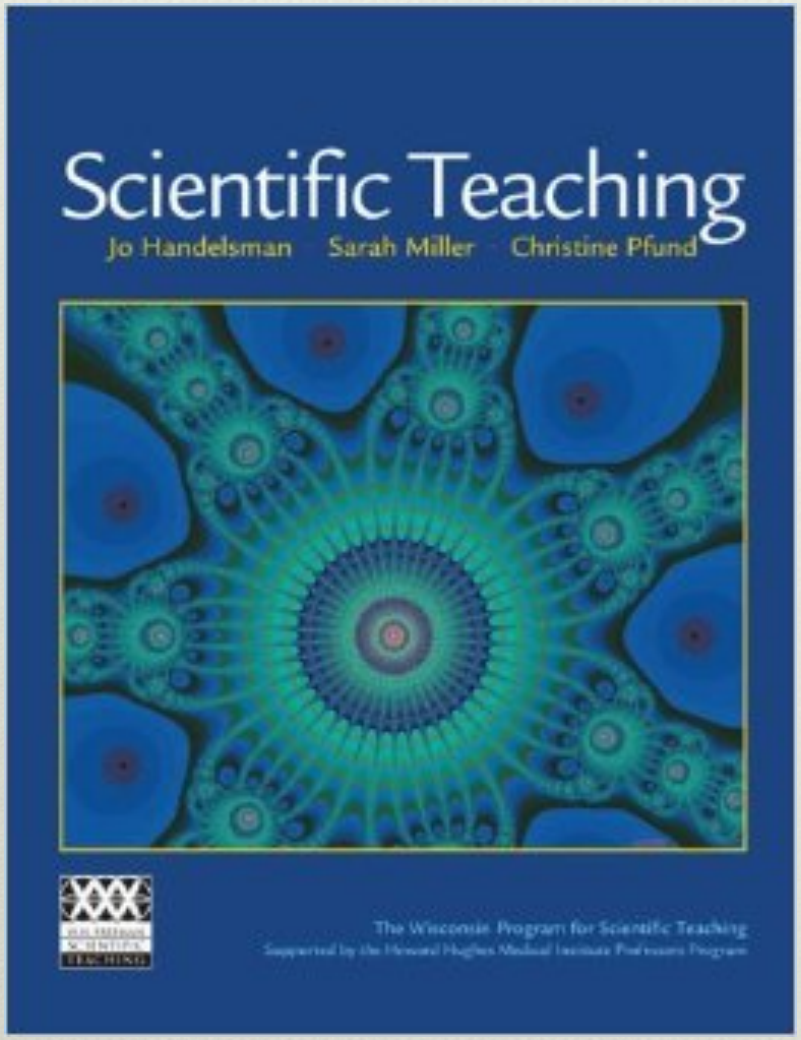
Scientific Teaching

NANSI Workshop
June 8-13, 2015

Why is change needed?

- The outcomes of our teaching are not adequately meeting the opportunities:
  - Too few undergraduates are recruited and retained in science programs to meet the nation's future needs (PCAST report, 2013)
  - Poor retention of students in science
  - College graduates unable to engage in conceptual & analytical thinking
  - Poor retention of content from lecture



<u>Scientific Teaching</u> - The principles and skills scientists use to guide their work in the lab are the same ones needed to guide activities in their classrooms

Lab Work and Teaching

Lab

- Determine purpose of experiment
- Develop experimental protocol
- Carry out experiment
- Analyze data
- Modify and refine

Classroom

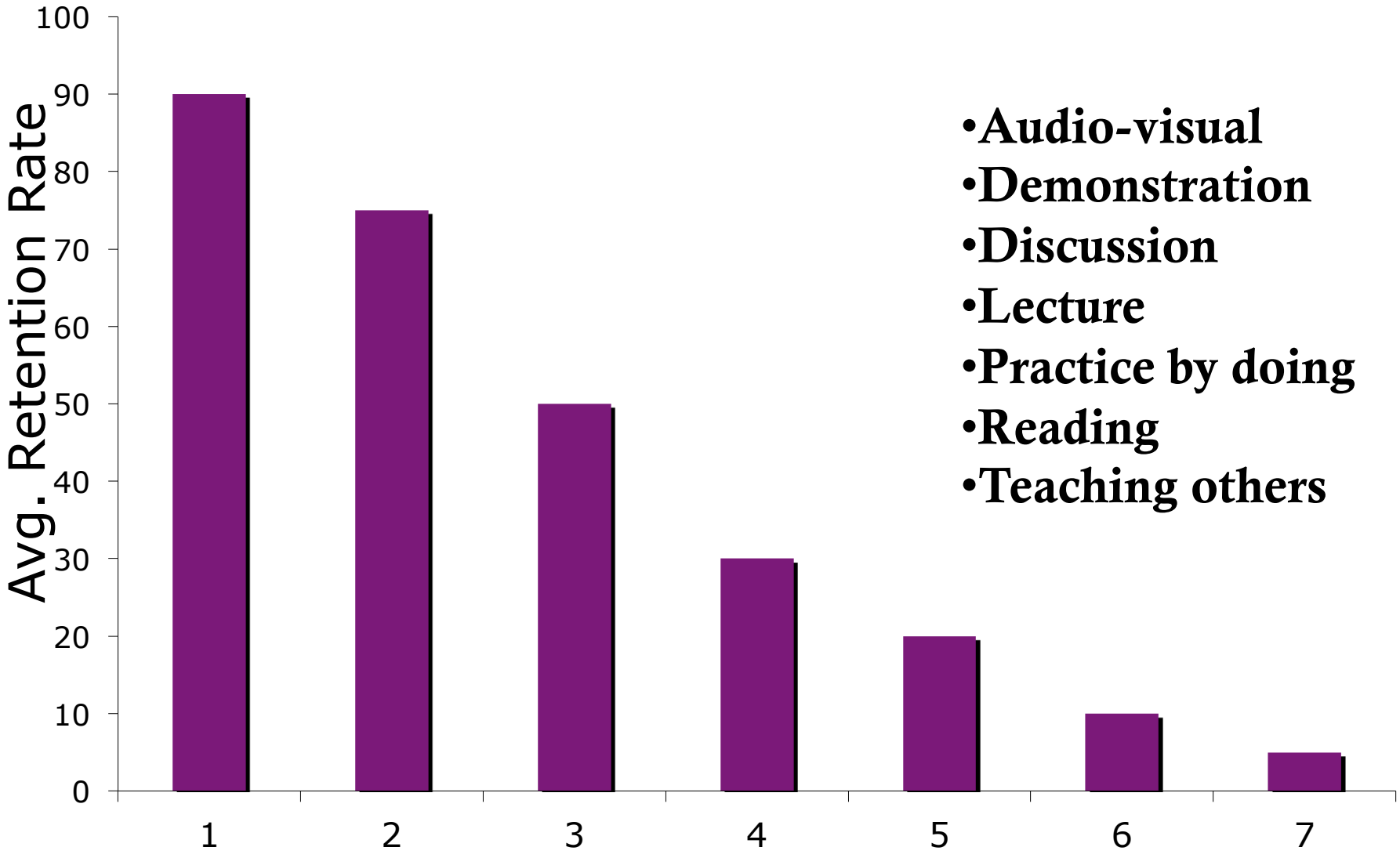
- Formulate learning goals (purpose)
- Develop learning objectives and activities
- Teaching/Learning Process
- Assessment
- Modify and refine

Three Themes of Scientific Teaching

- Active learning
- Assessment
- Diversity/inclusion

Handelsman et al., 2004 Science 304:521-522.

Active Learning


Avg. Retention Rate
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
•Audio-visual
•Demonstration
•Discussion
•Lecture
•Practice by doing
•Reading
•Teaching others

Science of Learning

The percentages listed represent the average amount of information that is retained through that particular learning method.

- Teach others = 90%
- Practice by doing = 75%
- Discussion Group = 50%
- Demonstration = 30%
- Audiovisual = 20%
- Reading = 10%
- Lecture = 5%

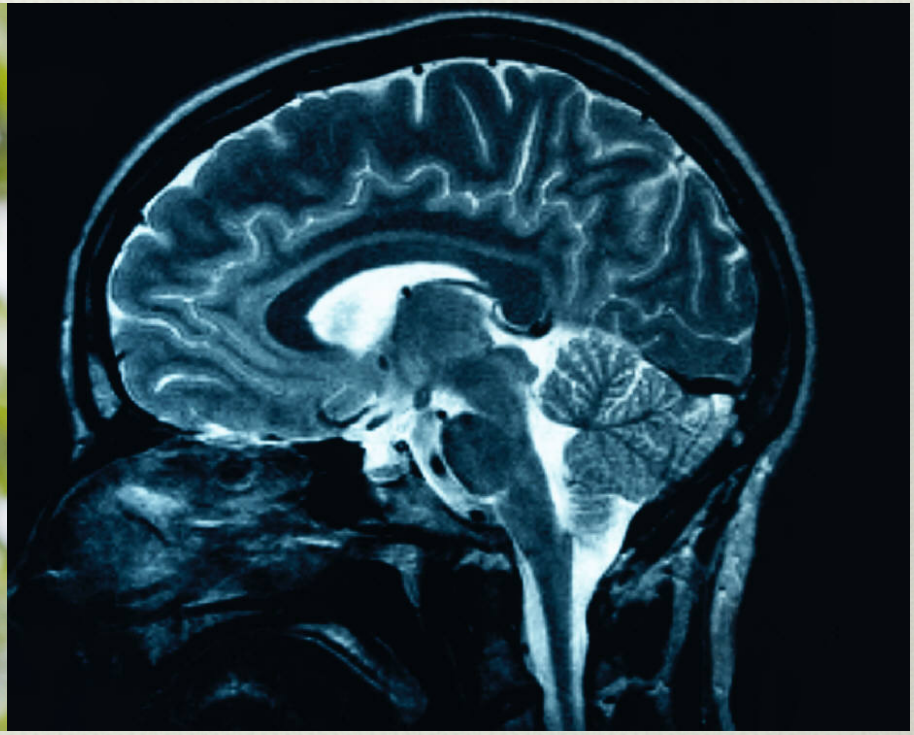
What does that mean?

- 15 wk semester, 3 classes week = ~45 hrs
  - 5% retained through lecture-based instruction = ~**2 hrs**
  - 50% retained through discussion-based instruction = ~**22 hrs**

It’s all about what our students do.

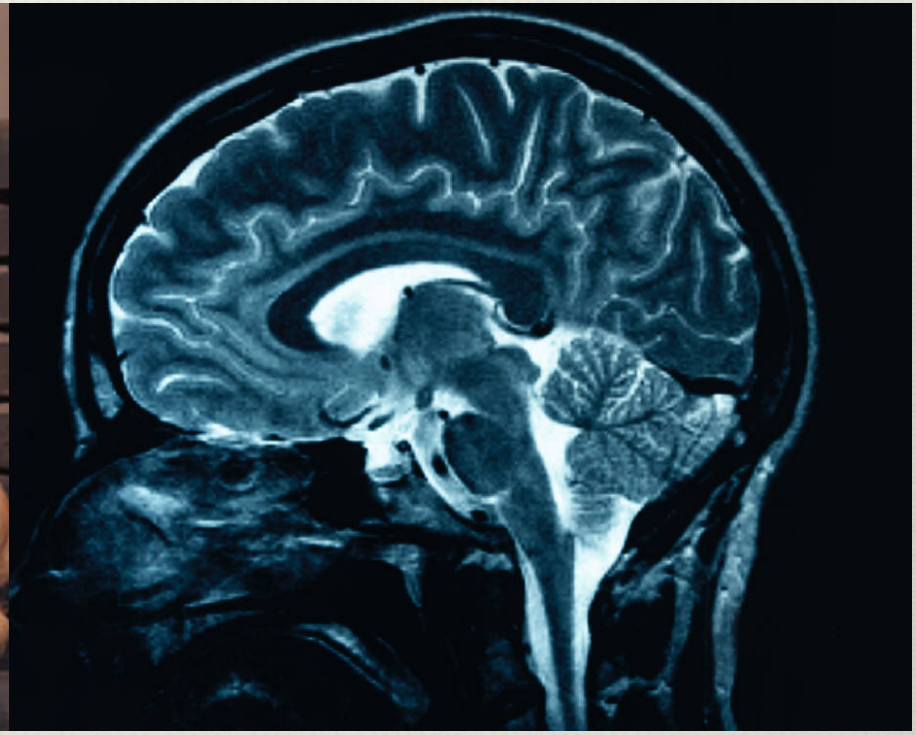
How People Learn

What I pay attention to is what I learn.



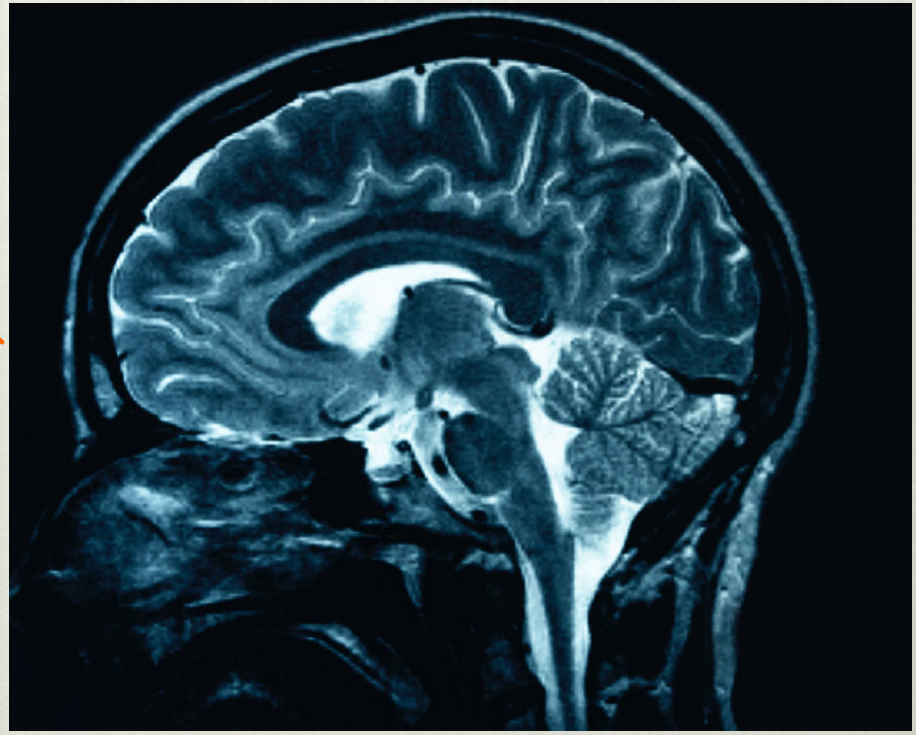
After Terry Doyle, http://learnercenteredteaching.wordpress.com/

Activation of multiple senses enhances learning.



After Terry Doyle, http://learnercenteredteaching.wordpress.com/

The brain is social and emotional.

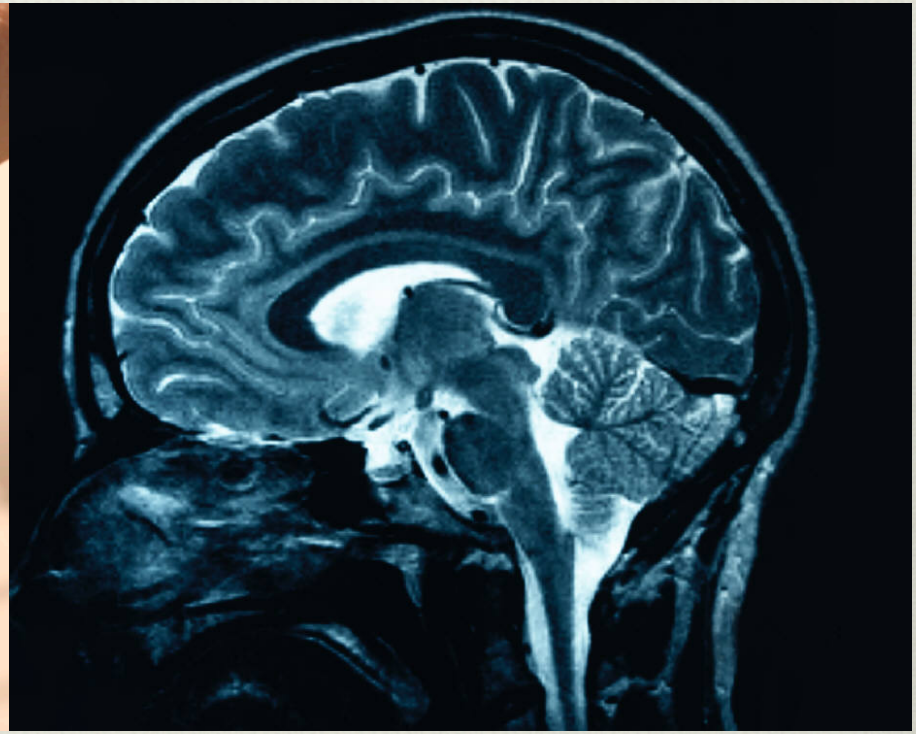


After Terry Doyle, http://learnercenteredteaching.wordpress.com/

The person who does the work does the learning.

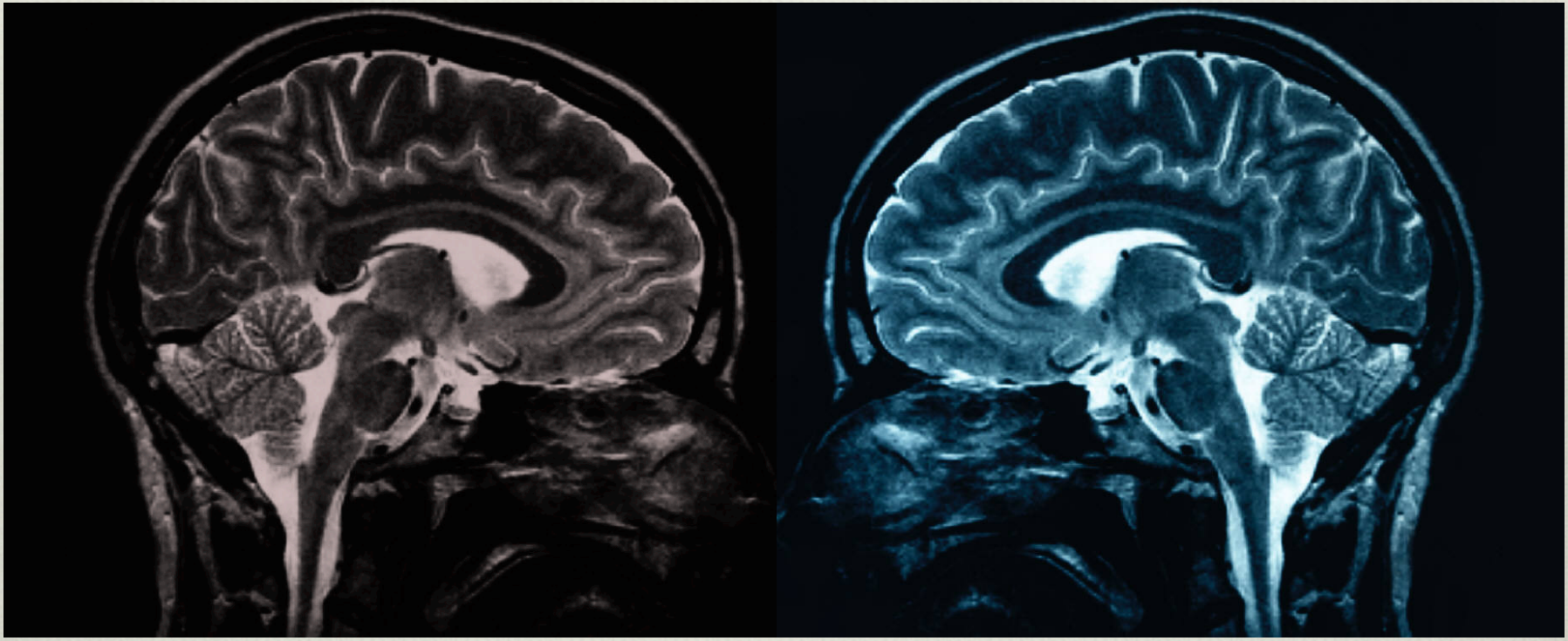
After Terry Doyle, http://learnercenteredteaching.wordpress.com/

Making memories requires repetition, elaboration, & sleep.



After Terry Doyle, http://learnercenteredteaching.wordpress.com/

Metacognition enhances learning.

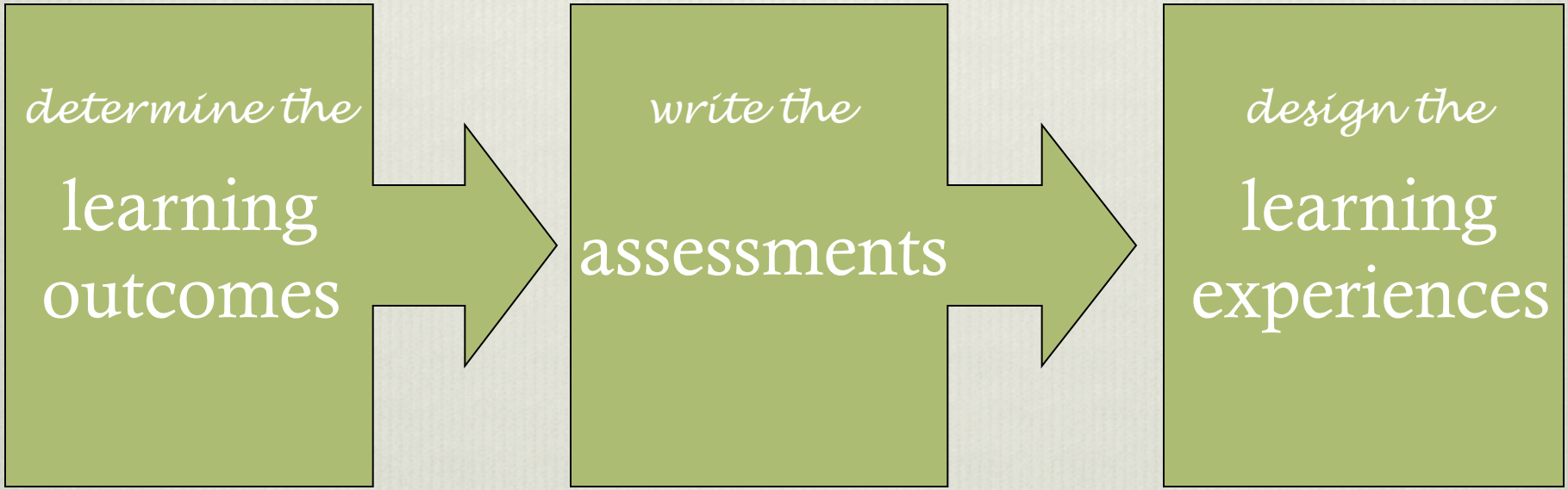


After Terry Doyle, http://learnercenteredteaching.wordpress.com/

It’s all about what our students do.

Designing Instruction

Backward Design



Horizontal Alignment

learning goal	learning outcome	assessment	learning experience
What will students learn?	If they have learned it, what will students know and be able to do?	What will students do to demonstrate they know it or are able to do it?	What activities will students do to learn it?
Students will understand the transfer of information from DNA to proteins	*Students will be able to predict changes in amino acid sequences caused by mutations*	*Students will predict the new amino acid sequence that results from a mutation in a given gene sequence*	*Students are given sequence of DNA and corresponding amino acid sequence. Students identify reading frame & predict amino acid changes due to mutations in that sequence*

Assessment Drives Learning

- Key points:
  - Is more than grades
  - Provides feedback for students and instructors - during the learning activities
  - Drives student learning

What Did We Do?

A Week of Activities

- We learned about scientific teaching
- Created a “Teachable Unit” called “From Meiosis to Mendel”
- Presented our teachable unit to the other participants
- We committed to using our teachable unit in our courses this year
- We committed to telling others at our university about the workshop

What would we like to do now?

- Build an active learning community
- Gauge interest in going through the book
- Determine interest in meeting regularly to discuss/ share active learning strategies