Using Cognitive Science to Make Training Stick

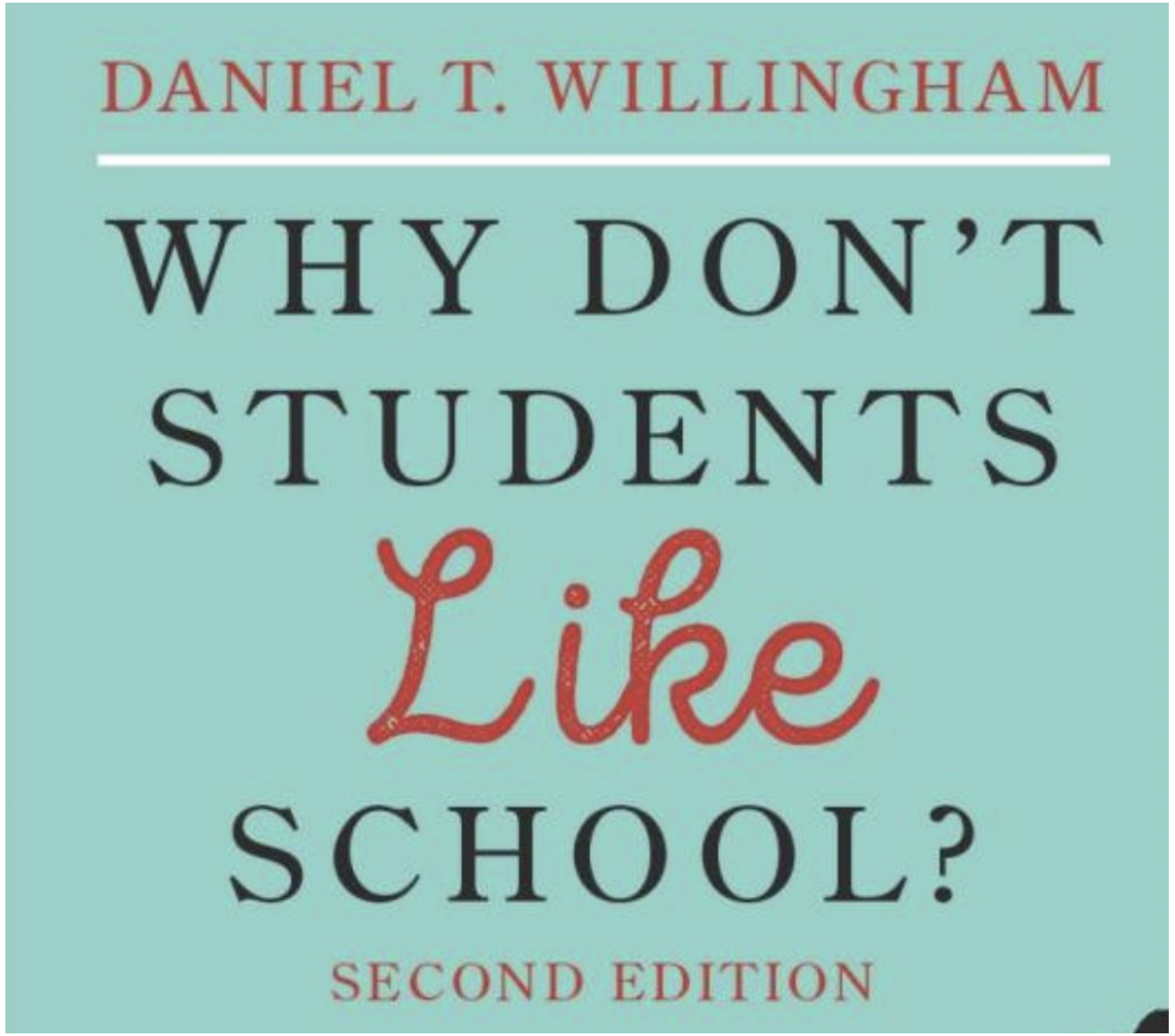
Ted Laderas,
DNAnexus,
Science Deep Dive
10/7/22

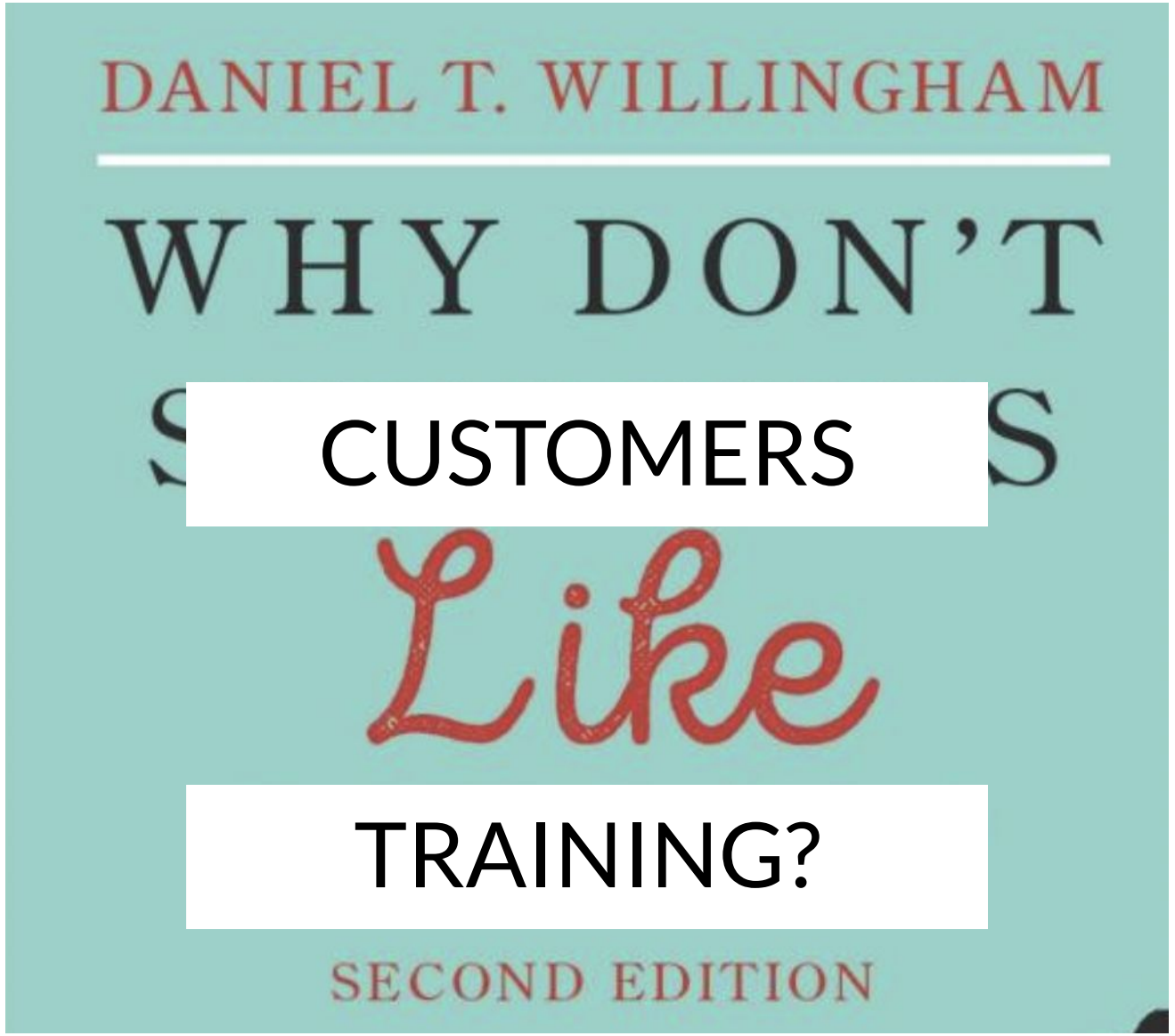
What we'll talk about today

- Presenting information clearly using cognitive science
- Reducing external distractions
- Active Learning

Who am I?

- Bioinformatics Trainer for DNAnexus Academy
- Bioinformatician with 18+ years of experience
  - Systems Biology / Systems Science
  - Microarray
  - Proteomics
  - Microbiome (16S)
  - Flow Cytometry
  - Clinical Data
- Former assistant professor, Oregon Health & Science University
  - Clinical Informatics / Data Analytics
  - Bioinformatics / Machine Learning
  - Data Science / Statistics
- **Passionate about data science education and inclusion**


DANIEL T. WILLINGHAM
WHY DON'T STUDENTS Like SCHOOL?
SECOND EDITION


DANIEL T. WILLINGHAM
WHY DON'T
S
S
CUSTOMERS
Like
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SECOND EDITION

Learners new to a topic experience information overload; difficult for them to understand what details are relevant

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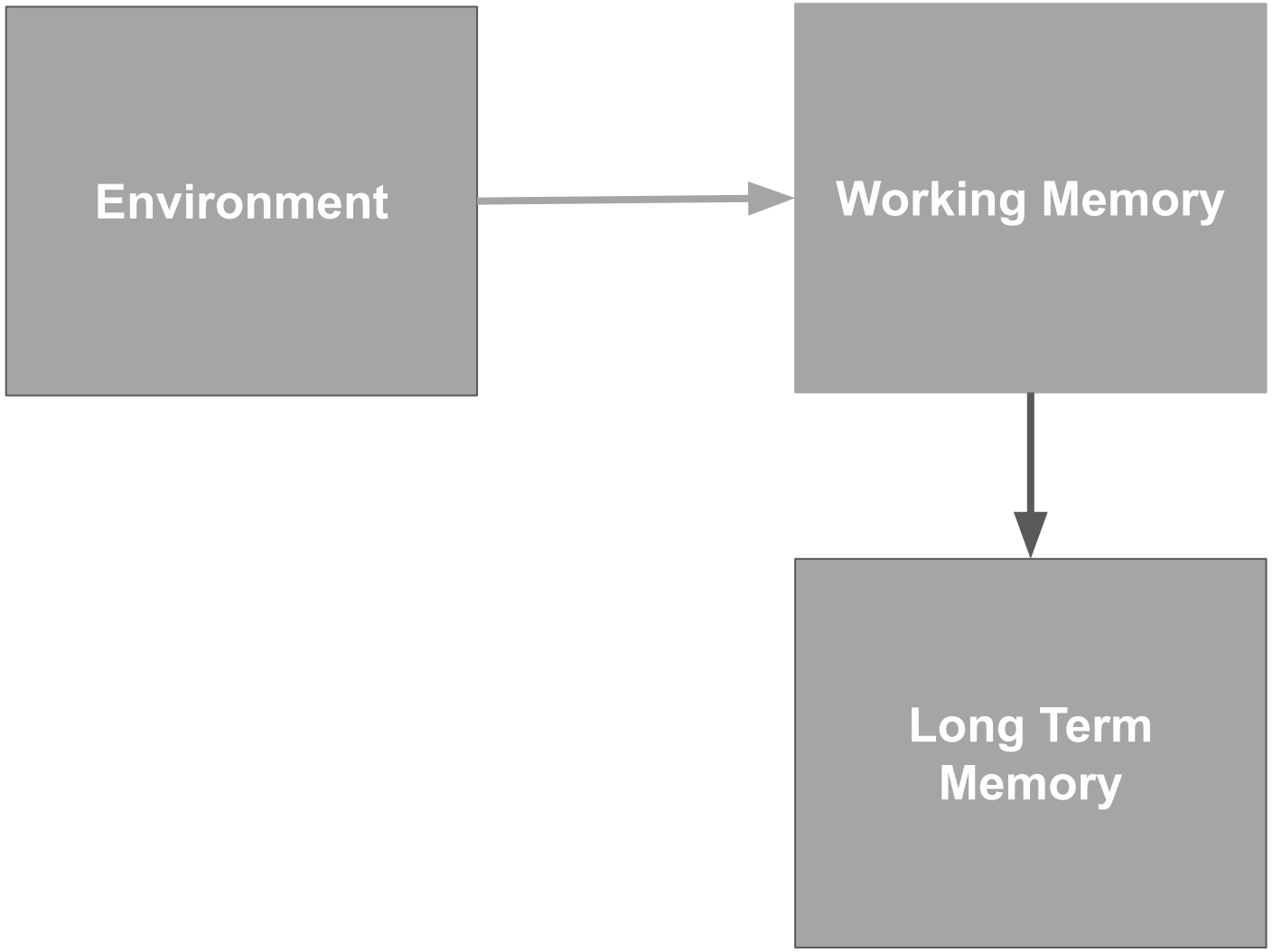
Effective Teachers manage cognitive load and make an emotional connection

Willingham

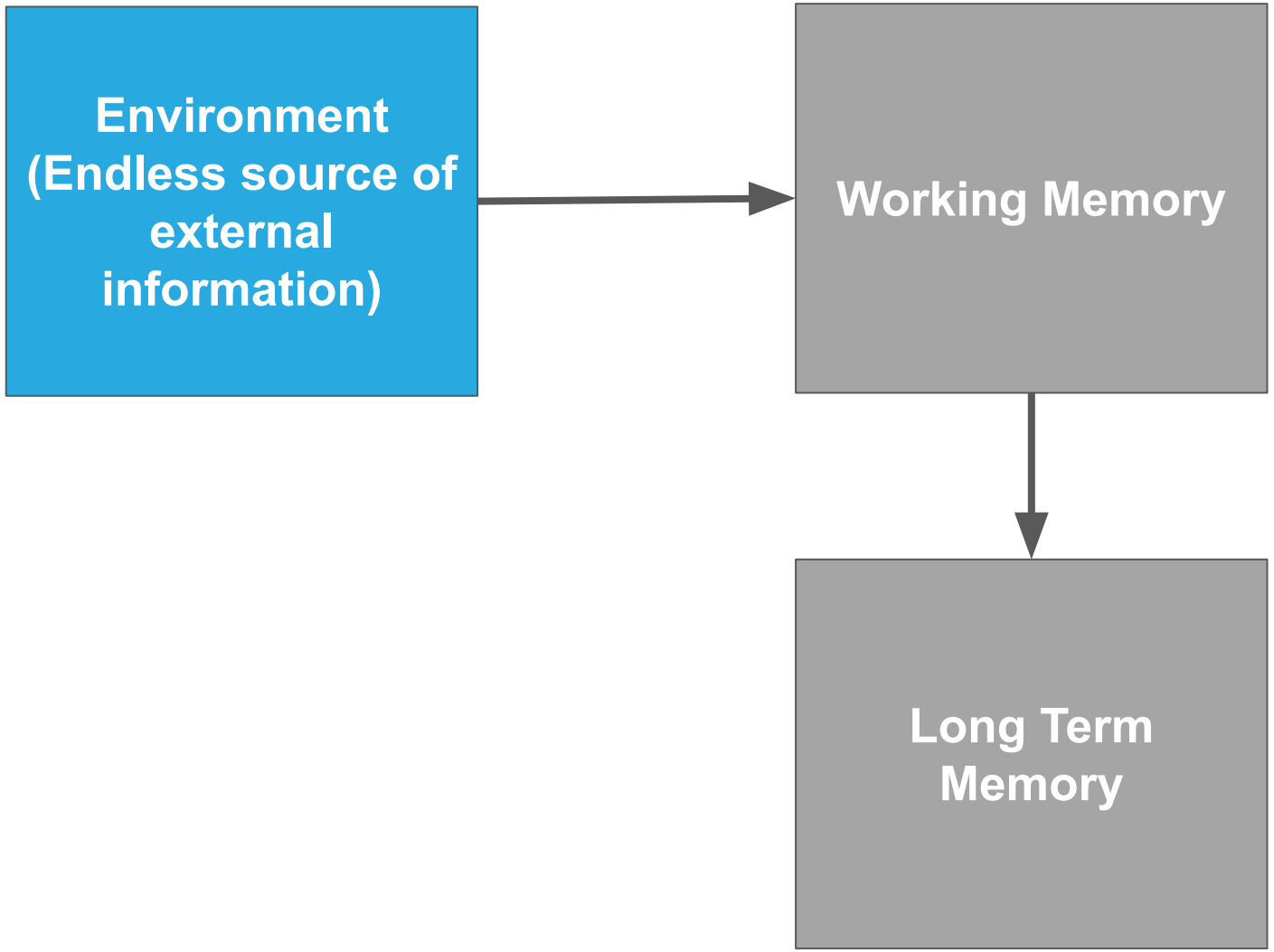
Effective Teachers **manage cognitive load** and make an emotional connection

Simplest Model of the Mind

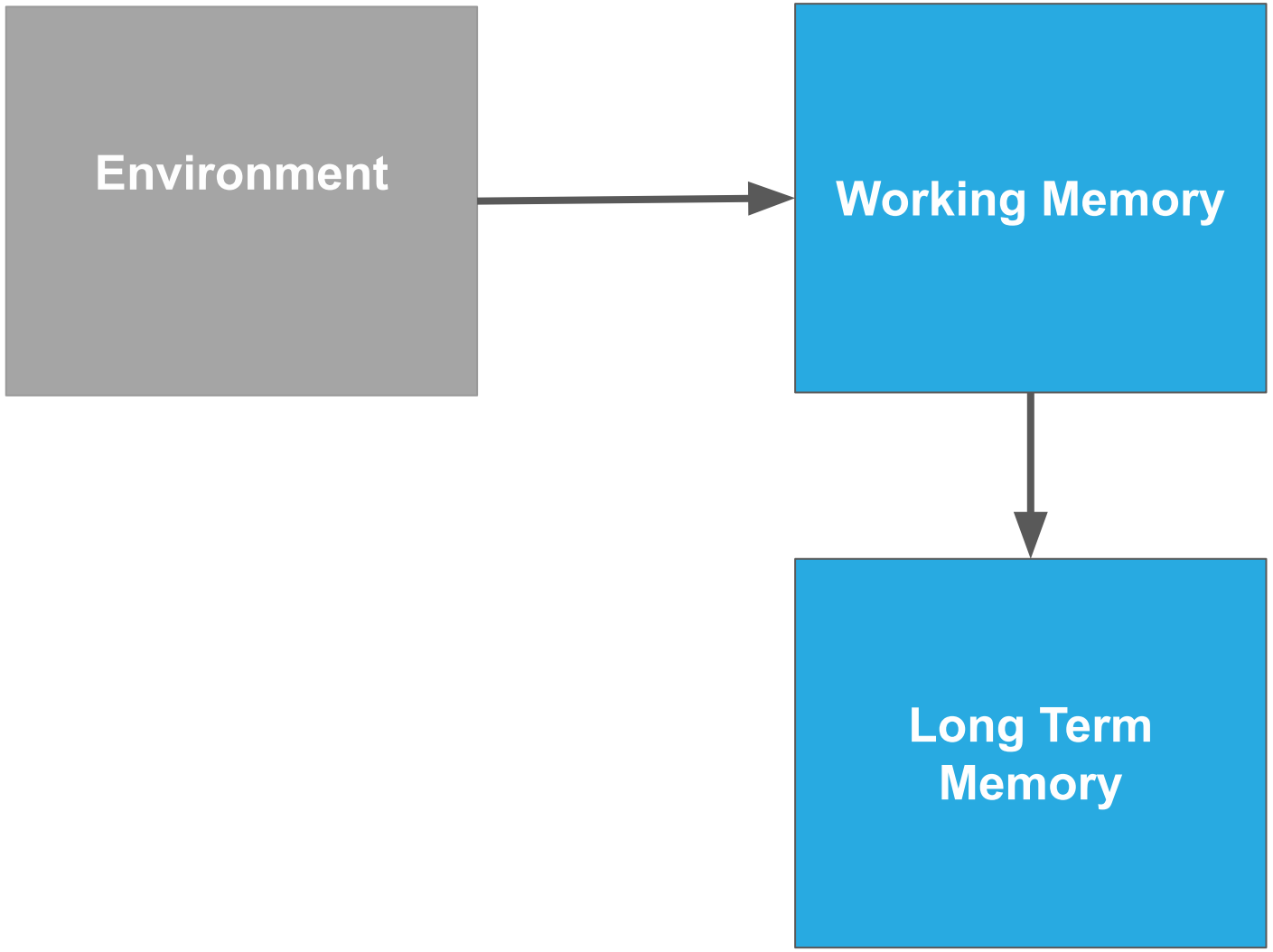


Lovell

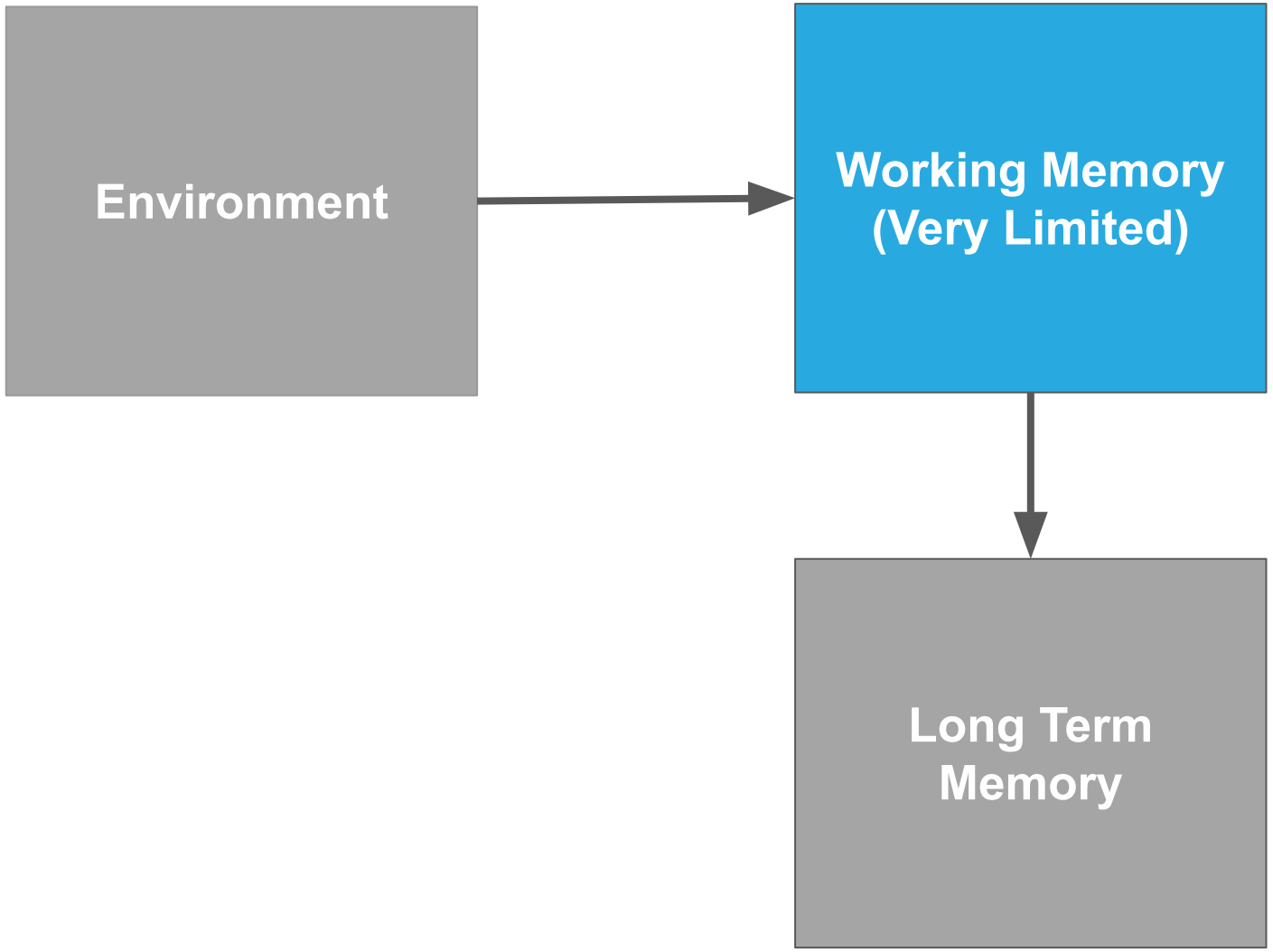
Simplest Model of the Mind

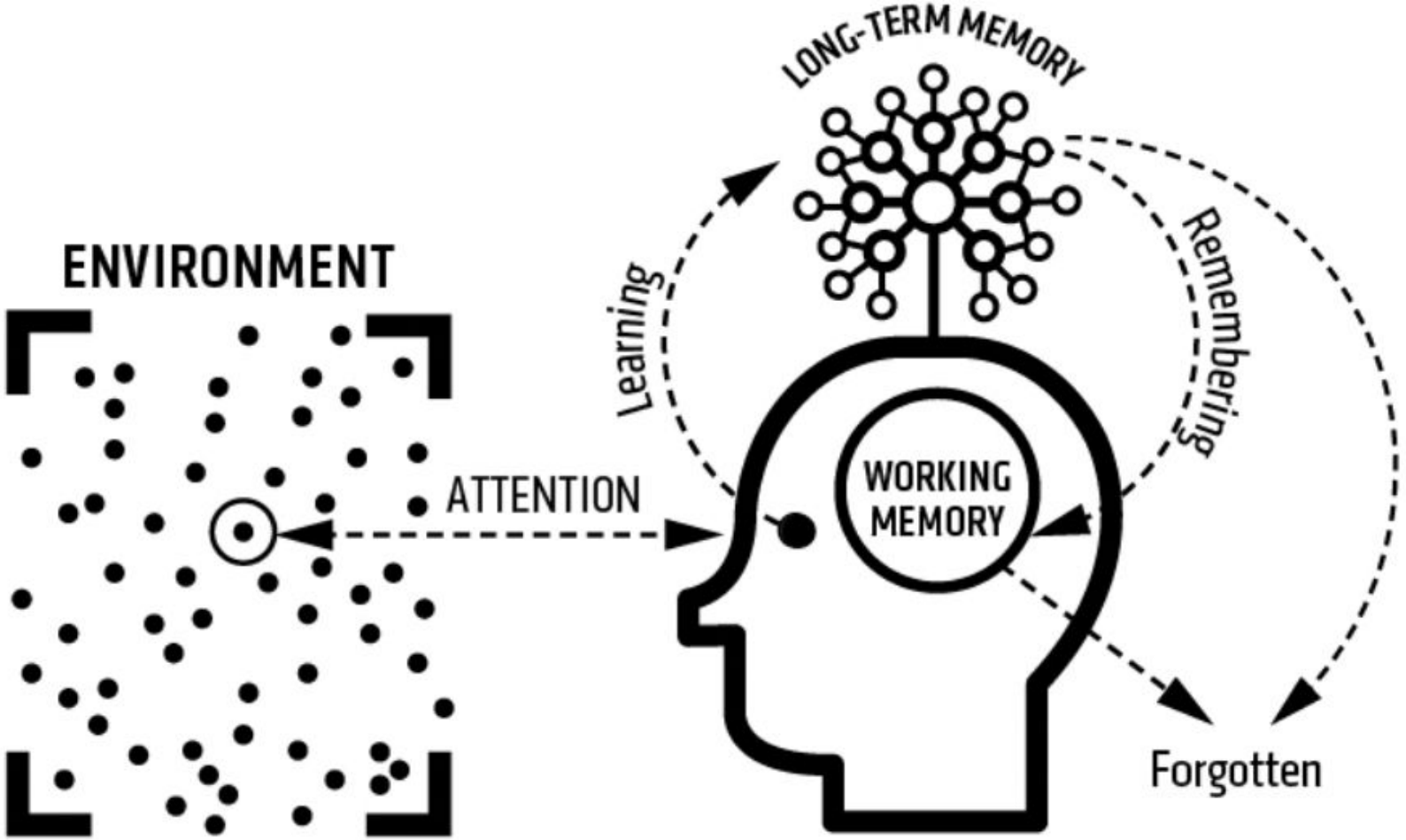


Our Goal: Transfer



What we need to accommodate




LONG-TERM MEMORY
ENVIRONMENT
Learning
Remembering
ATTENTION
WORKING MEMORY
Forgotten

Lovell

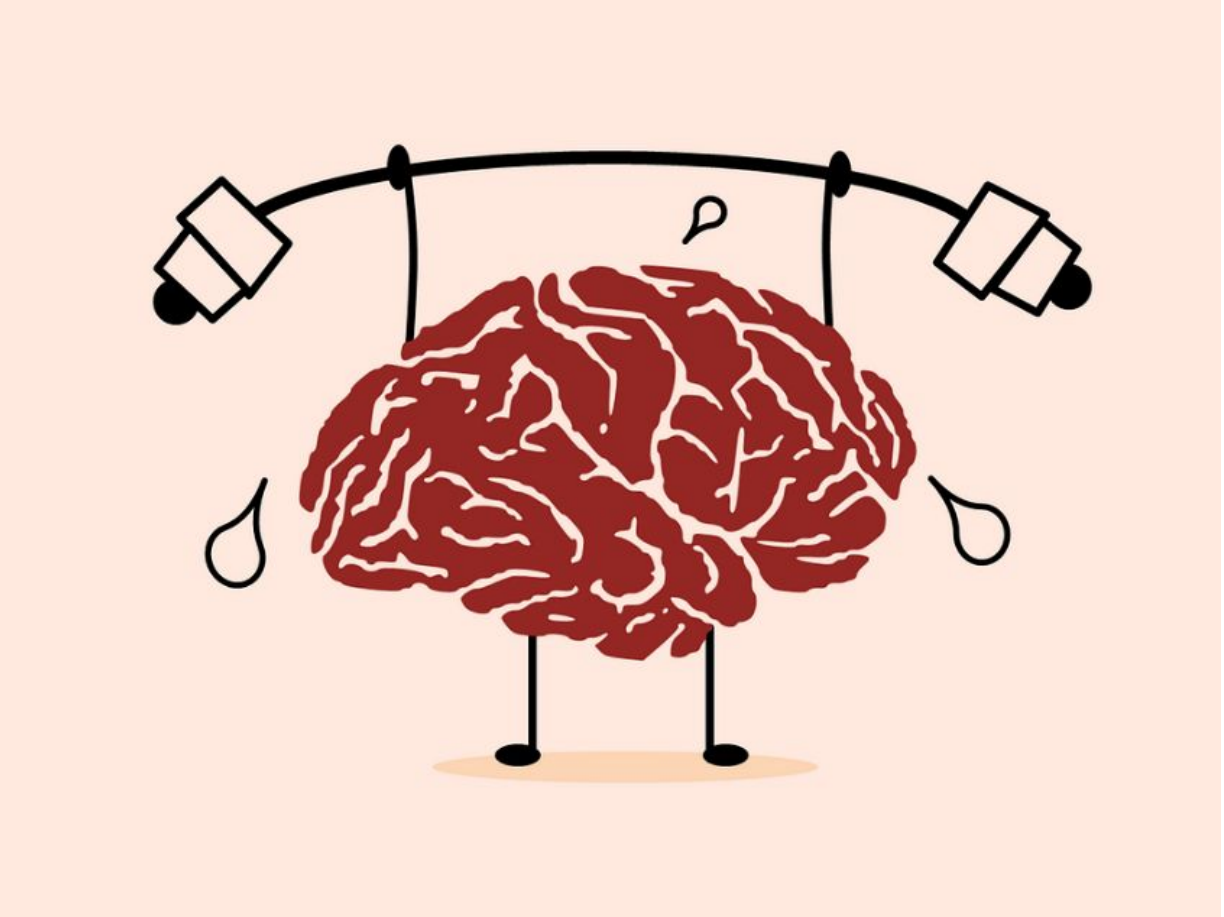
Working Memory is Limited

People are Tired and Cranky

Too much overwhelms us

Teaching is about managing working memory

5-7 Objects/relationships at once



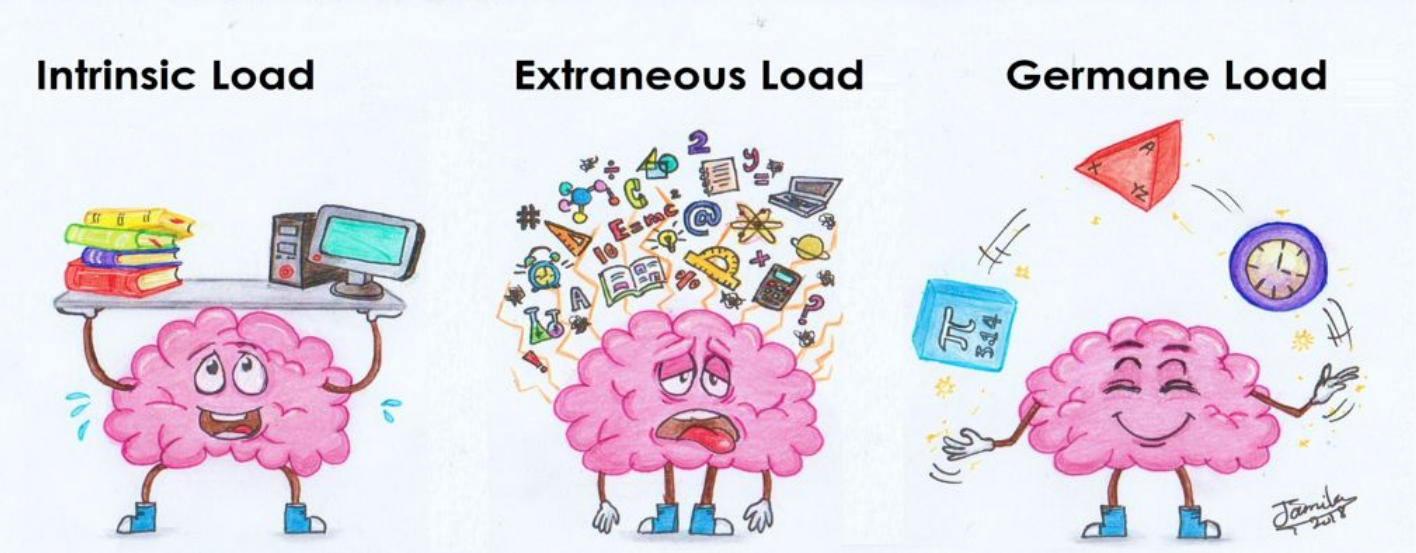
https://cogbites.org/2019/02/18/what-is-working-memory-training-and-what-makes-it-work/

What is cognitive load?

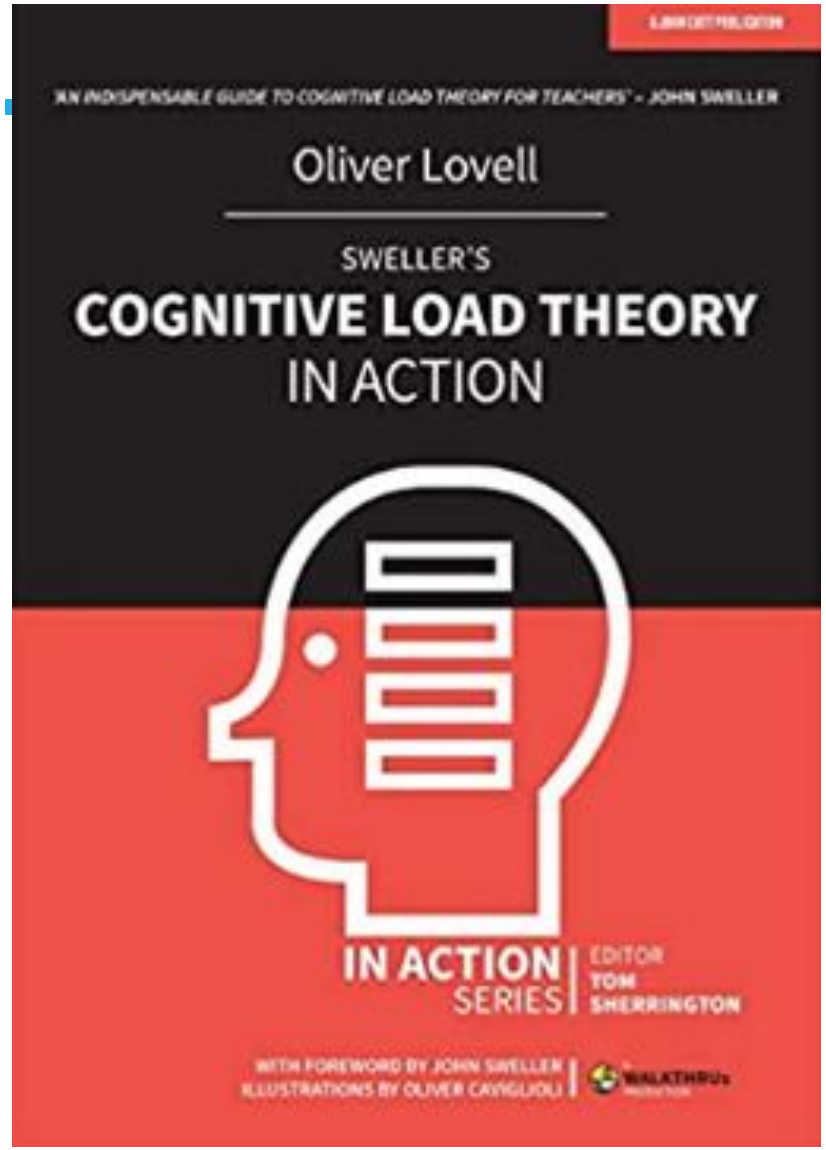
We are limited by our working memory

More than that, learners get overwhelmed and don't learn

As educators, we need to help manage students' cognitive load



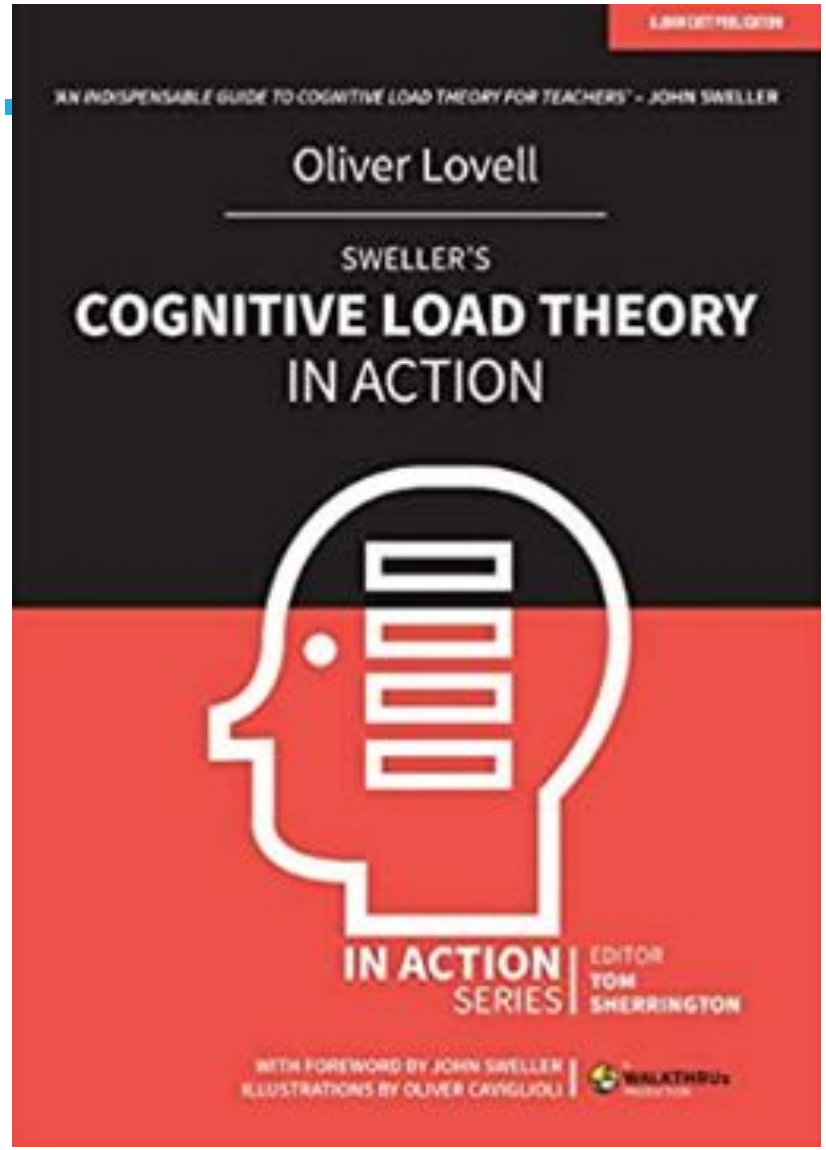
https://medium.com/feedzaitech/cognitive-load-101-f89468e0a4d8



Sweller's Cognitive Load Theory

In order to increase learning:

1. Reduce extraneous load, and
2. Optimize intrinsic load



Sweller's Cognitive Load Theory

In order to increase learning:

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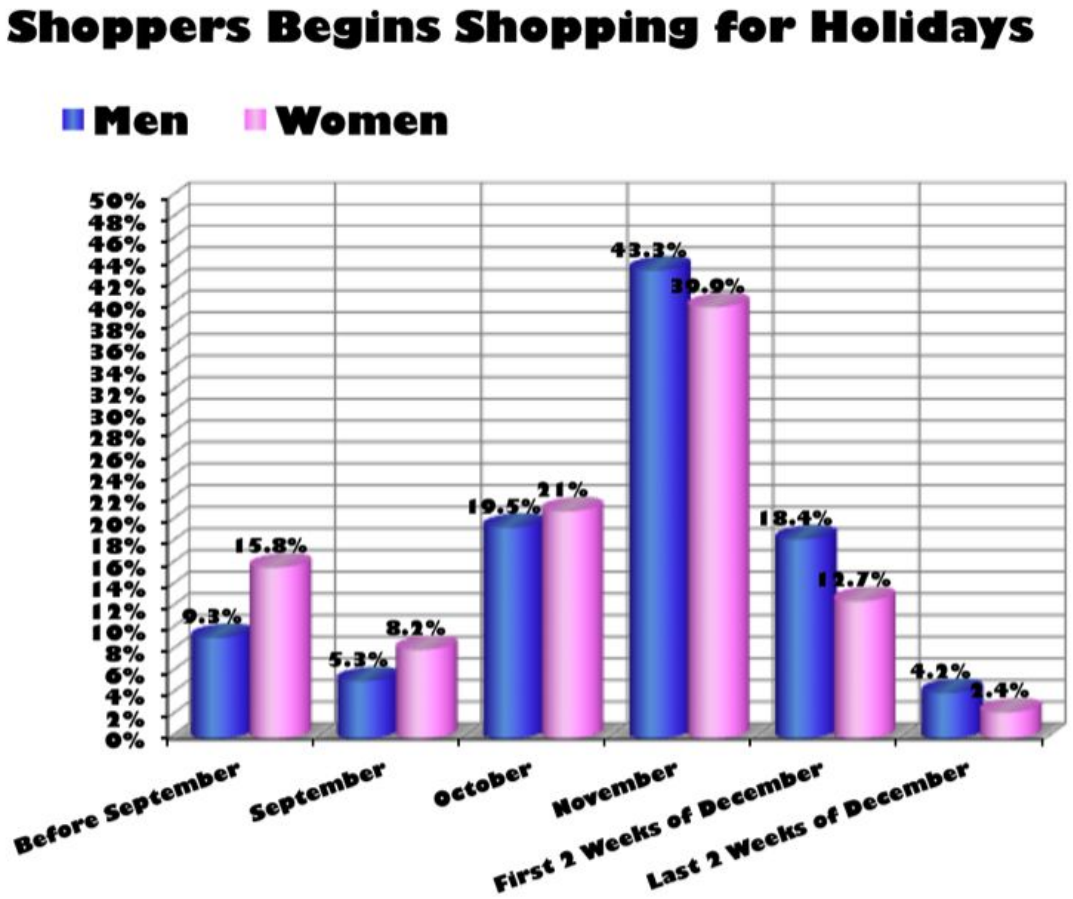
Manage extraneous cognitive load by eliminating non-relevant details

Example: eliminate non-relevant details

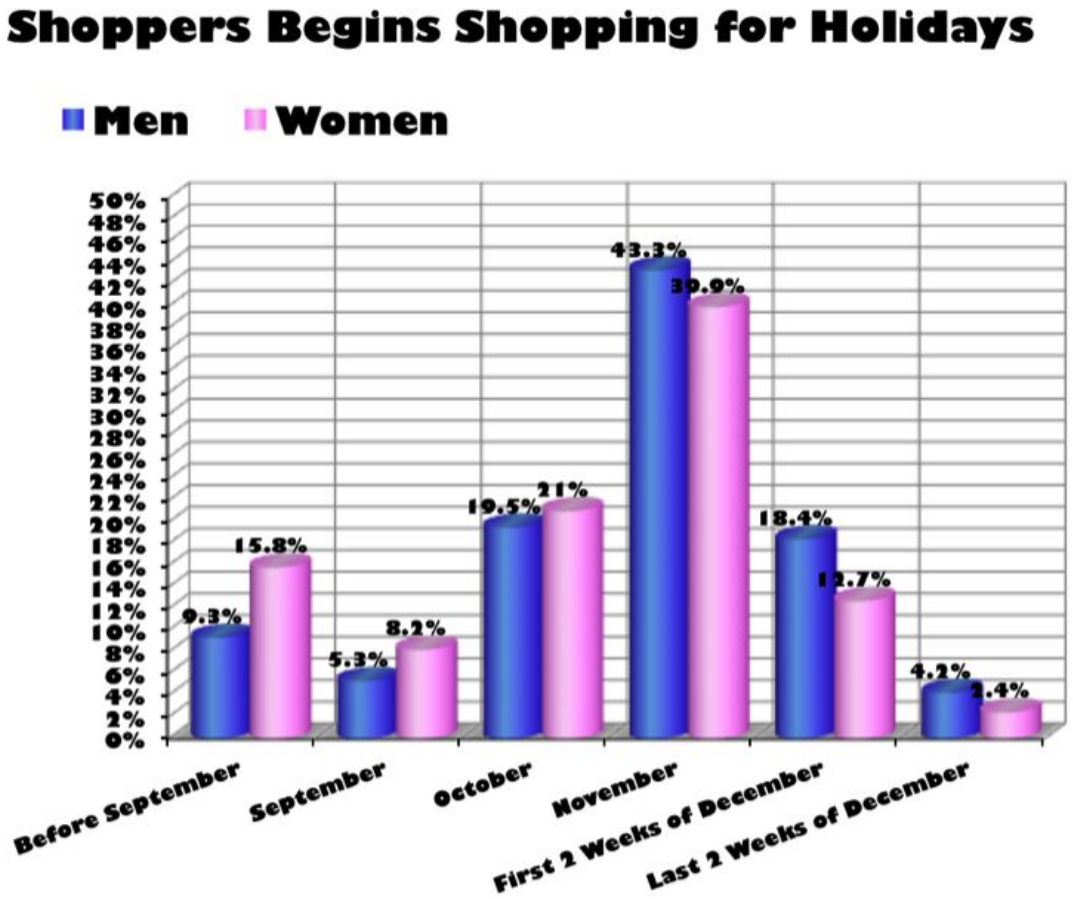
Before & after

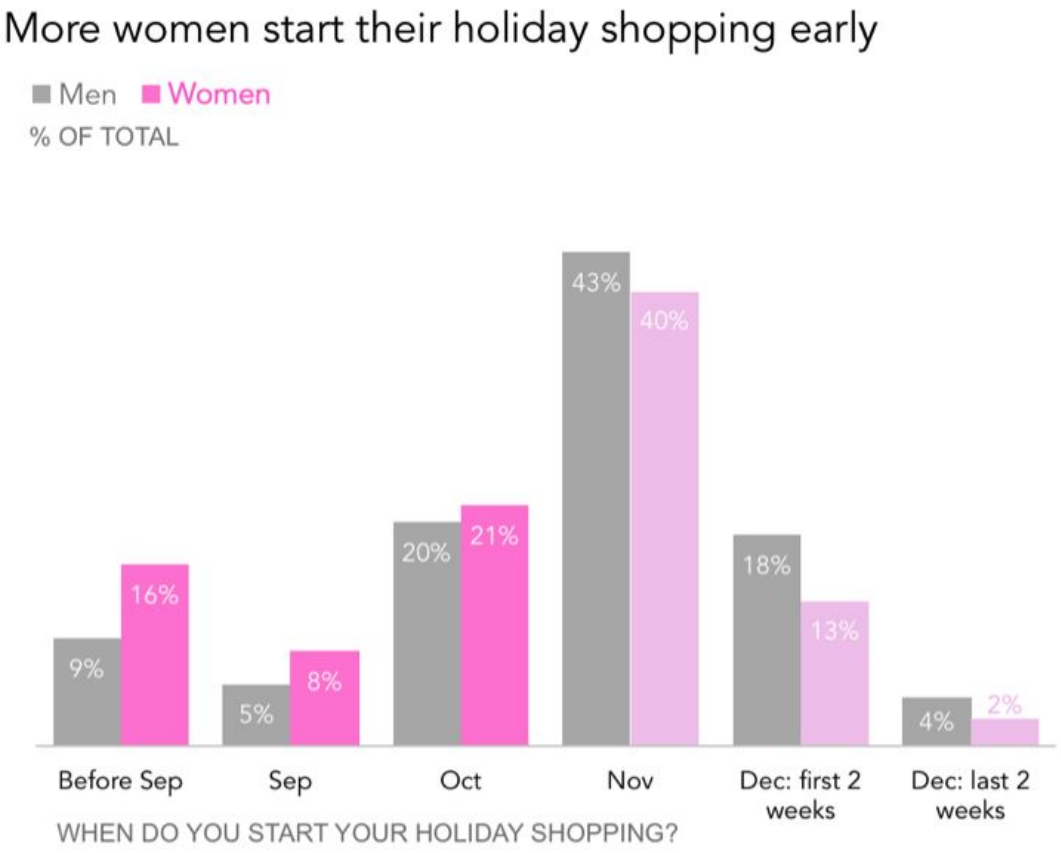


Storytelling with Data

Example: eliminate non-relevant details

Before & after





Storytelling with Data

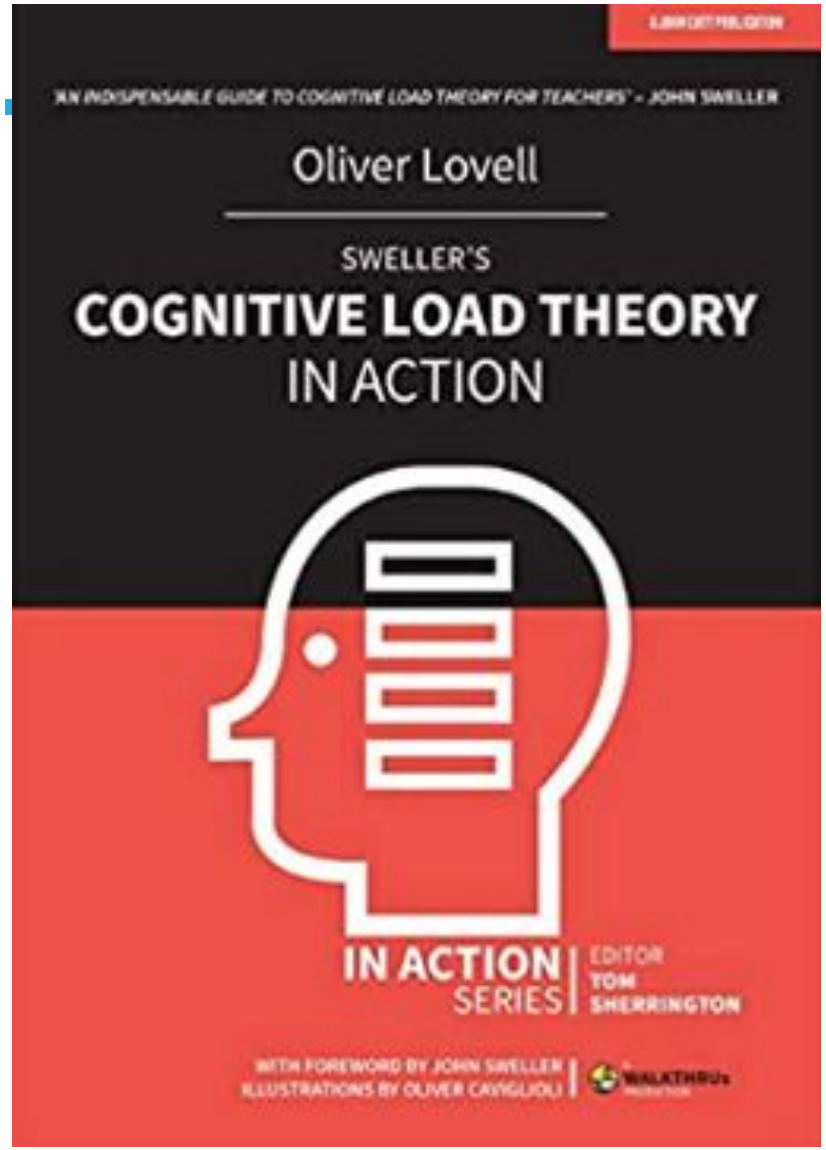
Educational Materials / Figures are pared down

Remove irrelevant details

Use figures rather than photos

Walkthrus

Explain relationships



In order to increase learning:

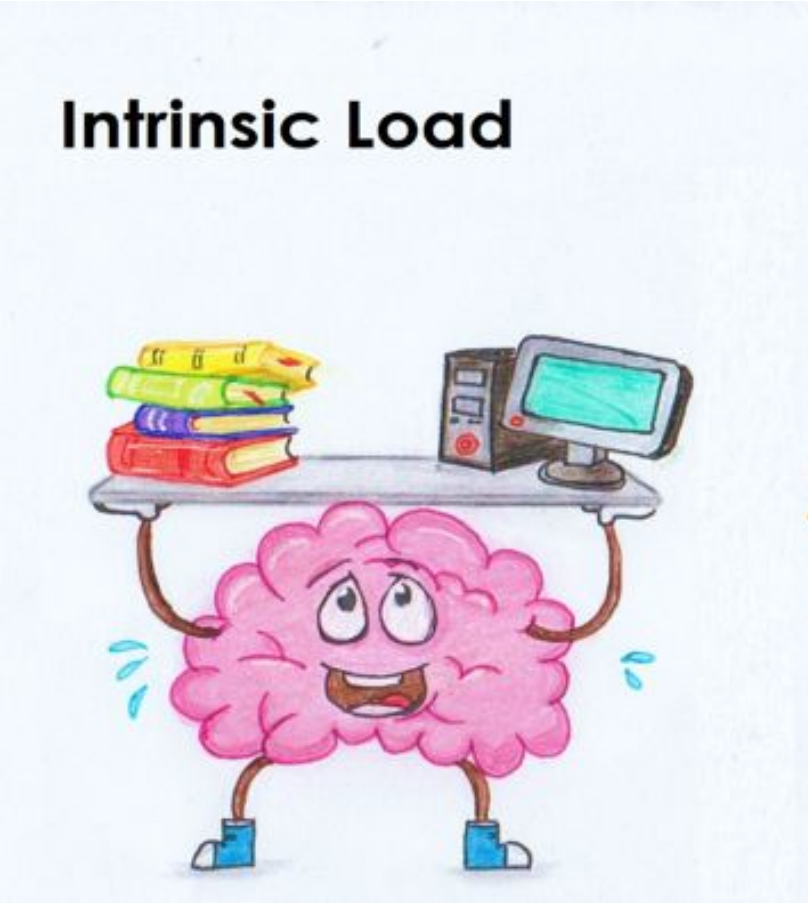
1. Reduce extraneous load, and
2. **Optimize intrinsic load**

What is intrinsic load?

Inherent complexity of a topic

How many elements?

How many relationships?



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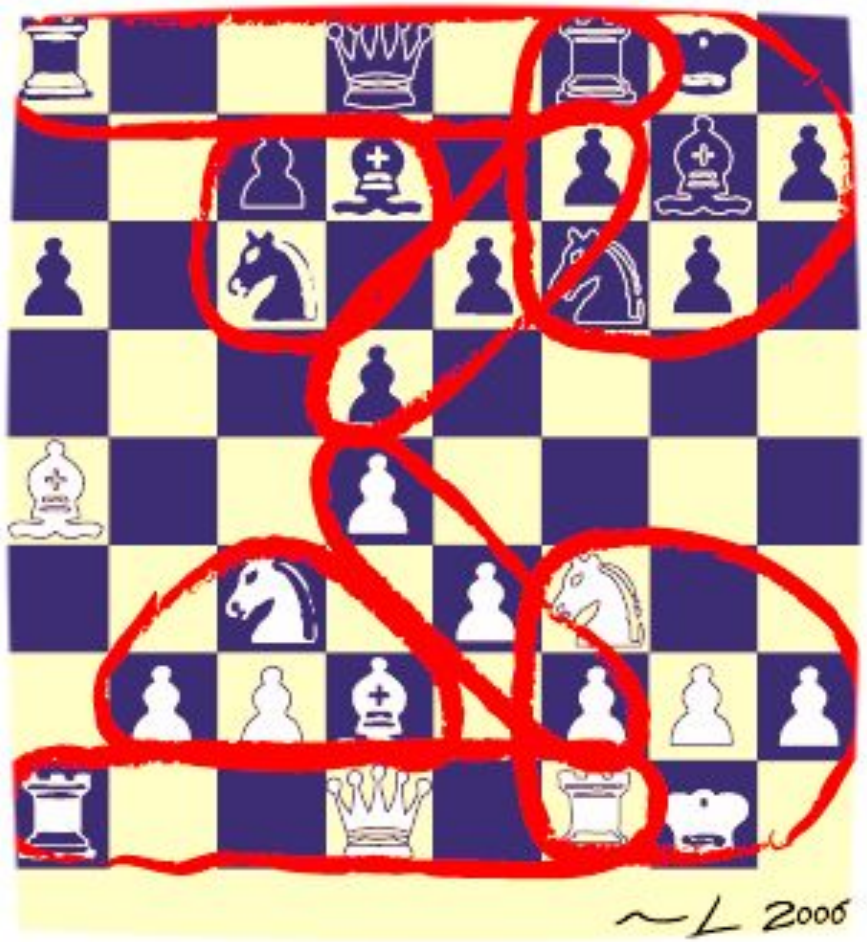
Manage intrinsic cognitive load by managing working memory and using careful sequencing of concepts using instructional design principles

Manage intrinsic cognitive load by managing working memory and using careful sequencing of concepts **using instructional design principles**

Chunking Knowledge

- Reduce cognitive load by showing how information is grouped
- Helps learners know what to focus on and what to ignore
- Define "mental models" and show students how to shift them



https://www.parentcorticalmass.com/2013/09/what-is-chunking.html

Instructional Design (very simplified)

1. Write a learning objective
2. Decompose into smaller concepts
3. Establish relationships between concepts
4. Order/sequence concepts in lesson plan

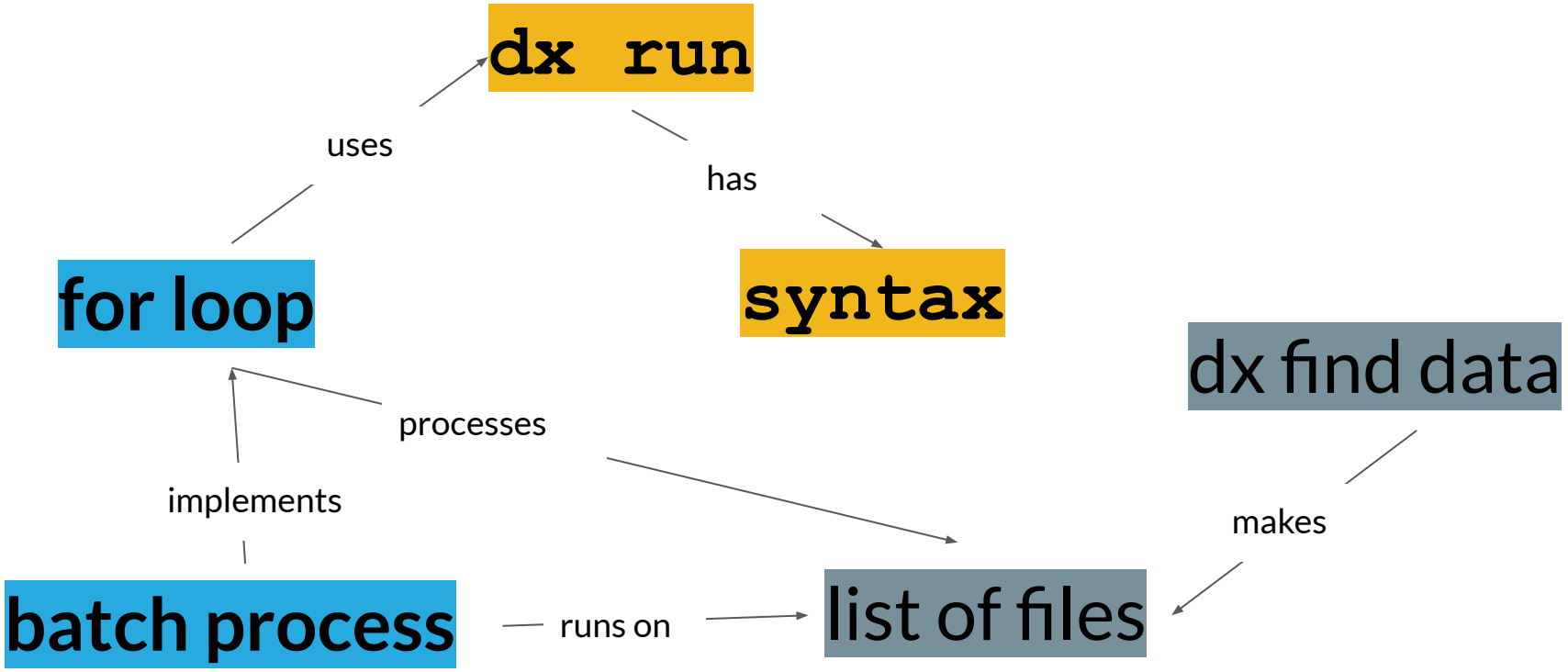
1. Learning Objective

Use `dx run` to **batch process** a list of files

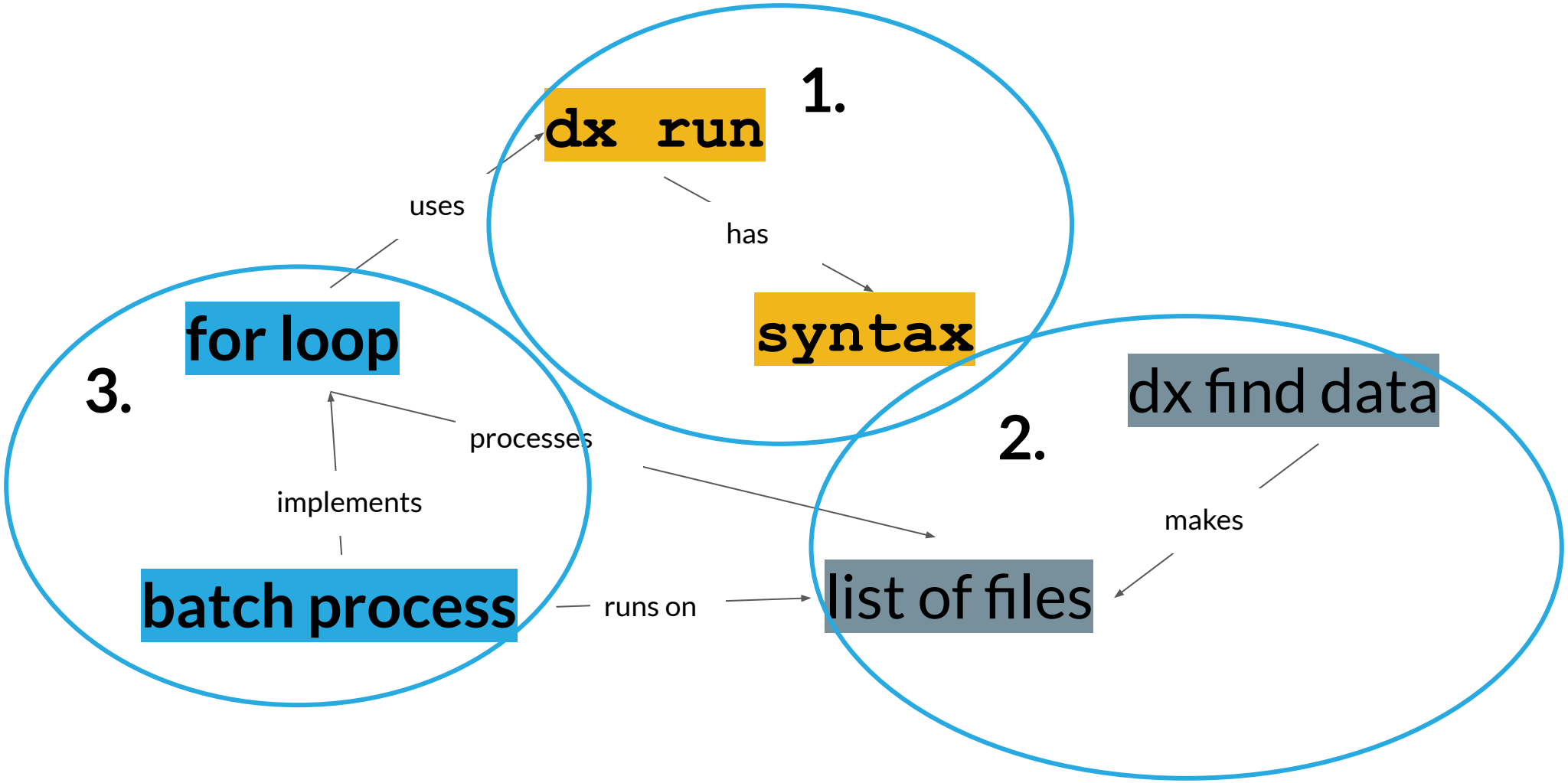
2. Decompose into Smaller Concepts

Use `dx run` to batch process a list of files

3. Establish Relationships (Concept Map)



4. Chunk and order



Active Learning using Challenges

How does coffee consumption affect medication usage in women?

Hypothesis:
Females who consume coffee have higher ibuprofen use than those who don't.

Do female coffee drinkers show a difference in ibuprofen usage compared to controls?

Treatment/medication code |...

Participants 15,646 34,332

Item	female_coff...		female_cont...	
paracetamol	3,203	18.82%	6,917	18.59%
aspirin	2,230	13.10%	4,948	13.30%
ibuprofen	2,086	12.26%	4,634	12.45%
simvastatin	1,939	11.39%	4,231	11.37%
glucosamine product	1,164	6.84%	2,433	6.54%

Designing Active Learning is Hard

- Testing and iteration important
- "Edge of Challenging"
  - (not too simple, not too hard)
- Use goal-focused questions with concrete answers
- Make sure the directions follow rules of cognitive load
- Review and reflect on answers to make sure students understand

Take Home Lessons

- Effective communication
- Goal and task oriented documentation
- Establish and sequence core concepts that are necessary to be successful in running cloud jobs on the platform

Sequencing the flow of knowledge

Don't show a complex diagram all at once

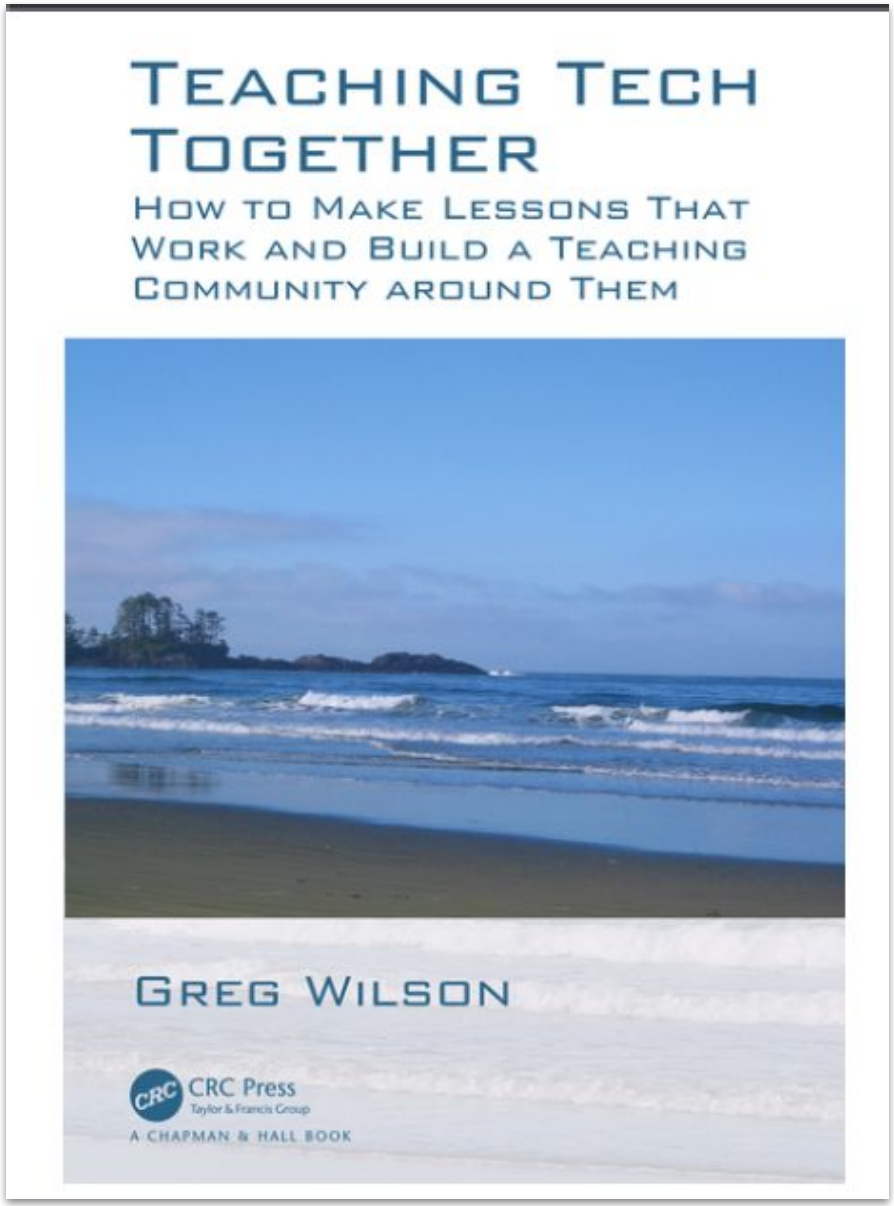
Talk about parts of the diagram

Explain relationships

Further Reading

(non affiliate links!)

- Why Don't Students like School?
- Sweller's Cognitive Load Theory in Action
- Storytelling With Data
- **Teaching Tech Together**



Thank You! Questions?