FRAMING OUR DISCUSSION

1. What is learning?
2. How do we know when our students have gained mastery of what they have learned?
3. What does memory have to do with learning?
TODAY’S AGENDA

1. Learning at the neural level
2. Forgetting and learning
3. Retrieval practice
4. Mixing it Up: Interleaving
5. Your Implementation
OBJECTIVES

By the end of this session, you will be able to:

• Identify principles that support durable and transferable learning.
• Name and explain several teaching practices that are effective for student learning.
• Identify next steps in your own teaching practice.
LEARNING AT THE NEURAL LEVEL
THE HUMAN BRAIN

100,000,000,000

The number of neurons we have at birth.
One neuron can make up to 10,000 connections through its dendrites.

Image from Matt Lee on Flickr: https://www.flickr.com/photos/razorsmile/526249719
NEURAL PATHWAYS DEVELOP

**Image Description:**
- **Newborn:** Few neurons, sparse connections.
- **1 Month:** Increase in neuron density, more connections.
- **9 Months:** Substantial growth in neuron connections.
- **2 Years:** Further development, complex network.
- **Adult:** Fully developed neural network.

**References:**
67. Neurogenesis

**Citation:** Corel, JL. The postnatal development of the human cerebral cortex. Harvard University Press; 1975.
A PUZZLE

When you navigate you use the hippocampus.

Why do London taxi drivers have a larger hippocampus than London bus drivers?

Maguire, Woollett, & Spiers, 2006
PRINCIPLE 1

Learning ________ your brain.
RECAP: THE HUMAN BRAIN

True or False?

Learning happens when neurons make new connections.
True or False?

Neural connections are permanent.
True or False?

Some neural connections become stronger than others.
True or False?

The more connections a memory has, the more durable the memory is.
True or False

Our brains change over our lifetimes.
Learning is about making __________.
Write 2 ideas we discussed in Part 1.
★
★

Write one question you have.
?
STRETCH!
“Of course I never forget. I’ve got a lifetime supply of post-it notes.”
FORGETTING AND LEARNING
In 1885, Hermann Ebbinghaus discovered that information is lost very quickly after it is learned.
THE FORGETTING CURVE

Without any reinforcement or connections to prior knowledge, information is quickly forgotten—roughly 56% in one hour, 66% after a day, and 75% after six days.

James Zull, 2002

True or False?
By 5:00 today, you will have forgotten more than half of what you heard in this session.
Forgetting is _______.
THE FORGETTING CURVE & THE LEARNING CURVE

Graph showing the forgetting curve and the learning curve over time. The graph illustrates how retention decreases with time and how reviews can help maintain learning progress.

http://www.lincolnguitartuition.com/Guitar_Lessons_Lincoln_10.htm
1. What is the forgetting curve? Can you give an example of it in your own life?

2. What is the learning curve? Can you give an example of it in your own life?
Learning requires
WHAT KIND OF REPETITION?

True or False?

1. You remember better when you practice one point and master it, before you move on to practicing the next point.

2. You memorize something faster when you practice it at intervals.

3. You remember more when you use the same prompts and the same context each time you practice something.
HIGH SCHOOL FRENCH VOCABULARY

Bloom & Shuell,
SPACED REPETITION VS. MASSED REPETITION

![Bar chart comparing mean test scores for spaced practice and massed practice.]

- Spaced Practice (3 lessons over three days): 75%
- Massed Practice (3 lessons on the same day): 55%
1. Why doesn’t cramming work?

2. Why does spaced practice work?
BREAK TIME!
RETRIEVAL PRACTICE
TWO ASPECTS OF MEMORY

1. Memory Storage
2. Memory Retrieval
LEARNING IS A TWO-WAY STREET
WHAT IS THE MOST EFFECTIVE WAY TO STUDY?

1. Close books and write what you remember.

2. Write a summary from your notes.

3. Reread the text and your notes.
**REVIEW VS. RETRIEVE**

Group A read a passage and then recalled their learning by writing on a blank piece of paper.

Group B spent twenty minutes studying the passage.

*How much did they remember?*

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 minutes later</td>
<td>75%</td>
<td>81%</td>
</tr>
<tr>
<td>7 days later</td>
<td>56%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Roediger and Karpicke (2006)
REVIEW VS. RETRIEVE

When you **review** material, you are recognizing material that looks familiar.

When you **retrieve** material, you are remembering it. Recall (or retrieval) strengthens your memory.
PRINCIPLE 5

Use it or lose it.
RETRIEVAL ACTIVITIES

Total Recall
Last Class Recall
Pre-test
Recall with a picture
Vocabulary recall
Stand & Talk
Exit Ticket
# Remember your Learning!

1. Read.

2. Read again.


4. Write what you remember.

5. Open the book.

6. Check your work
RETRIEVAL ACTIVITY

Last Class Recall

• At the start of class, ask students:

  What did you learn last class?  (New words?  New grammar? )
RETRIEVAL ACTIVITY

Pre/Post Test

Before you introduce new material, give a short pre-test.

• True/False.
• Multiple choice.
• Open questions: who, what, where, when, why, how.

Repeat the test after students learn the material.
RETRIEVAL ACTIVITY

Recall with a Picture

Show a picture new to students but related to content. Ask students to describe what they see.
RETRIEVAL ACTIVITY

Vocabulary Recall with TTT

• Call out a category and ask learners to write a list of words that fit the category.

Memory:

The Brain:
RETRIEVAL ACTIVITY

Stand & Talk

• Between activities, students stand up and turn to talk to a partner about what they are learning.

• Teacher supplies questions.

  Why do humans forget so quickly?
  What is retrieval practice? Why is it important?
  What is spaced practice? Why is it important?
Exit Ticket

• At end of class, students write down a response to a teacher prompt. They hand to teacher as they exit room.

• Example prompts:

  “What are three new words you learned today?”
  “What is something you learned today? What is something you want to practice more?”
Read the list of retrieval activities.

★ Draw a star next to any you’d like to adapt to your context.

❓ Write question mark next to anything that is not clear to you.
Recycle old learning.
Write questions students have learned how to answer. For example:

- *What is the forgetting curve?*
- *What is “interleaving”?*
- *Why do humans forget so quickly?*

Write 1 question per card. Use the cards to practice at intervals.
INTERLEAVED PRACTICE

Vocabulary Flashcards

1. Students write new vocabulary on flashcards.

2. Students quiz one another with the flashcards.

What is [word]?

How do you spell [word]?
INTERLEAVED PRACTICE

Vocabulary Flashcards

Students sort cards according to categories.

Which words relate to [topic]?

Which words are verbs? nouns? both?
INTERLEAVED PRACTICE

Compare and Contrast Topics

Martin Luther King

Abraham Lincoln
INTERLEAVED PRACTICE

Compare and Contrast Structures

- Present perfect
- Simple past
What are three classroom activities to recycle old learning?

1. Question Cards
2. Vocabulary Cards
3. Compare and Contrast
1. Chose one activity you want to think about more.

   1. Question Cards
   2. Vocabulary Cards
   3. Compare and Contrast

2. How would you use it in your own context?

3. Share your ideas.
TOTAL RECALL
LEARNING PRINCIPLES

1. Learning changes your brain.
2. Learning is about making connections.
3. Forgetting is natural.
4. Learning requires repetition.
5. Use it or lose it.
1. Review the activities in your handout.

2. Review your notes.

3. Do the goal implementation sheet.
THANK YOU!

SARAH LYNN
BLOG: TEACHERTWOTEACHER.WORDPRESS.COM
One neuron can make up to 10,000 connections through its dendrites.

Image from Matt Lee on Flickr: https://www.flickr.com/photos/razorsmile/526249719
67. Neurogenesis

“Neurons that fire together, wire together.”

Donald Hebb, 1949
“Each time we rebuild the neural network, the skill or concept becomes more stable and automatic. The highest level of skill or understanding results from repeatedly experiencing this building-rebuilding cycle over time (years), moving through a sequence of increasingly complex levels. That movement is not linear and steady; it is dynamic and messy.”

“Brains and Schools: A Mismatch” by Alden Blodget
NEUROGENESIS

When we have healthy brain habits, we can grow **700** new neurons a day!
True or False?

Only young people grow new brain cells.
RECAP:

True or False?

The best way to memorize something is to practice it single-mindedly until your burn it into your memory.
True or False?

Varying the way you practice material confuses your memory.
True or False?

Rereading a passage is an excellent way to get information into long-term memory.
True or False?

We begin to forget new information days after we hear it.
Group 1: Massed Practice
Instruction on a topic and then practice the topic.
Instruction on A. Then practice A.
Instruction on B. Then practice B. . . . . etc.

Group 2: Interleaved Practice
Rotating instruction and practice.
Instruction on A, B, C, D. Then practice A, C, D, B.

Dunloskey (2013)
Strengthening the Student Toolbox: Study Strategies to Boost Learning