

Project-Based Learning at 150 MPH

Dr. Armen Amirkhanian, P.E.



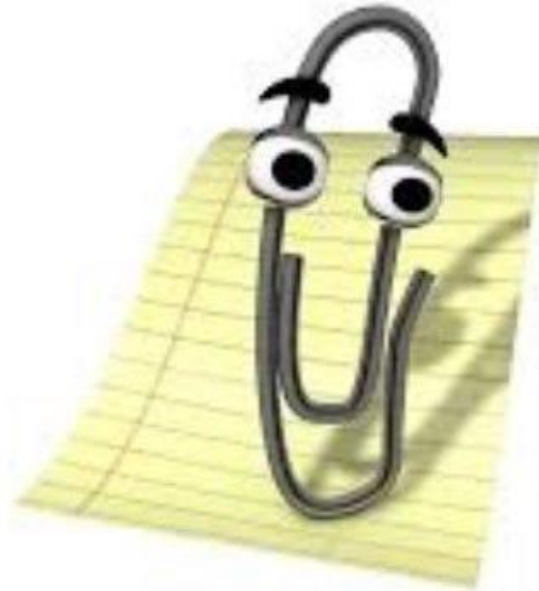
THE UNIVERSITY OF
ALABAMA[®]

College of
Engineering





HI! I'M CHAT GPT!



**LOOKS LIKE YOU'RE HAVING
A HARD TIME GETTING YOUR IDEAS
ACROSS. WOULD YOU LIKE SOME HELP?**

imgflip.com



Traditional Approach

- “Independent” activities
- Low cognitive load
- One-touch





*are not
always*

LABS

EXPERIENTIAL!



ABET Student Outcome 6

ability to

develop and conduct experiments,

analyze and interpret data,

and use engineering judgment

to draw conclusions



CE262 – Civil Engineering Materials

- Sophomore Level
- 3 Credit Hour
- Average Enrollment: 90 students per semester
- First civil engineering course in our curriculum



Laboratory Outline

Integrated Labs (Modules): Five lab experiments scaffolded through semester, each contributing knowledge to the final project:

- *Sieve Analysis:* Determine aggregate size distribution for concrete mix design.
- *Aggregate Properties:* Measure specific gravity and bulk density of coarse and fine aggregates.
- *Steel Tension Test:* Test a steel reinforcing bar's yield strength and behavior in tension.
- *Concrete Mixing & Workability:* Design a concrete mix (vary cement, water, aggregate ratios) and test slump/workability.
- *Concrete Compression Test:* Cast and crush concrete cylinders to gauge compressive strength at 7 and 28 days.



Will It Tornado?

- Design a thin-brick precast concrete panel
- “Must” survive the impact of a 2x4 traveling at 150 mph
- Economy of mixture design and reinforcement accounted for
- 100% Student Driven





Scaffolding/Constructivism

- Early labs introduce core concepts (e.g., what is a good aggregate gradation or proper curing for strength); subsequent labs and the project continually **reinforce and expand** on those concepts. Students revisit and apply ideas multiple times in new contexts, progressively deepening their understanding.



Scaffolding/Constructivism

- Learners *build new knowledge upon the foundation of previous knowledge*. Students actively **construct understanding** rather than absorb facts, especially when learning is contextual and social

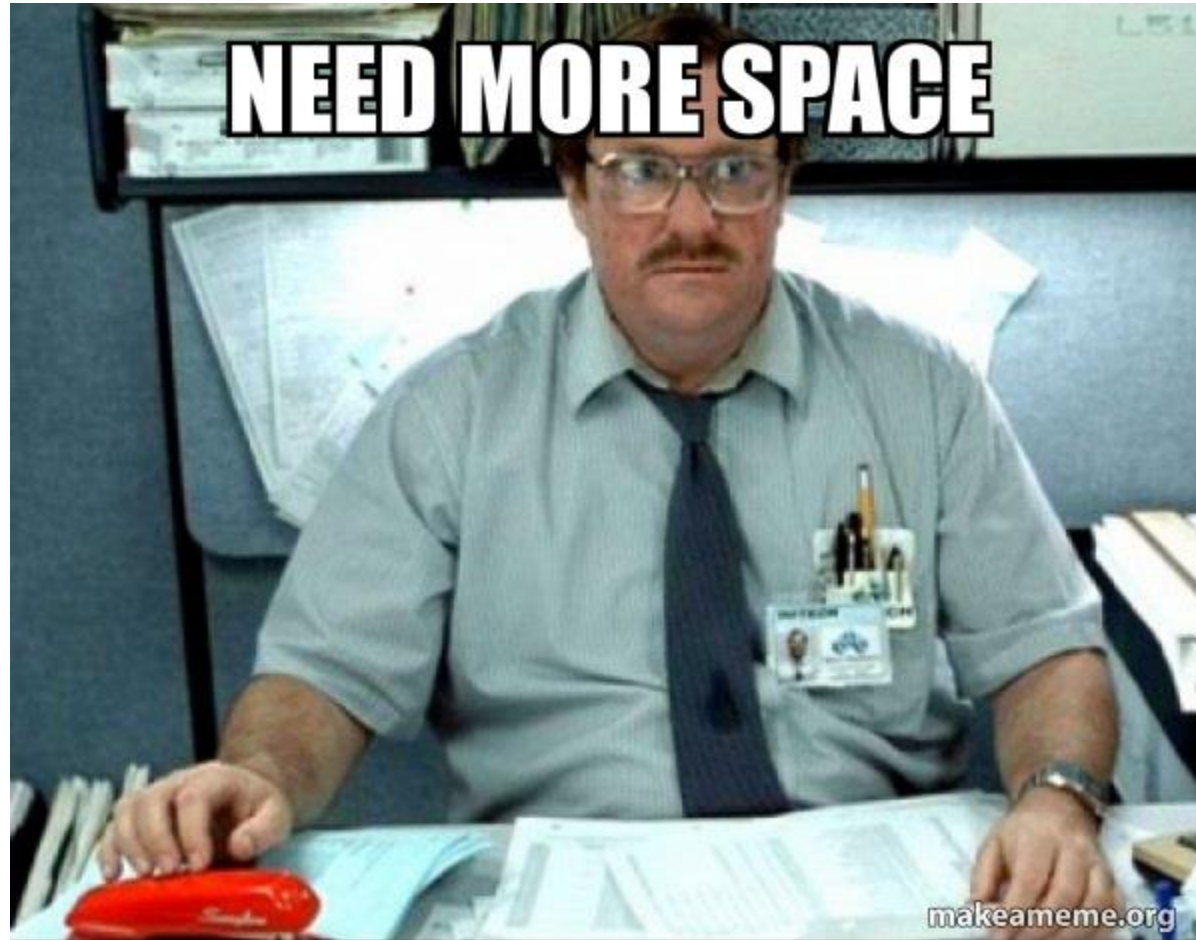


Learner Centered

- The project shifts the role of instructor to facilitator. Students must explore and ask questions (e.g., “How does water-cement ratio affect strength?”) and discover answers through experimentation. This open-ended inquiry mirrors inductive teaching methods that are all characterized as **constructivist**, placing responsibility on learners to seek and integrate knowledge



BIGGEST THING





Spacing

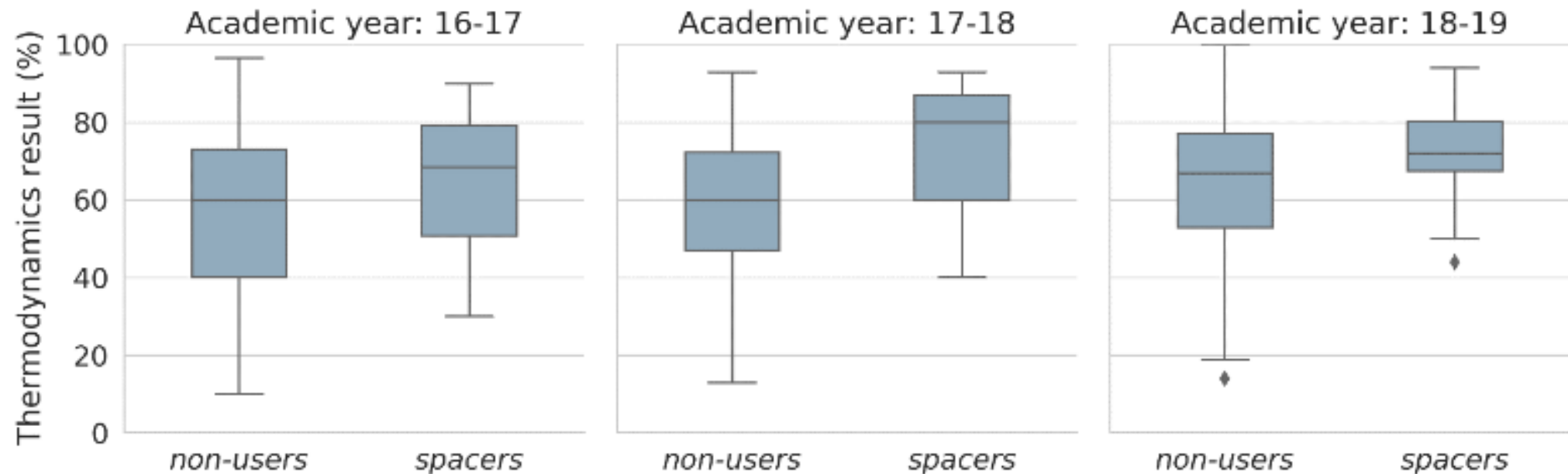
- Distributing learning opportunities over time (as opposed to massed, one-shot exposure) greatly enhances retention and mastery¹
- Repeated retrieval and use of knowledge strengthens long-term memory by combatting the natural forgetting curve¹

¹Voice, A., & Stirton, A. (2020). Spaced Repetition: Towards More Effective Learning in STEM. *New Directions in the Teaching of Physical Sciences*, 15(1), n1.



Seriously, Spacing

Studies show that students who engage in spaced practice perform **significantly better** on assessments and retain knowledge longer than those who cram or only see content once

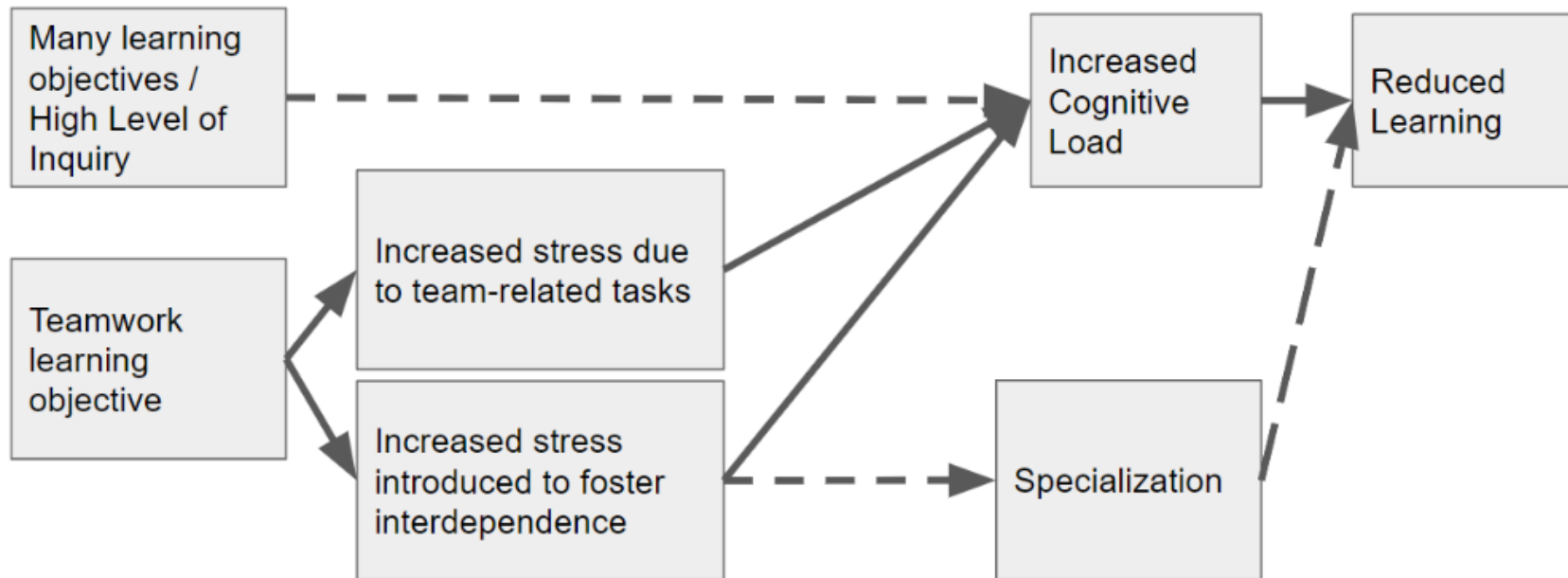


¹Voice, A., & Stirton, A. (2020). Spaced Repetition: Towards More Effective Learning in STEM. *New Directions in the Teaching of Physical Sciences*, 15(1), n1.



For This Course

- Students have *seen each fundamental concept multiple times*.
- Human working memory has limited capacity; learning suffers if that capacity is overwhelmed by too much novel information or complexity at once²



²Wickham, G., & Spencer, M. (2023, June). Work in Progress: Re-Interpreting Engineering Laboratory Literature Through the Lens of Cognitive Load. In 2023 ASEE Annual Conference & Exposition.

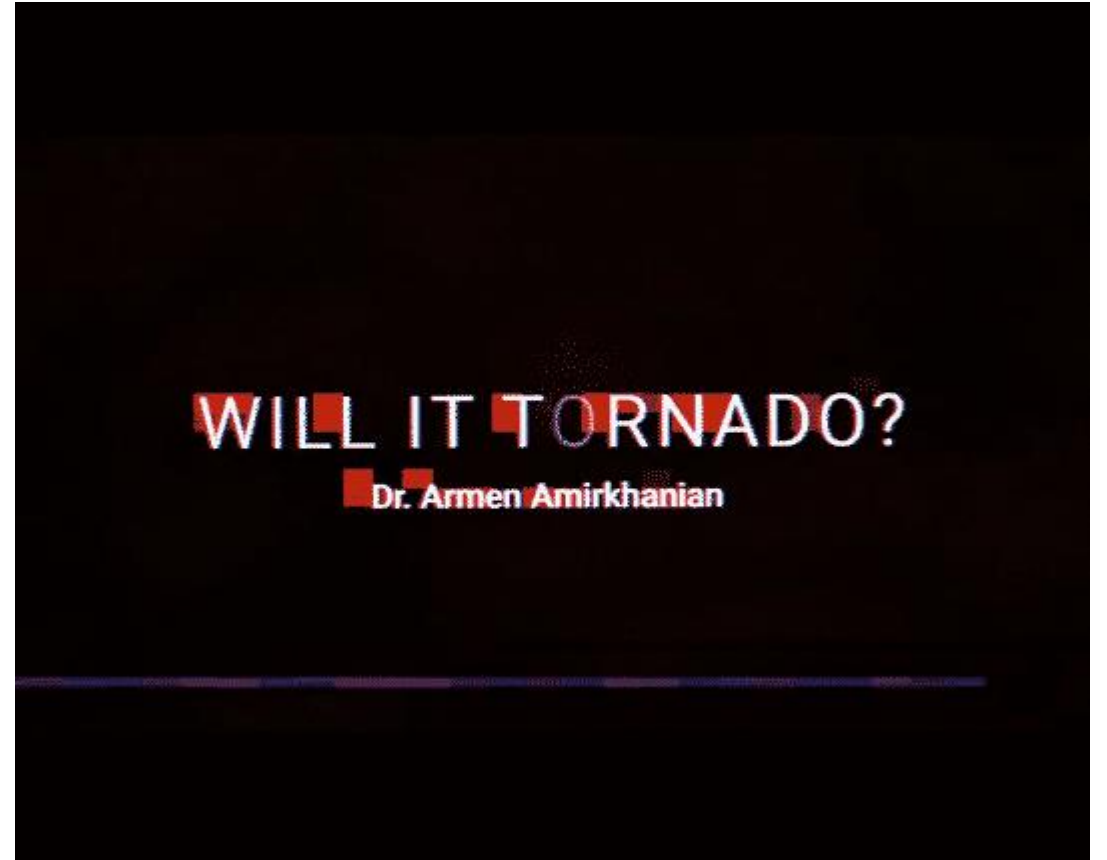


Results

- Course went from DFW rate of 20-30% to 10-15%
- Students no longer complained about labs
- Students wanted to go to lab
 - Students realized each lab had a purpose
- Students **developed** and conducted experiments!



Results





**WHERE
LEGENDS
ARE MADE®**

Dr. Armen Amirkhanian
[Vimeo.com/armencrete](https://vimeo.com/armencrete)

THE UNIVERSITY OF
ALABAMA®

College of Engineering
The University of Alabama
3011 HM Comer Hall
Box 870200
Tuscaloosa, AL 35487