Four Cognitive Science Principles Every Stats Teacher Should Know

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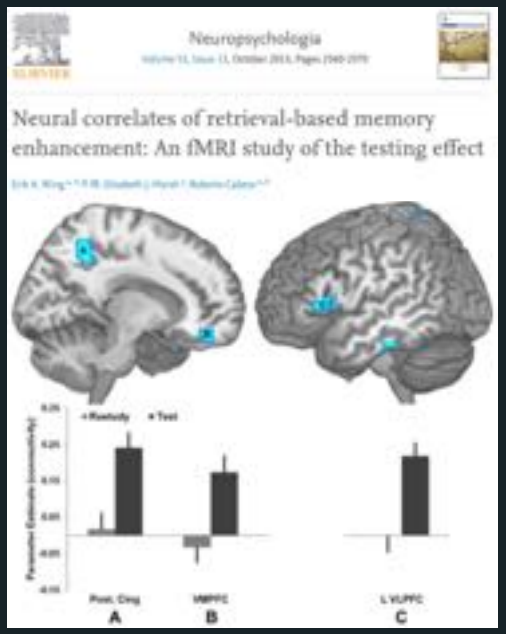
Decades of cognitive science research…



have identified actionable principles…

THE LEARNING SCIENTISTS

learningscientists.org

Retrieval Practice

retrievalpractice.org

that are being put to use to improve learning

Pearson

The learning science behind MyLab Statistics

Khan Academy

An Introduction to Learning Science at Khan Academy

* Not endorsements

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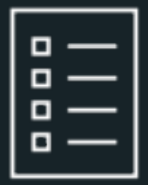
Four cog sci principles every stats teacher should know

Activate prior knowledge



Practice memory retrieval

Manage cognitive load

Encourage metacognition

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Difficult to comprehend 1 2 3 4 5 Easy to comprehend

DOING THE LAUNDRY

The procedure is actually quite simple. First you arrange things into different groups. Of course, one pile may be sufficient depending on how much there is to do. It is better to do too few things at once than too many. A mistake can be expensive, as well. Once the procedure is complete, the materials can be put into their appropriate places. Eventually, the whole cycle will have to be repeated.

Bransford & Johnson, 1972; Journal of verbal learning and verbal behavior

Activate prior knowledge

What
Trigger prior knowledge recall *before* beginning introducing new content

Why
Directs attention, aids working memory, improves long-term memory encoding

How
Provide activity cueing students to *purposefully* recall relevant knowledge

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Activate prior knowledge

Scenario: First lesson on variance

Good

★☆☆

"Recall that the mean is the central tendency in the data."

"The newest Marvel movie got an 86/100 on Metacritic. But obviously not every reviewer gave it the exact same score."

Better

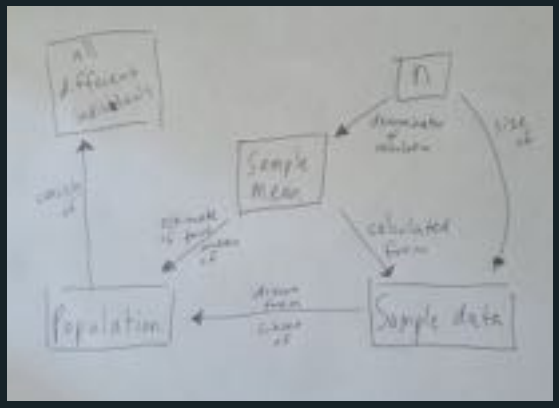
★★☆

"Write down a quick list of what you remember about the mean."

"Think of a time you saw product reviews that were all over the place. How confident did you feel about the quality of the product? Why?"

Best

★★★



[concept map]

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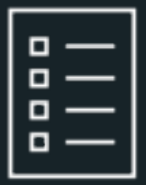

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Practice memory retrieval

Type answer into chat

Which activity most improves memory?

A. Rereading textbook, slides

B. Group discussion

C. Reviewing own notes

D. Taking an exam

Retrieving information from memory is more beneficial than being re-exposed to information

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Practice memory retrieval

What
Practice retrieving information from memory (facts, procedures)

Why
Endogenous activation of semantic brain networks strengthens memory

How
Challenging no-stakes quizzes, clicker questions, “exit tickets”, etc.

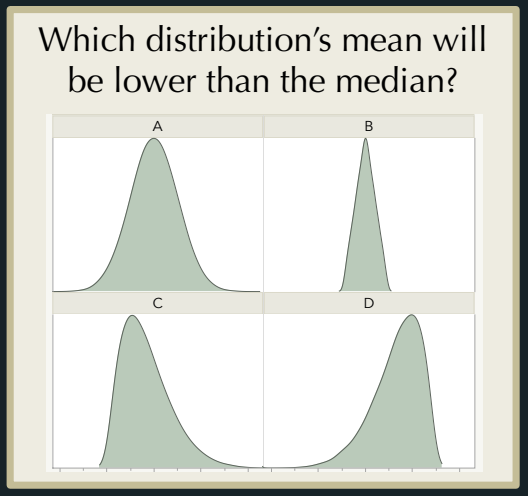
Space practice out – Interleave different concepts – Provide correct answer feedback

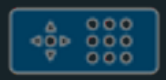
Practice memory retrieval

Good

"Who can remind us what skew is?"

Better





Best

"Better" plus…

- Immediate feedback
- Revisited periodically throughout course
- Interleaved with questions targeting other concepts or procedures

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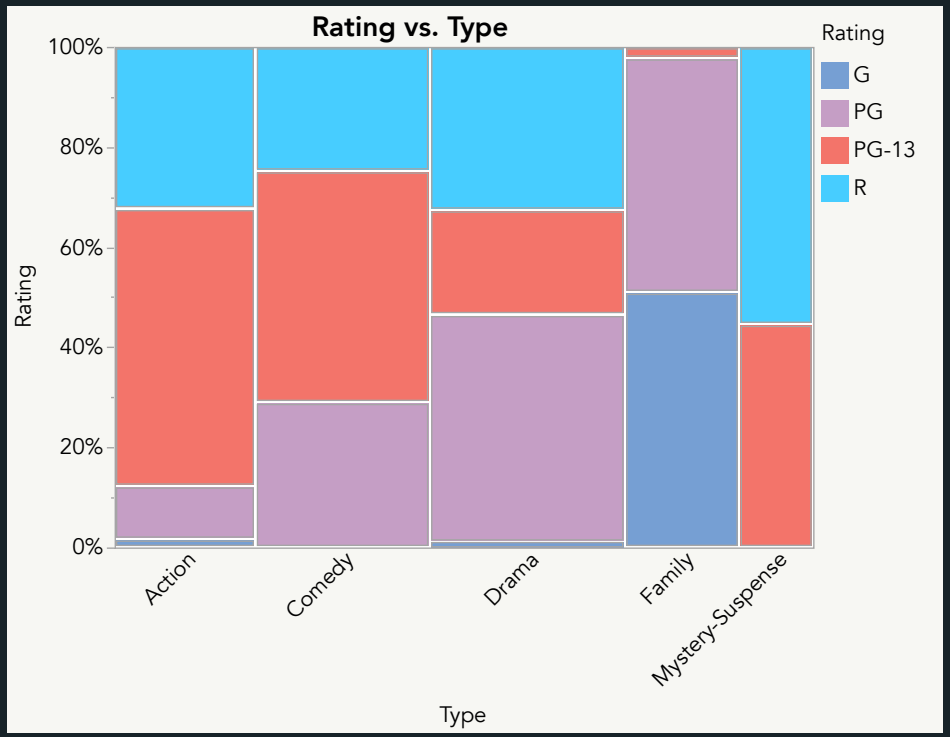
*Which rating is more common in **Drama** movies, PG-13 or R?*



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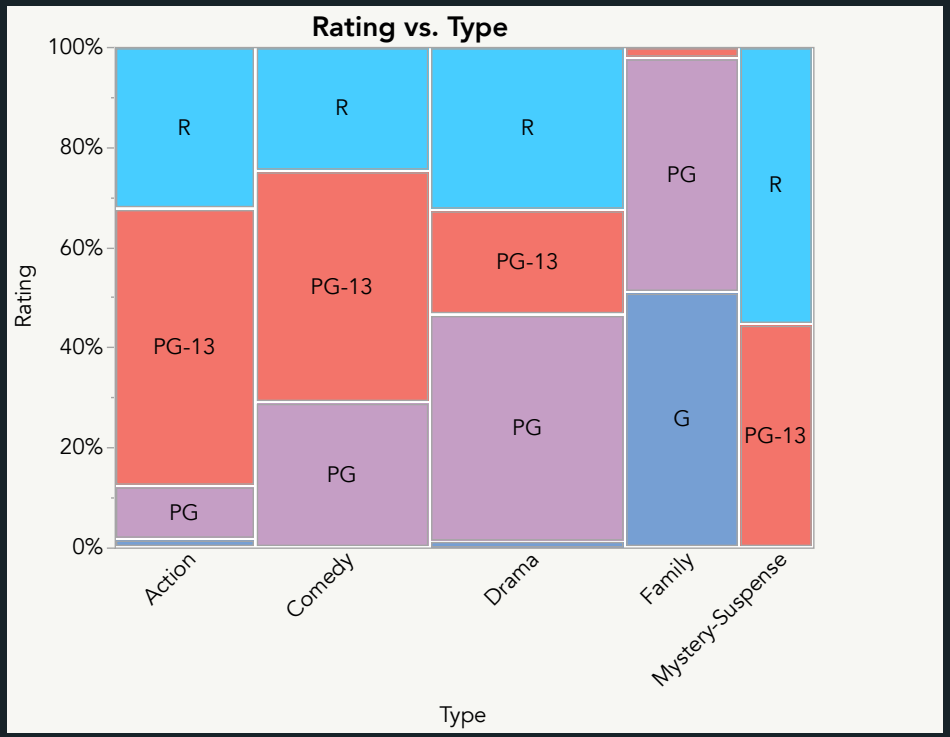
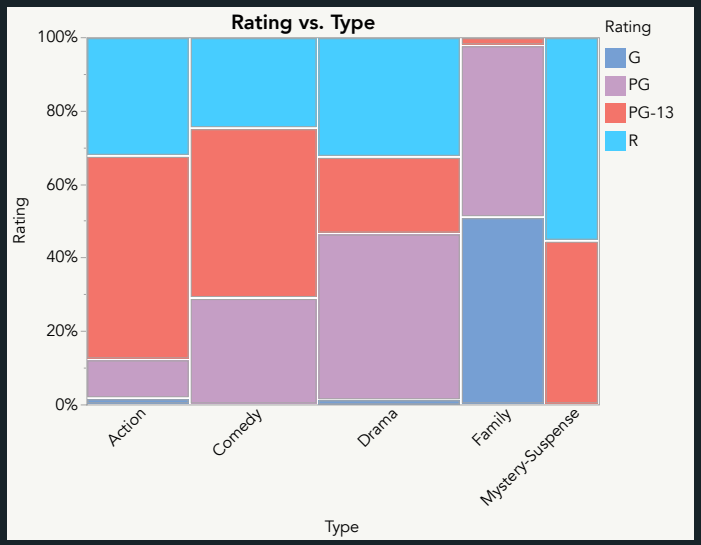
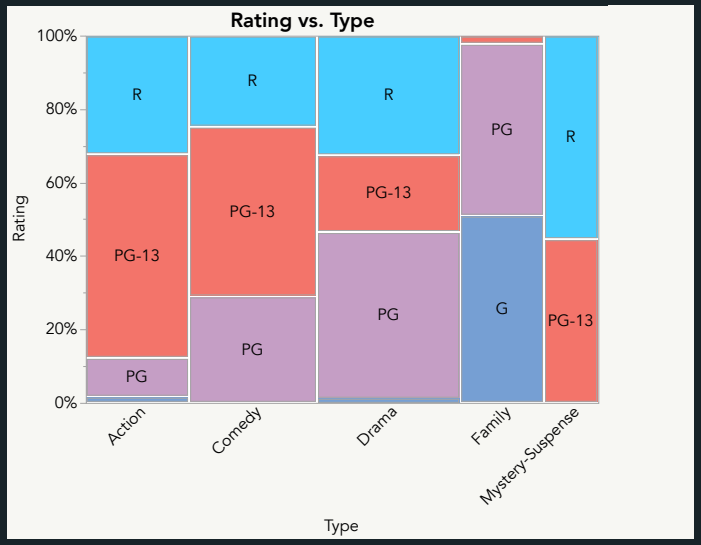


Manage cognitive load

Split attention = bad



Integration = good



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Manage cognitive load

What
Avoid *extraneous* demands on attention and working memory

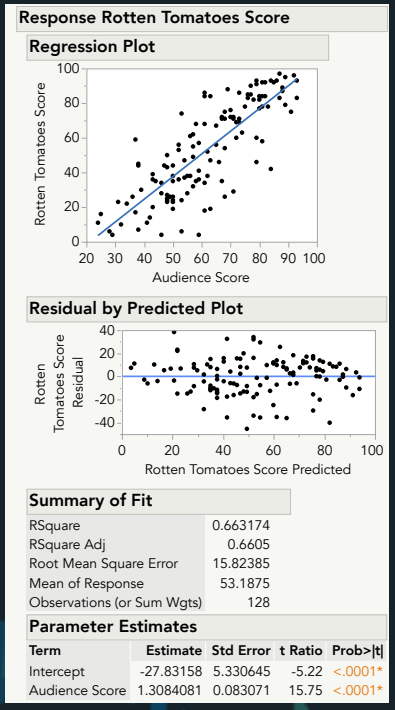
Why
Devoting limited attention and memory resources to important info aids learning

How
Spatially integrate text and visuals, avoid redundant or extraneous info, simplify outputs, annotate (sparingly) graphs and equations

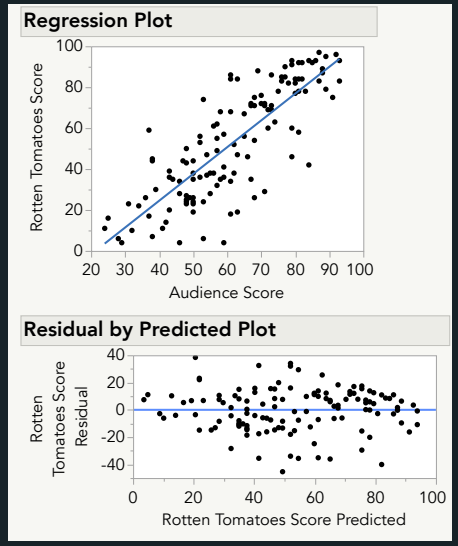
Manage cognitive load

”A residual plot graphs the distance between each point and the line”

Good



Better



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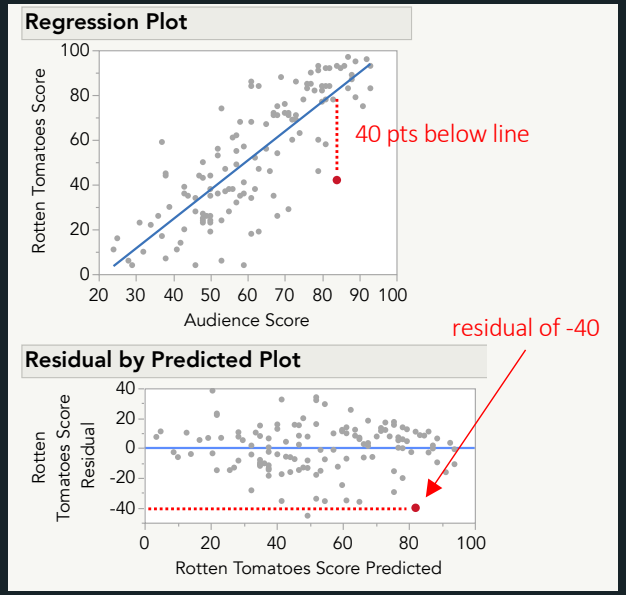

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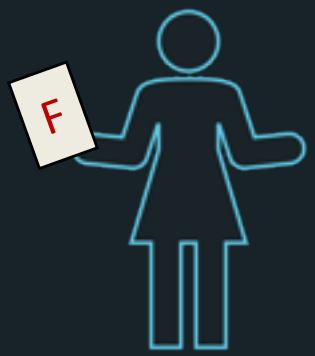
The “illusion of knowing”

“The final should be easy”

“What?!”



Encourage metacognition

What
Support students' continual self-evaluation of knowledge and skills

Why
Monitoring knowledge helps students successfully *control* learning

How
Provide opportunities for students to test their knowledge followed by
(a) immediate prompts to reflect on understanding and (b) advice for self-study

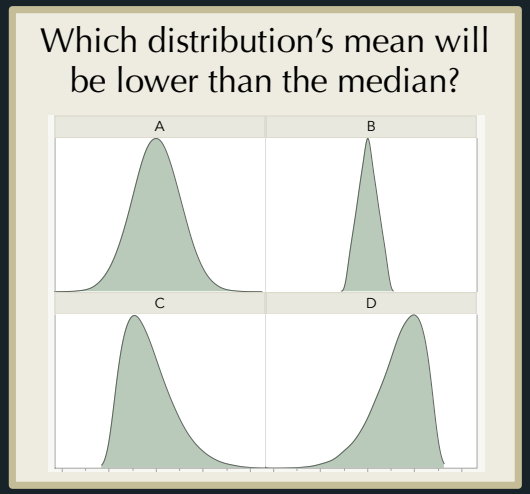
Encourage metacognition

Good

"How well do you think you'll be able to reproduce this one week from now?"

"Look at your notes from today and star the one thing you most need help with."

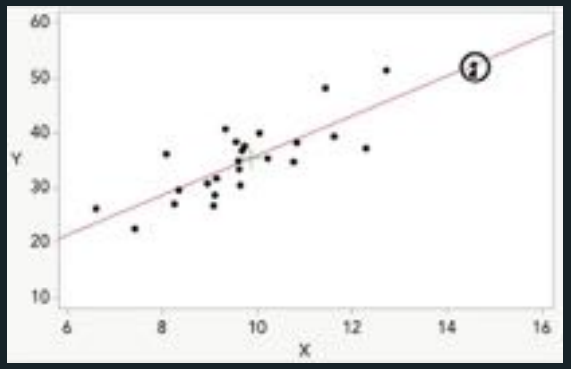
Better



…followed by **"Good"**

Best

"How will the slope of the line change as point moves to Y=10? Why?"



"Why did the line move how it did? Why were you right or wrong?"

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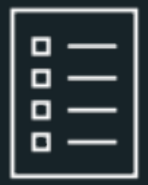

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