What is statistics?

Example: using statistics to determine best teaching practices

Learning Principle 1:

Question: Which of two learning strategies is better?

- Imagine a learning task where you'll be tested on the second word in a related pair of words.
- There are 2 ways to learn the pair:
  - See the word pair on screen for 10 seconds.
  - See the first word, be forced to guess the second word within 5 seconds, and then see the correct word pair on screen for 5 seconds.

Learning Principle 1:

- Option one:
  - WATER - RIVER
- Option two:
  - TREE - ?
  - TREE – SHADE

- A day later, we'll test both sets of students to see how many pairs they can remember when prompted with one of the two words!

Learning Principle 1:

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  1. See the word pair on screen for 10 seconds.
  2. See the first word, be forced to guess the second word within 5 seconds, and then see the correct word pair on screen for 5 seconds.

  Which statement best characterizes university students' performance on this task?

  A. Students learned better using method 1, and believed they learned better using method 1.
  B. Students learned better using method 1, but believed they learned better using method 2.
  C. Students learned better using method 2, and believed they learned better using method 2.
  D. Students learned better using method 2, but believed they learned better using method 1.

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Huelser and Metcalfe, "Making related errors facilitates learning, but learners do not know it." Memory and Cognition 40 (2012), 514-527.

Learning Principle 1: Embrace Difficulties

- Making errors during learning *does not* lock the error into memory
- Many types of difficulties enhance the learning process! (Note: this doesn't mean the difficulty will feel good to the learner.)
- Some difficulties don't.

- Corollary: Students' preferences, or their beliefs about the learning strategies that "work best for them," can **often be wrong!**

Learning Principle 2:

Question: Which of two learning strategies is better?

- A college math class was taught how to solve four types of problems (volume calculations for four categories of geometric solids). The class was then split into two groups – either practicing only one type of problem at a time (**blocked practice**), or mixing all four problem types throughout the practice session (**mixed practice**). Which do you predict best describes their performance?

- A. The blocked section did better during the practice and during a later exam
- B. The blocked section did better during the practice, but the mixed section did better on a later exam
- C. The mixed section did better during the practice and during a later exam
- D. The mixed section did better during the practice, but the blocked section did better on a later exam

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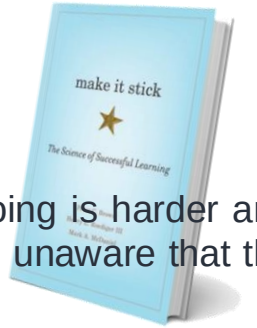
- D. The mixed section did better during the practice, but the blocked section did better on a later exam

- Rohrer and Taylor, 2007. The shuffling of mathematics problems improves learning. Instructional Science 35, 481-498.

Learning Principle 2:
Mix up your practice
("Interleaved", not blocked)

- Mixing up practice feels harder, but produces longer lasting learning gains
- Comparing the two components of problem solving – identifying the problem type, and actually solving it

The items below are adapted from a book review of Make It Stick:
https://rkbookreviews.wordpress.com/2014/06/06/make-it-stick-summary



a) We are **poor judges** of when we are learning well and when we're not. When the going is harder and slower and it doesn't feel productive, we are drawn to strategies that feel more fruitful, unaware that the gains from these strategies are often temporary.

b) Learning is deeper and more durable when it's **effortful**. Learning that feels "easy" is like writing in sand, here today and gone tomorrow.

c) **Rereading** text and "massed" practice of a skill or new knowledge are by far the preferred study strategies of learners of all stripes, but they're also among the **least productive**. By massed practice we mean the single-minded, rapid-fire repetition of something you're trying to burn into memory, the "practice-practice-practice" of conventional wisdom. Cramming for exams is an example. Rereading and massed practice give rise to feelings of fluency that are taken to be signs of mastery, but for true mastery or durability these strategies are largely a waste of time.

d) **Retrieval practice** — the act of recalling facts or concepts or events from memory — is a more effective learning strategy than review by rereading. Periodic practice halts the biological process of "forgetting", strengthens retrieval routes, and is essential for hanging onto the knowledge you want to gain.

e) When you **space out practice** at a task and get a little rusty between sessions, or you **"interleave"** (mix together) the practice of two or more subjects, retrieval is harder and feels less productive, but the effort produces longer lasting learning and enables more versatile application of it in later settings.

f) **Trying to solve a problem before being taught the solution leads to better learning, even when errors are made in the attempt.**

g) **Rereading** has three strikes against it: It is time consuming. It doesn't result in durable memory. And it often involves a kind of unwitting self-deception, as growing familiarity with the text comes to feel like mastery of the content.

h) In virtually all areas of learning, you build better mastery when you use **frequent, low-stakes testing** (including self-testing, as with flash cards) as a tool to identify and bring up your areas of weakness. The very act of answering a test question is itself an act of retrieval, which strengthens your mental connections.

Winter 2017 Final Exam Research Questions

1. Does using an online homework system led to better outcomes in a college algebra class?
2. Does a simulation-based curriculum improve understanding of statistical concepts when comparing with a traditional approach?
3. Does incorporating in-class activities into a college-level lecture improve student learning outcomes when compared with just lecture?
4. Do most students prefer the majority of their course grade to come from projects or exams?
5. Which is the best predictor of a student's course grade, their homework grade or their final exam grade?

*What **research questions** would you like to use statistics to answer on your midterm and final exams?*