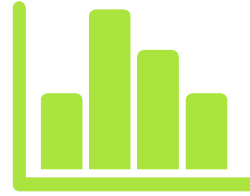




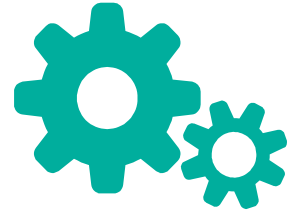
# Effective Communication in the Sciences



# Hello!

**I am Joab Corey, PhD.**

I love teaching, boxing, skydiving, and SCUBA diving



# Hello!

## I am Nathan Crock

I love teaching, boxing, neuroscience, and tango

# Outline

- ◆ How is our scientific education system doing?
- ◆ A deeper look at communication and learning
- ◆ Sharper tools for our teaching utility belt
- ◆ General teaching tips
- ◆ Let's try it out!



**1.**

# Current State of Science Education

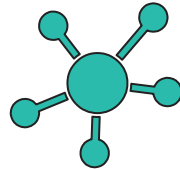
**“A problem clearly stated is a problem half solved”**

**Dorothea Brande**



A typical introductory science class consists of a couple of hundred students, most of whom have no plans to continue with the subject, **nor a great deal of prior knowledge**. But in a world that increasingly depends on science and technology, it is more important than ever that these students learn the scientific basics.

# The National Math + Science Initiative





Sitting in a 3.8-metre sea  
kayak and watching  
a four-metre great  
white approach you is  
a fairly tense experience

# MOTIVATION

If there is a better reason to paddle, I don't know what it is.



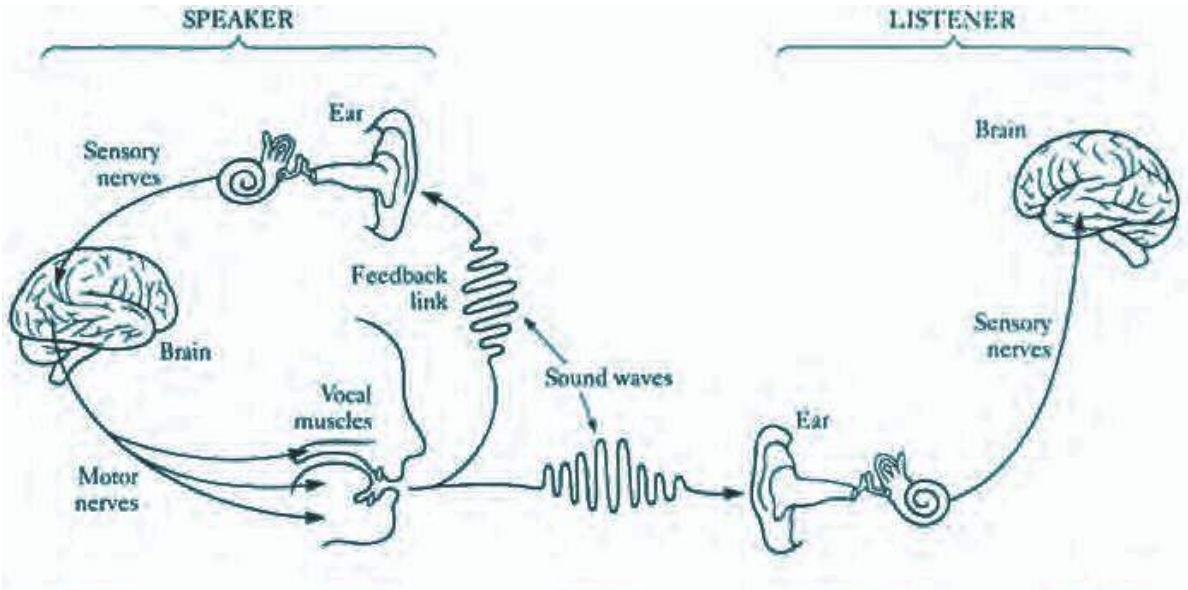
2.

# Communication and Learning

“The single biggest problem in communication is  
the illusion that it has taken place”

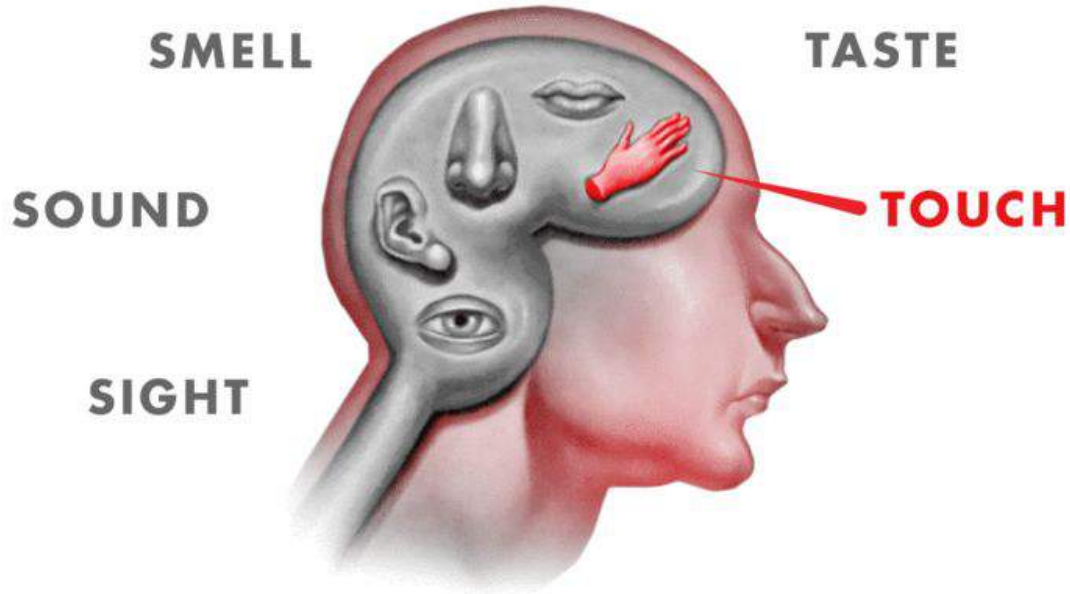
George Bernard Shaw

# Teaching is Essentially Magic



In teaching, we strive to somehow implant a particular concept into our student's brain

# The Brain's Measurement Devices



There exist many avenues with which to **mold** and **manipulate** our student's thoughts

# Theory for Cognition

## Likelihood

How probable is the evidence given that our hypothesis is true?

## Prior

How probable was our hypothesis before observing the evidence?

$$P(H | e) = \frac{P(e | H) P(H)}{P(e)}$$

## Posterior

How probable is our hypothesis given the observed evidence?  
(Not directly computable)

## Marginal

How probable is the new evidence under all possible hypotheses?  
 $P(e) = \sum P(e | H_i) P(H_i)$

It is believed that the brain operates via Bayesian inference

# Apply this to Learning

## Association and Differentiation

Form their prior by using all of their senses to compare the new concepts to things they already know.

## Evidence and Update

Then present the evidence and the students will (hopefully) update the priors accordingly

**This is similar to Priming!**

3.

# Using This to Improve Instruction

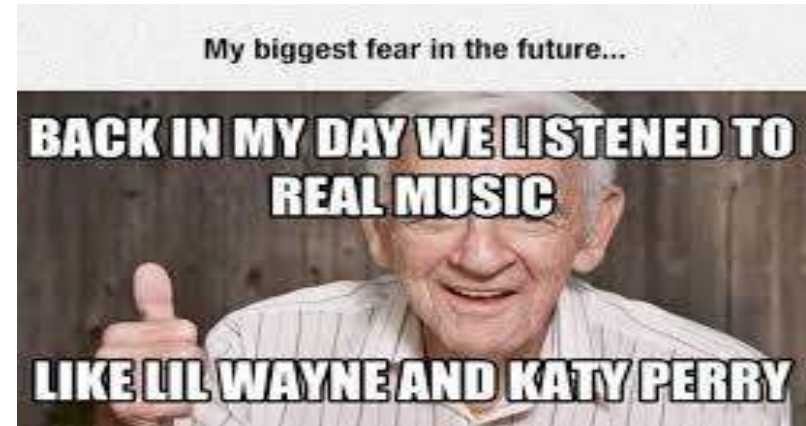
“Those who know, do. Those that understand, teach.”

Aristotle

# It Starts with a Survey

I use this survey for two reasons:

- 1) To reassure worried students
- 2) To find out what music, movies, television shows, and hobbies my students are currently into.



# Pop-Culture References

I then use the results to modify standard questions to match their favorite shows, movies, and hobbies. These questions appear on both their exams and in class:

## Standard Law of Comparative Advantage

Kelly is an attorney and also an excellent typist. She can type 120 words per minute, but she charges attorney fees at \$100 per hour. Todd would like some typing work but can only type 60 words per minute. According to the law of comparative advantage, Kelly should hire Todd to do her typing if and only if his wage rate is less than\*



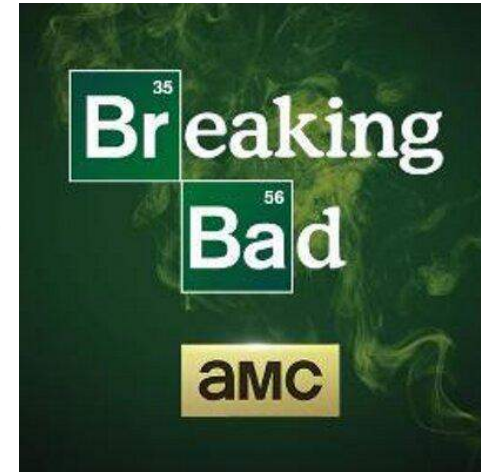
\*Gwartney, James, et al. *Economics: Private and public choice*. Nelson Education, 2014.



# Pop-Culture References

## Law of Comparative Advantage: Breaking Bad

Walter White works as a high school chemistry teacher and also cooks methamphetamine to make a living. Walter White can make 40 pounds of high quality meth a day, but he is pressed for time because he has all the teaching work he can handle at \$60 an hour. Jesse Pinkman sells marijuana and is also known for cooking high quality methamphetamine, but can only cook 20 pounds of meth a day. According to the law of comparative advantage, Walter White should hire Jesse to cook meth for him as long as Jesse's wage rate is less than



# Pop-Culture References

## Law of Comparative Advantage: How I Met Your Mother

Ted Mosby works as an architect and is also the co-owner of a bar named Puzzles with his friend Barney Stinson. He can serve 20 customers an hour but is pressed for time because he has all the architecture work he can handle at \$100 an hour. Barney, whose job title and salary are undisclosed, can only serve 10 customers an hour. According to the law of comparative advantage, Ted should hire Barney to cover his shifts at the bar if and only if Barney's wage rate is less than



# Pop-Culture References

You can use pop-culture examples to set up concepts, drive home important lessons, or as a more entertaining way to quiz students on the material.

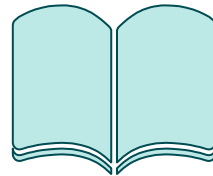
## Benefits

1. More enthusiastic classroom environment
2. Better able to connect students to the material
3. You show students that your material can relate to everyday life!

# Pop-Culture References

In summary, present your class examples and problems with modern pop-culture references that are relevant to your students!

For more examples and ideas skim through your field's teaching journals



# What About Math?

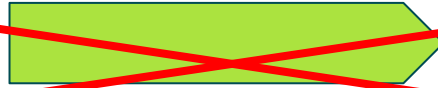
Mathematics is a succinct symbolic way  
to represent concepts or ideas



# Teaching Math

## ~~Prior~~

~~Introduce new symbols, definitions and or ideas~~



## ~~Evidence~~

~~Apply the new material to a familiar problem~~

## Prior

Introduce a familiar problem or scenario



## Evidence

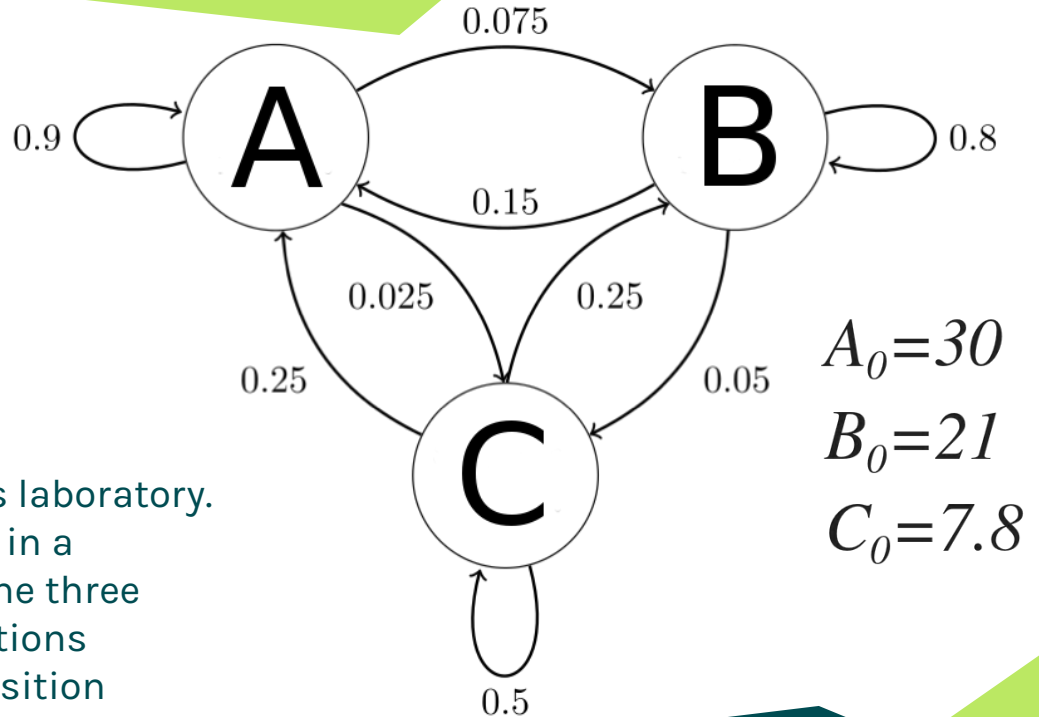
Apply the new ideas within the context of the familiar problem

# Pop-Culture Reference

## Ex-Machina



Ava has just broken free from Nathan's laboratory. To remain unnoticed she plans to hide in a densely populated city. She observes the three closest cities and notices their populations change according to the following transition diagram. Should Ava go to city A, B, or C?



# What About Statistics?



The brain has been shown to be a bad intuitive statistician. Interesting examples are helpful



# Teaching Statistics



Joab believes, but unfortunately does not know for sure, that the average amount of suntan lotion it takes to cover Halle Berry's body from head to toe is 4.0 ounces or less. A sample of 36 times that Halle Berry put suntan lotion on reveals a mean of 4.4 ounces. The population standard deviation is 1.1 ounces.

Q: Test Joab's belief at the 0.10 significance level.



Joab's sister believes, but unfortunately does not know for sure, that the average amount of suntan lotion it takes to cover Brad Pitt's body from head to toe is exactly 6.5 ounces. A sample of 49 times that Brad Pitt put suntan lotion on reveals a mean of 6.2 ounces. The population standard deviation is 1.7 ounces.

Q: Is the mean number of ounces of suntan lotion required to cover Brad Pitt's body different from 6.5 at the 0.01 significance level?

# What About Programming?



Programming is like learning a new language.

# Teaching Programming

When making slides you can easily cover too much material



**Instead, write the program during class!**

- ◆ Feign ignorance and ask the students to help you
- ◆ Interactively compile and debug. Again, ask for help
- ◆ For large classes use clickers or Socrative
- ◆ When a suggestion is made, ask the student why? Propose a discussion
- ◆ This simulates student teaching which has been shown to be one of the best ways to learn

# Pop-Culture Reference



## Batman v Superman

Batman is trying to find Kryptonite to use in his battles against Superman. He has found thousands of potential sellers and assigned to each the probability that they are selling real Kryptonite. He now wants to start with the most reputable seller and work his way down the list.

How can Batman find the seller with the highest probability of selling real Kryptonite in his list of thousands?



4.

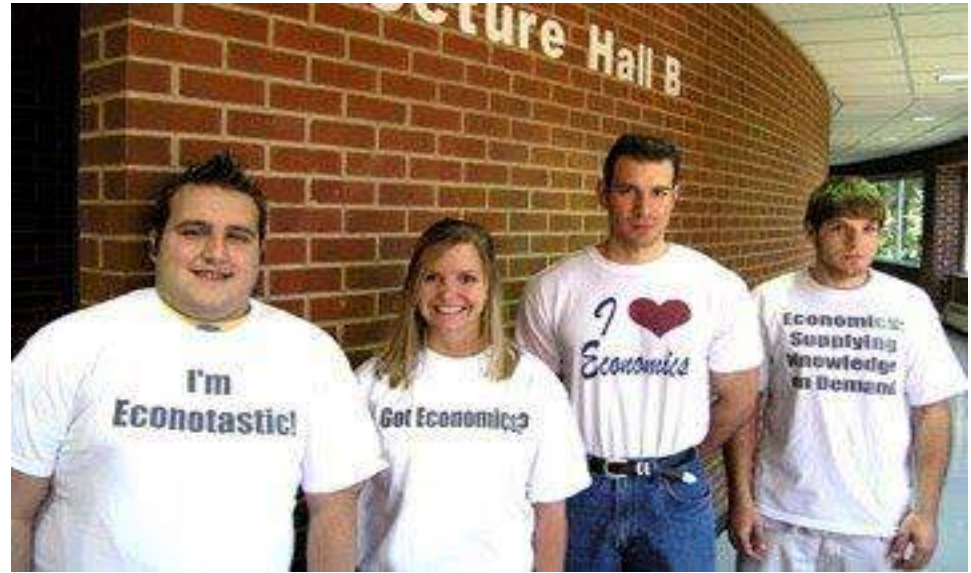
# General Teaching Advice

“Tell me and I forget. Show me and I remember. Let me do and I understand.”

Confucius

# Get Excited!!

Passion and enthusiasm are infectious. If you're not excited, your students won't be excited either.



# Use Multimedia

TV remains the dominant type of media content consumed, at 4:29 a day. (Ages 8-18)

It is followed by:

1. Music/audio at 2:31;
2. Computers at 1:29;
3. Video games at 1:13;
4. Print at 0:38, and
5. Movies at 0:25 a day.





# Use Multimedia

Time spent with every medium other than movies and print increased over the past five years:

- ◆ 0:47 a day increase for music/audio
- ◆ 0:38 for TV content
- ◆ 0:27 for computers, and
- ◆ 0:24 for video games.



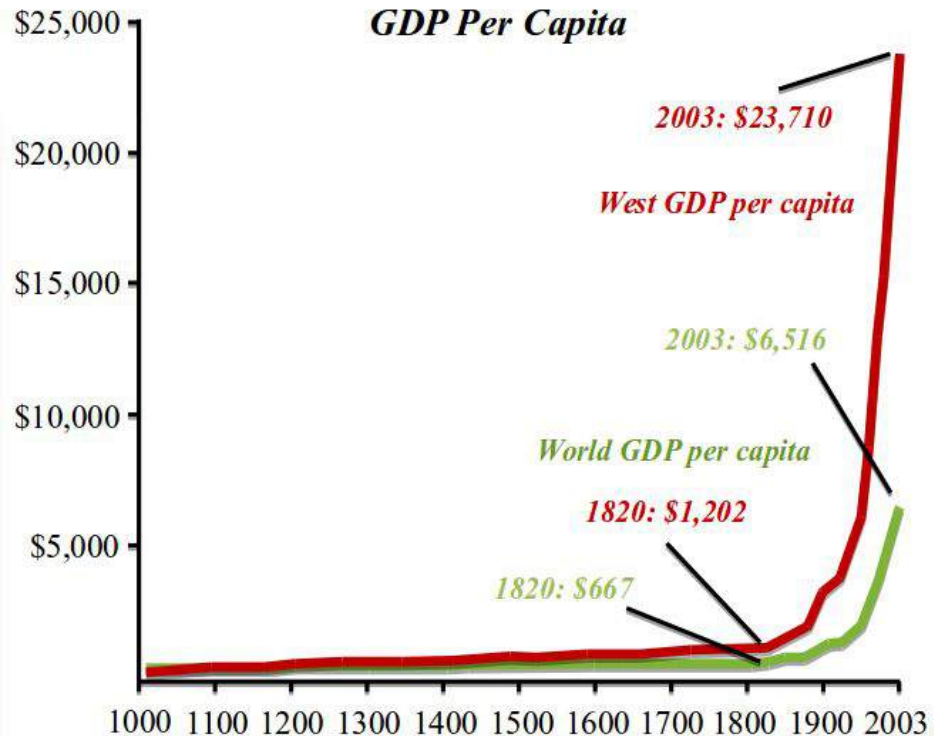
Reference: Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). Generation M2 : Media in the lives of 8 to 18 year Olds. Retrieved from Kaiser Family Foundation at [www.kff.org/entmedia/upload/8010.pdf](http://www.kff.org/entmedia/upload/8010.pdf)

# Per Capita Income: Last 1000 Years

Income stagnated for the 800 years following year 1000, but growth has exploded during the last 200 years.

(Measured in 1990 dollars)  
world per capita income was \$667 in 1820 – only about 50% higher than year 1000. By 2003, however, income had risen to \$6,516 – 10 times the level of 1820.

During the past 200 years, the income growth of the **high-income industrial countries (West)** has grown even more – nearly 20 fold.





# Use Video Clips

You can use these video clips to explain concepts or set up assignments



# Teaching Dos and Don'ts

- ◆ Move around! Do not stand in one place
- ◆ Talk with energy! Do not use a monotone voice
- ◆ Chalk and Talk
  - ◆ Do not face the board.
  - ◆ Write only what is necessary
  - ◆ Do not say what you write
  - ◆ Write big enough for people in the back
- ◆ Use a doc cam if possible (especially for large classes)
- ◆ Limit the amount of information on slides

5.

# Let's Try Some Examples!

“Seeing is believing, doing is knowing.”

Neil Beyersdorf

# Interactive Games and Examples



Students love interactive demonstrations in class. It's often what they remember most...

# Interactive Games and Examples

## Voluntary Exchange: The Candy Game

Because the value of a good or service is subjective, voluntary trade moves goods from people who value them less to people who value them more

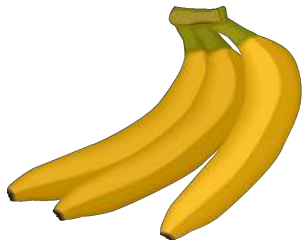




# Interactive Games and Examples

## The Law of Diminishing Marginal Utility: Banana Eating Contest

I demonstrate this principle with a banana eating contest in class!

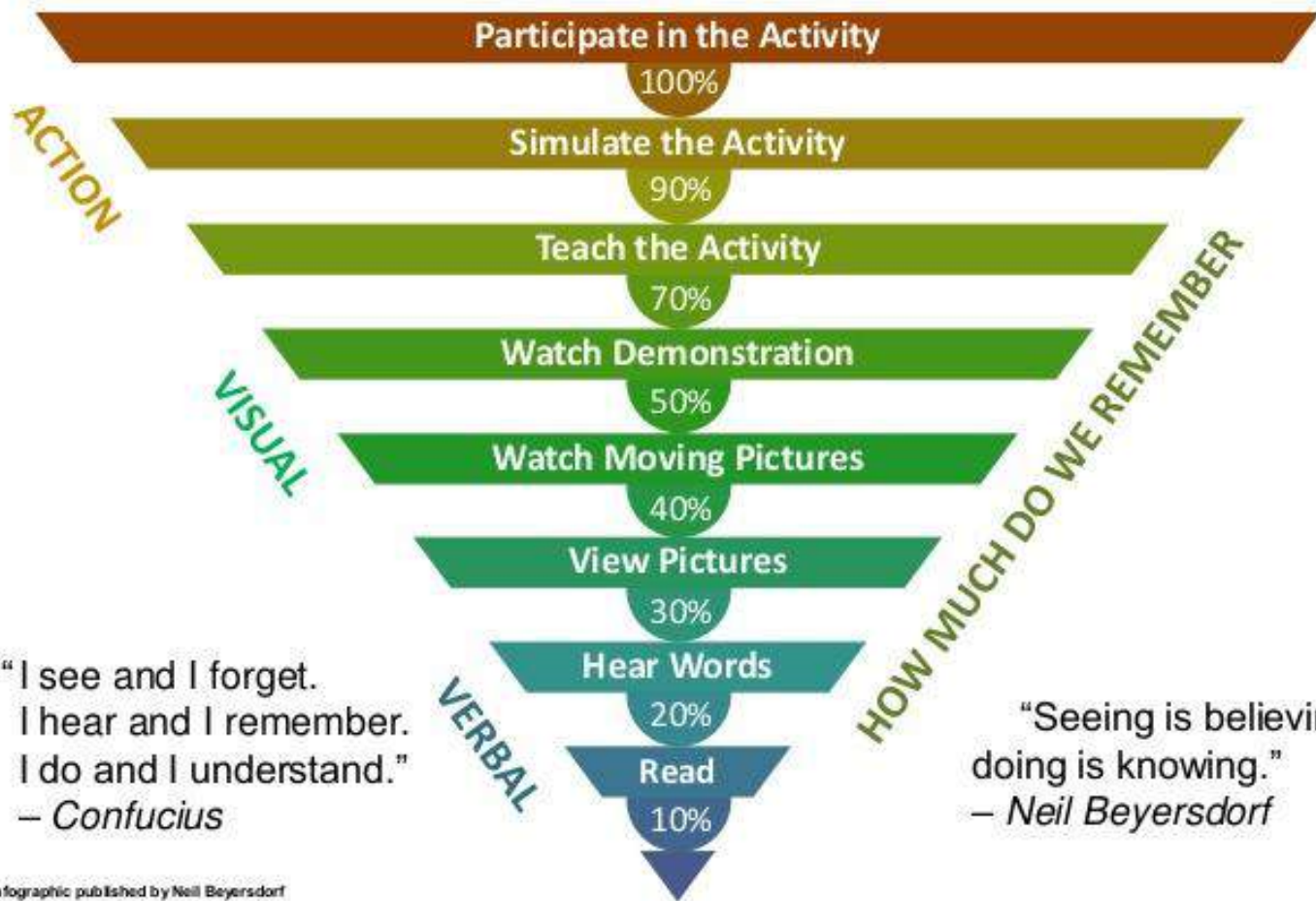


Why is this important? How does this relate to the real world around me

# Recap and Final Comments

“Aim for brevity while avoiding jargon.”  
Edsger Dijkstra

# How We Learn and How Much We Remember



“I see and I forget.  
I hear and I remember.  
I do and I understand.”  
– Confucius

“Seeing is believing,  
doing is knowing.”  
– Neil Beyersdorf

# Remember

- ◆ Be excited! (in your own way)
- ◆ Offer review sessions (especially if you teach large lectures)
- ◆ Get to know your students (first day survey)
- ◆ Use pop-culture references (make examples based off of what your students are into)
- ◆ Students love interactive demonstrations!
- ◆ Show video clips (there are plenty out there)

## Make Adjustments

I also give out a midterm teacher evaluation midway throughout the semester and often make adjustments given their responses



Winners make adjustments  
Losers make excuses

**IF YOU DON'T STUDY**

**YOU SHALL NOT PASS**

# Credits

Special thanks to all the people who made and released these **awesome resources** for free:

- ◆ Presentation template by [SlidesCarnival](#)
- ◆ Photographs by [Unsplash](#)