



# Lecture Based Tutoring- A New Active Learning Technique

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# Assumption: Teaching is a System

- Systems can be optimized (Industrial Engineering)
- Feasibility (requirements)
  - Cover the expected material
  - Do no harm
- Common goals of faculty (objectives)
  - Student learning
  - Good student evaluations
  - Enjoyment of teaching
  - Less faculty effort
- Individuals personalize style regardless of tools

# Active Learning

- Active learning occurs when you directly engage the students during the class.
- Active learning tends to improve student learning outcomes
- Lots of active learning techniques
  - Student voting
  - Pair and share
  - Problem based learning
  - Written methods

# My Views on Common Active Learning Methods

- Give up control of classroom
  - Not all time is spent by all groups learning (wasting class time)
  - Incorrect theories/ideas may not always be identified
- Takes too long
  - Flipping the classroom can help. Students watch a lecture before hand and then class time is spent in active learning activities.
  - Preparation (active writing)
- I like student voting with hands

# Active Learning: Lecture Based Tutoring

- Head Mathematical Athletic Coordinator at Georgia Tech
  - Every student must pass business calculus and a finite math class
- Goal: Have the students pass math classes
  - Meet in groups of 4-10 twice a week
  - Go around and tutor people individually
  - Lecture
  - Call people up to board and tutor
  - Individually tutor the student while seated, but in a lecture setting
  - Individually tutor multiple students through the same problem while seated
  - Math GPA rose by .8

# History of Lecture Based Tutoring

- Assistant professor at Kansas State University
  - Lecture – resulted in average quality of class
- Second year I was required to enroll in a teaching quality course. I learned about active learning.
- Can I ask a particular student a question?

# Simplex Method for Linear Programs

- Obtain the solution. The identity matrix identifies basic variables, which have the value of the right hand side. The other variables are nonbasic and have a 0 value.  
$$\begin{matrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix}$$
- Select the most negative column based upon the coefficient in the objective row, called improving column.
- Perform ratio test (divide RHS by improving column, a value less than or equal to 0 in the improving column equals infinity). Select minimum of ratio test for the row
- Perform a pivot, which creates a new identity column (entering and leaving variable) using elementary row operations.

# Linear Program Problem in Standard Form

- Maximize  $z = 2x_1 + 3x_2$   
Subject to  $-x_1 + x_2 + x_3 = 6$   
 $3x_1 - x_2 + x_4 = 4$   
 $x_1, x_2, x_3, x_4 \geq 0$

1. Find solution
2. Find column
3. Select row
4. Pivot

<b>z</b>	<b><math>x_1</math></b>	<b><math>x_2</math></b>	<b><math>x_3</math></b>	<b><math>x_4</math></b>	<b>RHS</b>
1	-2	-3	0	0	0
0	-1	1	1	0	6
0	3	-1	0	1	4

What is the current solution?

$$z=0, x_1=0, x_2=0, x_3=6, x_4=4$$



# Iteration 1

<b>z</b>	<b>x<sub>1</sub></b>	<b>x<sub>2</sub></b>	<b>x<sub>3</sub></b>	<b>x<sub>4</sub></b>	<b>RHS</b>
1	-2	-3	0	0	0
0	-1	1	1	0	6
0	3	-1	0	1	4

1. Find solution
2. Find column
3. Select row
4. Pivot

What is the most improving column?

Perform the min ratio test divide the RHS by this column? Note: This is not performed on objective row.

$$6/1=6 \text{ and } 4/-1 = \infty$$

# Pivoting

$z$	$x_1$	$x_2$	$x_3$	$x_4$	RHS
1	-5	0	3	0	18
0	-1	1	1	0	6
0	2	0	1	1	10

Perform a pivot.

$$R_1 := R_1 + 3 R_2$$

$$R_3 := R_3 + 1 R_2$$

What is the new solution?

$$z=18, x_1=0, x_2=6, x_3=0, x_4=10$$

# Iteration 2

$z$	$x_1$	$x_2$	$x_3$	$x_4$	RHS
1	0	0	5.5	2.5	43
0	0	1	1.5	$\frac{1}{2}$	11
0	1	0	$\frac{1}{2}$	$\frac{1}{2}$	5

What is the next step?

What is the next step?

$$6/-1 = \infty$$

What is the next step?

$$10/2 = 5$$

$$R_3 := \frac{1}{2} R_3$$

$$R_1 := R_1 + 5R_3$$

$$R_2 := R_2 + R_3$$

What is the current solution?

$$z=43, x_1=5, x_2=11, x_3=0, x_4=0$$

What happens next?

# Lecture Based Tutoring Concept

- Convert the lecture into one on one tutoring sessions with different students. This is accomplished by asking a particular student a question.
- If the person answers the question incorrectly, then the person is tutored to a solution. If the answer is correct, then move on or add additional insight.
- Attempt to ask a question to each person in the class and have at least numerous (20-50) such questions in each class period. (I use 3x5 cards w pics, alphabetical or seating order)

# Lecture Based Tutoring Nonexact Topics

- **Provide background**
- **Ask a question to several people according to order.**
  - **Have a follow up summary or discussion with each person.**
    - **This puts your seal of approval on the comment.**
- **Potentially ask entire class for other comments**
- **The next slide has all the topics you want to cover.**

What are some perceived benefits of lecture based tutoring?

What are some perceived weaknesses of lecture based tutoring?

# Benefits of Lecture Based Tutoring

- Better student learning and teacher evaluations
- Minimal preparation time and rarely boring as an instructor
- Identify where each student is lacking in understanding and lend individual attention
- Exhaustive random sampling: Spend time on only concepts that are confusing to the class
- Students are willing to ask question
- Cover more material

# Weaknesses of Lecture Based Tutoring

- Student Stress



# Voting with hands

- How did you feel when I first started asking questions?  
Terrified, stressed, indifferent, excited to participate
- How did you feel near the end?  
Terrified, stressed, indifferent, excited to participate
- Should students be stressed during lecture?
  - Yes, Partially, No

# Successful Strategies for Lecture Based Tutoring

- Create an expectation of failure
  - Never work an example
  - Have students derive theory
  - Ask graduate or research level questions
  - Fail yourself
  - Deflect attention away from student?
- Ask how a student came up with an answer
- Be prepared for sleepers and willing to repeat questions

# Hints: Types of Questions

- No trivial questions (What is  $2+2$ ?)
- Never ask, Are you prepared?
- Yes or no/multiple choice questions must have follow up.
- Step questions
- Opinion questions
- Open ended questions
  - Why, how, what, etc.

# Body Language

- Body language is important and the body provides nonverbal clues regarding teaching.
- Body language that creates a hostile environment
- Body language that creates an inviting discussion atmosphere.

# IMSE 680-Quantitative Problem Solving

- IMSE 680 is taught as a distance class.
- In summer 2014 the class was changed from a lecture to a lecture based tutoring format.
- 97 students enrolled in the class from Fall 2011-Spring 2014.
- 39 students enrolled in the class from Summer 2014 - Fall 2015
- As a distance class students are given an incomplete if all items are not turned in by the end of a semester. This changes to an F at the end of the next semester.

# Student Outcomes

Anecdotal evidence: I have received far fewer email questions and student evaluations have improved by .5 on a scale of 1-5.

## IMSE 680 Lecture Sections

Number of Students	Completed First Semester	Completed	Failed
97	26 (27%)	77 (79%)	20 (21%)

## IMSE 680 Lecture Based Tutoring Sections

Number of Students	Completed First Semester	Completed	Failed
39	26 (67%)	35 (90%)	4 (10%)

# Student Learning Outcomes

- The midterm exams are essentially the same and no other changes have occurred to the course.
- Scores from the midterm exam are used to perform a paired t test assuming unequal variances with  $\alpha=.01$ .

	Lecture Based Tutoring	Lecture
Mean	91.87	83.94
Variance	40.95	188.47
Observations	35.00	77.00
df	110.00	
t Stat	4.17	
P(T<=t) two-tail	<0.0001	
t Critical two-tail	2.62	

With 99% confidence the means of the midterm exams are not the same. Lecture based tutoring improved student learning.

# Impact on Student Ratings

- A senior level Industrial Engineering course (Simulation) was taught twice with a lecture format and 9 times with lecture based tutoring. There were no other substantial changes.
- The data of teacher ratings using the Idea form (1-5) with 5 being highest.
- The national average is about 4.05.



# Data and Analysis

Class	Lecture	Lecture Based Tutoring
1	3.8	4.9
2	4.3	4.9
3		4.4
4		4.8
5		4.9
6		4.7
7		4.8
8		4.9
9		4.9
<b>Average</b>	<b>4.05</b>	<b>4.8</b>

The 95% confidence interval of Lecture based tutoring teacher ratings is (4.67,4.93). Thus, both the 3.8 and 4.3 teacher ratings are statistically rejected from being the mean of the evaluations of the lecture based tutoring class. One can conclude that lecture based tutoring leads to significantly better teaching evaluation

# Invitation to Collaborate

- One teacher sample is not sufficient for a quality paper.
- If you try and enjoy. Please contact me and with a few others we can submit a paper or grant.

# Questions