W17 2D**
  - Mean: 78.4
  - Median: 81.0

- **M142 W17 3D**
  - Mean: 85.3
  - Median: 88.5

- **M142 Sp17 3D**
  - Mean: 82.2
  - Median: 86.0
Test 1 Grades by Class Type

- Math & 142 2D
  - A: 24%
  - B: 30%
  - C: 14%
  - D: 22%
  - F: 11%

- Math & 142 3D
  - A: 41%
  - B: 38%
  - C: 9%
  - D: 3%
  - F: 9%

T-test Values

- All Data
  - p-val = 0.051
- Data: 9 -> 49
  - p-val = 0.026
- Data -1 Outlier
  - p-val = 0.016
PreCalculus II Test 1 Success Rates

<table>
<thead>
<tr>
<th></th>
<th>Unsuccessful</th>
<th>Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>32.4%</td>
<td>67.6%</td>
</tr>
<tr>
<td>3D Active</td>
<td>11.5%</td>
<td>88.5%</td>
</tr>
</tbody>
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Notes:
Lecture Population = 37, Winter Quarter 2017
3D-Active Population = 61, Winter and Spring Quarter 2017
Successful = A, B, or C; Unsuccessful = D or F
Test 2 Means and Medians

M142 W17 2D: Mean 81.5, Median 85
M142 W17 3D/2D: Mean 83.8, Median 85.5
M142 Sp17 3D: Mean 86.3, Median 88
Test 2 Grades

- **M142 W17 2D**
  - A: 37%
  - B: 31%
  - C: 9%
  - D: 9%
  - F: 14%

- **M142 W17 3D/2D**
  - A: 41%
  - B: 22%
  - C: 28%
  - D: 3%
  - F: 6%

- **M142 Sp17 3D**
  - A: 46%
  - B: 35%
  - C: 12%
  - D: 8%
Notes:
Lecture Population = 67, Winter Quarter 2017
3D-Active Population = 27, Spring Quarter 2017
Successful = A, B, or C; Unsuccessful = D or F
Test 2 Observations

• All groups had predator-prey activity groupwork after graphing sine and cosine
• All groups had “Unit Circle warning”
• Need to refine the inverse function activity
Math& 142 Test 1 Success Rates

Notes:
Lecture Population = 67, Winter & Fall Quarter 2017
3D-Active Population = 27, Winter, Spring, & Fall Quarter 2017
Successful = A, B, or C; Unsuccessful = D or F
Math & 142 Test 2 Success Rates

Notes:
Lecture Population = 60, Winter & Fall Quarter 2017
3D-Active Population = 94, Spring & Fall Quarter 2017
Successful = A, B, or C; Unsuccessful = D or F
What about the time?
Do you measure the Speed of Coverage or Speed of Learning?
Other Observations

• Attendance not greatly affected
• Pods vs. Rows – difficult to see anything conclusive, but Pods seem to contribute to more student discussions
• Some classes ask really good questions, others...
Always remember to plan ahead.

Thingiverse.com
User: GraspTheMath

https://www.thingiverse.com/GraspTheMath/designs

Future Website:
Graspthemath.wordpress.com
MATH 175

Grasp the Math: Intro to 3D-Printing

Starting Fall 2017

2 Credit Class
Requires concurrent or prior enrollment in Math&142 or Math&151 or higher.
Design Software

- OpenSCAD
- Tinkercad
- SketchUp
- Onshape
- Autodesk
- Rhinoceros 5
Slicing Software

SIMPLIFY3D

Cura

Repetier-Host
• Refining lessons
• Tracking students through Calculus (I, II, III)
• Tracking student persistence in STEM

• Making lessons and objects available for download.
• Trying this in other classes!
• Feel free to look at other lessons and objects!