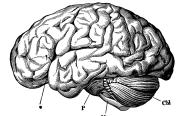


How to Teach All the Things
(including Shiny and the Tidyverse)



Two Ways to Teach

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1

What is a workshop?

2

So what is a workshop? Or a lecture, or a course, or any other teaching event?

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What is a workshop?

3

When done right, teaching is not like a movie that you film once and then replay over and over again exactly the same way.

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What is a workshop?

- scripts by nature are incomplete
- not automatable
- requires **stagecraft teaching craft**



4

When done well, teaching is more like a play: there is a script, but the script is incomplete until you perform it. To bring the script to life you need to make many performance decisions. To do that well requires knowing your craft: stage craft for a play, and teaching craft for us.

Learning teaching craft is an investment, and since you are in this room I suspect that you've already made deep career investments. How many people here are Data Scientists? Computer Scientists? Teachers by trade?

What is a workshop?

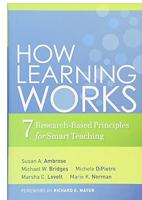


5

And in fact, good teaching often seems like a form of improv: everyone has something to say, and knows how to say it, but everyone also has to be comfortable including the audience in what they're doing.

Learning the craft of teaching takes time, and since you are in this room I suspect that you've already made some pretty significant investments in data science or programming. Since you've already mastered one skillset, why master another one?

What is possible?



6

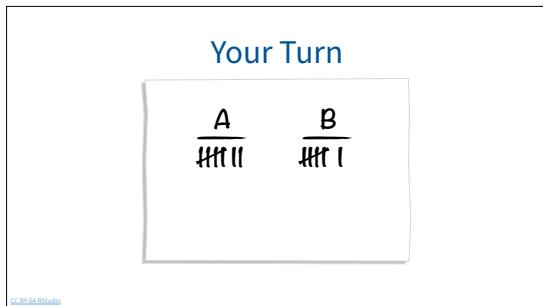
The answer is that as a species, we know as much about teaching and learning as we do about public health. The difference is, most of us don't know the pedagogical equivalents of purifying drinking water, getting immunized, or eating well. You don't have to learn very much to be a more effective teacher: you just have to learn things that are backed up by evidence, and that's what we're going to cover.

Day 1			
Morning	Afternoon		
9:00 - 10:00	Two Ways to Teach	13:15 - 13:45	Formative Feedback
10:00 - 10:45	Novice, Competent, and Expert	13:45 - 14:45	Teaching as Performance II
Coffee (15 min)			
11:00 - 11:45	Teaching as Performance I	15:00 - 15:45	Motivation and Demotivation
11:45 - 12:30	The Cognitive Craft	15:45 - 16:30	Multimedia Learning
Lunch (45 min)		16:30 - 17:00	
Wrapping Up/ Looking Forward			

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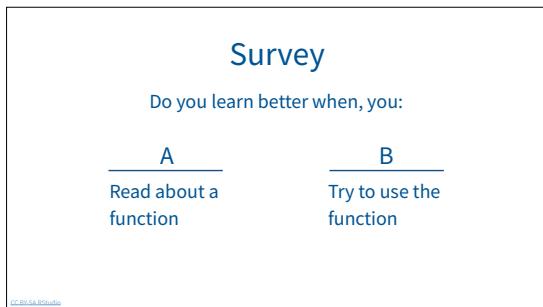
7

Here's the schedule for the first day. We're going to cover a lot of material, which means we're going to skate over some things pretty quickly, but our experience giving workshops like this over the past several years makes us believe it will be worthwhile.



8

To get started, take out a sheet of paper and write A and B at the top. For the next few minutes, we will compare a series of statements. In each case, note whether you agree more with statement A or statement B. At the end we can tally up our answers and compare notes.



9

Think back to when you learned R, did you learn better when you read about a function or tried to use it?

Survey

Do you learn better when, you:

A _____
Watch a video

B _____
Do exercises

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What about watching a video versus doing exercises?

Survey

Do you learn better when, you:

A _____
Attend a lecture

B _____
Discuss with an expert

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Or attending a lecture versus discussion a problem with an expert?

Survey

Do you learn better when, you:

A _____
Have an idea explained to you

B _____
Try to explain the idea to someone else

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Or having something explained to you versus explaining it to someone else (even, or particularly, if you don't understand it well yourself)?

Survey

Do you learn more from:

A	B
A long learning session that covers a lot of ground	Short sessions with time to try things out in between

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This one is a little different, but do you learn more from long sessions that cover a lot of ground, or short sessions interleaved with practice?

A	B
Read about it	Try it
Watch a video	Do exercises
Attend a lecture	Discuss with an expert
Hear it explained	Try to explain it
A long learning session that covers a lot of ground	Short sessions with time to try things out in between
Passive (teacher centered)	Active (student centered)

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Alright, let's tally our votes. Did anyone have a higher score in the A column than in B? How can you describe the differences between these two columns?

If we ignore the last case for a moment, the techniques in Column A are all passive from the student's point of view: the teacher does something and the student watches. This is called "teacher-led learning", and is typical of colleges class with assigned readings, lectures, and homework exercises that learners are supposed to do on their own without collaborating.

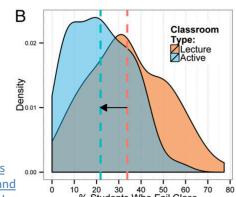
Active Learning in Action

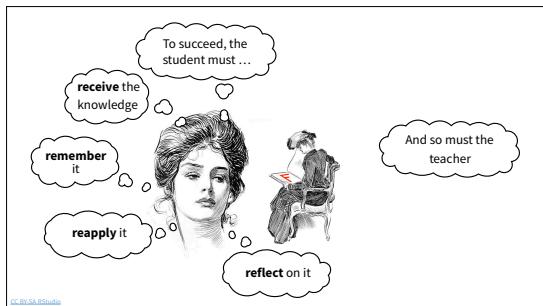
- Freeman, et al. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410-8415.

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15

Here's just one recent result from our field <http://www.pnas.org/content/111/23/8410.full.pdf>





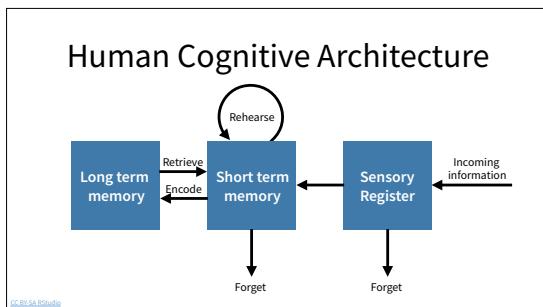
16

So here's our first big idea. For active learning to work, the learner must:

- Receive the knowledge
- Remember it
- Reapply it
- Reflect on it

And so must the teacher.

There must be feedback loops at several scales:

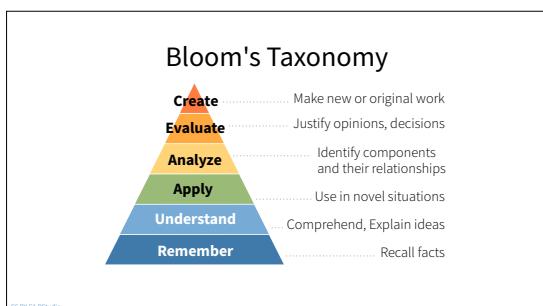


17

Adapted from Mayer, R. E. (2002). *Multimedia learning. Psychology of learning and motivation*, 41, 85–139. Chicago

Here's the second big idea. As a teacher, you don't have direct access to your learners' memories. Here's what you have instead:

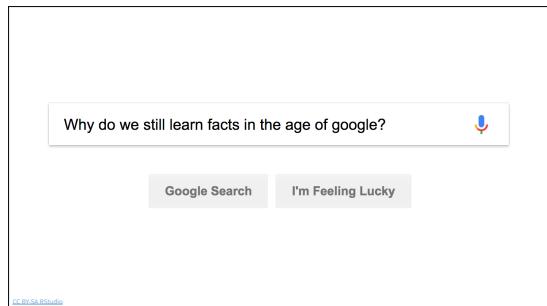
- Information goes through the sensory register to short-term memory.
- Once information is in short term memory, we either rehearse it or forget it.



18

Bloom, B. S. (1956). *Taxonomy of educational objectives. Vol. 1: Cognitive domain*. New York: McKay, 20–24 (as revised by Anderso and Krathwohl, 2001)

Here's our third big idea. Bloom's Taxonomy is a widely-used way to think about how well someone understands a subject. It was originally developed in the 1950s, and revised at the turn of the century, and while people can and will argue about exactly where a particular idea belongs, there's broad agreement that these different levels really do represent different cognitive processes.

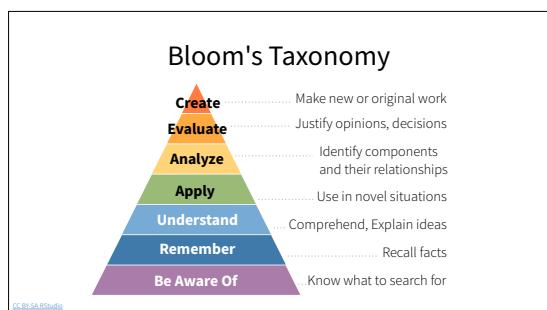


19

There is one other important level that is not recognized by Bloom's taxonomy.

Question: why do we still learn things in the age of Google?

Answer: because it is difficult to look up something if you don't know that it exists.

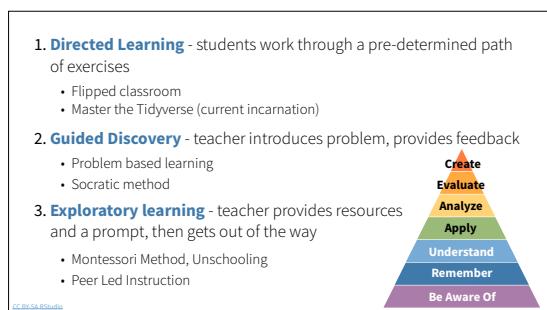


20

In other words, simply being aware of the existence of a thing is a useful level of mastery and one that falls below remembering (since you do not need to actually remember the thing itself).

This is partly why lectures have survived as a teaching method. Most people don't learn during the lecture: they learn outside when reading, reviewing, or doing exercises. What the lecture does is make them aware of what they ought to be studying.

When you're creating a workshop, a lecture, or a course, you need to decide what level of understanding you're aiming for. Yes, you would



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The level you're aiming for influences the style of teaching you use. Directed training has learners work through a pre-determined path of activities or exercises. It is good for learners who will need to do the featured tasks in a similar fashion after the training (apply).

Flipped class rooms are a special case of this. Student–professor interaction is focused on the activities, lectures and reading are reduced to out of class assignments.

Guided discovery involves setting up useful problems for students to solve and then providing feedback as the learner figures out how to

Rule #2: you are not your learners.

22

And this brings us to Rule #2. (No, we haven't seen Rule #1 yet – we'll get to it.) Rule #2 states that you are not your learners. In particular, there's a good chance that you're more of an autodidact than most people, i.e., that you're more comfortable teaching yourself by wandering around than the average human being. You have to be to some extent to get through grad school, but that means that if you (unconsciously) assume that the people you're teaching won't learn the same way you did, and won't value the same things you did. Ignoring this is the root cause of a lot of ineffective teaching.

Classify Learning Objectives

1. Explain what a tibble is and when tibbles should be used.
2. Write a few lines of R to read a table from a CSV file, keeping only records that were created between 1980 and 1990 inclusive.
3. What function or functions would you use to add a column to a tibble whose value in each row is the average of the values in the tibble's first three columns?

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1. On your own, decide what level of understanding each of these exercises is aiming for.
2. Compare your answers with your neighbor's and come to a consensus.
3. Present your final decision and reasoning for one question that you disagreed on to the class.

Note: this technique is called think-pair-share.