A 15+ Year Journey in Active Learning

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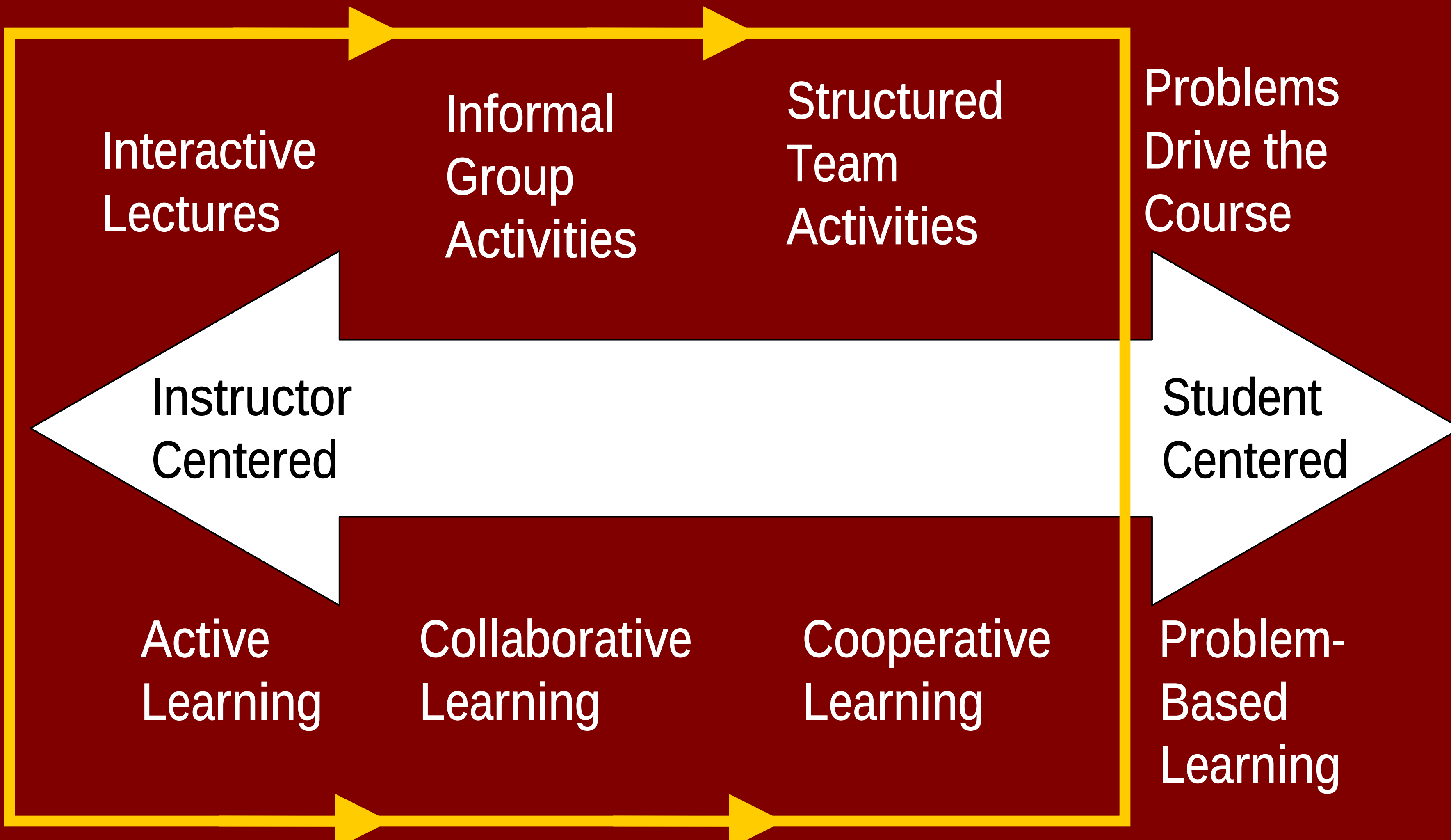
An Active Learning Continuum:

Introduction to Materials Science & Engineering, N = 90 - 145



Making Time for Active Learning: Sequencing Learning Activities

In-Class

Lectures

Out-of-Class

Homework and Problem Sets

Remember → Understand → Apply → Analyze → Evaluate → Create

Out-of-Class

Read, View Lectures

In-Class

Small Group Activities

Feedback

Class Discussions

Instructional Strategy Using Informal Collaborative Learning

	FOUNDATIONAL KNOWLEDGE			APPLY
Outside Class	Guided Textbook Reading	Online “Warmup”* Questions		Homework Problems
In-Class			Interactive Mini-Lectures: “Clicker” Questions, “Think-Pair-Share,” Feedback	
			APPLY	

*Novak et al., *Just-in-Time Teaching* (1999).

Example Questions

Activate prior knowledge

In Physics 1 you learned about the spring equation and spring constant. How is a material's modulus of elasticity (also known as Young's modulus) similar to and/or different from a spring constant?

Reveal inaccurate beliefs

Does a rubber band have a high or low modulus of elasticity (also known as Young's modulus)? Explain your reasoning.

Connect to learners' everyday lives

Think about the plastics in your everyday life and identify one product that shows <u>viscoelastic</u> behavior at room temperature. Explain your reasoning.

Foster organization of knowledge

Create a concept map to answer the following question: "What are the various ways in which a structural material can fail?"

Develop metacognition

Review the work we've done this week in class and formulate at least two questions that you would like to explore with instructors or classmates.

Resources: National Research Council, *How People Learn* (2000); Ambrose et al., *How Learning Works: 7 Research-Based Principles for Smart Teaching* (2010).

Instructional Strategy Using Team-Based Learning

	← FOUNDATIONAL KNOWLEDGE →				
Outside Class	Individual Preparation: View Microlectures	Individual Online Quiz			
In-Class			Team Quiz and Feedback	Team Problem Set and Feedback	Team Material Selection Challenge
				APPLYING	EVALUATING

*Michaelsen et al., *Team-Based Learning* (2004); Johnson et al., *Active Learning: Cooperation in the College Classroom* (1991).

Which strategies have you used (or would you consider using) in order to free up more class time for active learning?

1 minute: individual free write

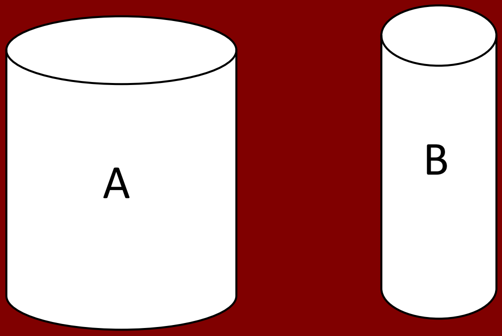
4 minutes: share with others

How Well Is It Working?

- Course evaluation data
  - Self-reports on learning, participation, effort
- Our own measures of student learning
  - Exam questions
- Research-based instruments
  - Concept Inventory Central (engineering.purdue.edu/SCI/workshop/)

Example Concept Question*

Pieces A and B are cut from the same metal plate that has uniform mechanical properties. They have different diameters, as shown, but their heights are equivalent. *The same tensile force, F, is applied to each cylinder along its axis.* Which cylinder will elongate more?



A. Cylinder A
B. Cylinder B
C. A and B will elongate equal amounts.
D. It's not possible to say without more information.

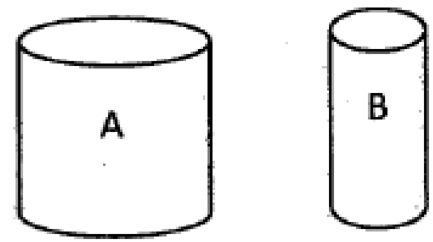
*Adapted from Rosenblatt and Heckler, ASEE Conference Proceedings (2010).

1. **(10 pts)** Pieces A and B are cut from the same metal plate that has uniform mechanical properties. They have different diameters, as shown, but their heights are equivalent. *The same tensile force, F, is applied to each cylinder along its axis.* Which cylinder will elongate more?

(ε)

$\varepsilon = \frac{\sigma}{E}$

A. Cylinder A
B. Cylinder B
(C) A and B will elongate equal amounts.
D. It's not possible to say without more information.

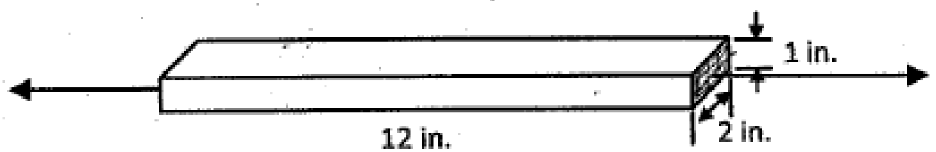


Provide one or two sentences that explain and justify your answer:

Since A and B both come from the same metal plate and are applied the same force both the elastic modulus and the stress will be consistent, making elongation be an intrinsic property

(15)

2. **(15 pts)** A metal plate with the dimensions shown will experience a tensile force of 20,000 lb along its length. Mechanical properties of the metal are tabulated below.

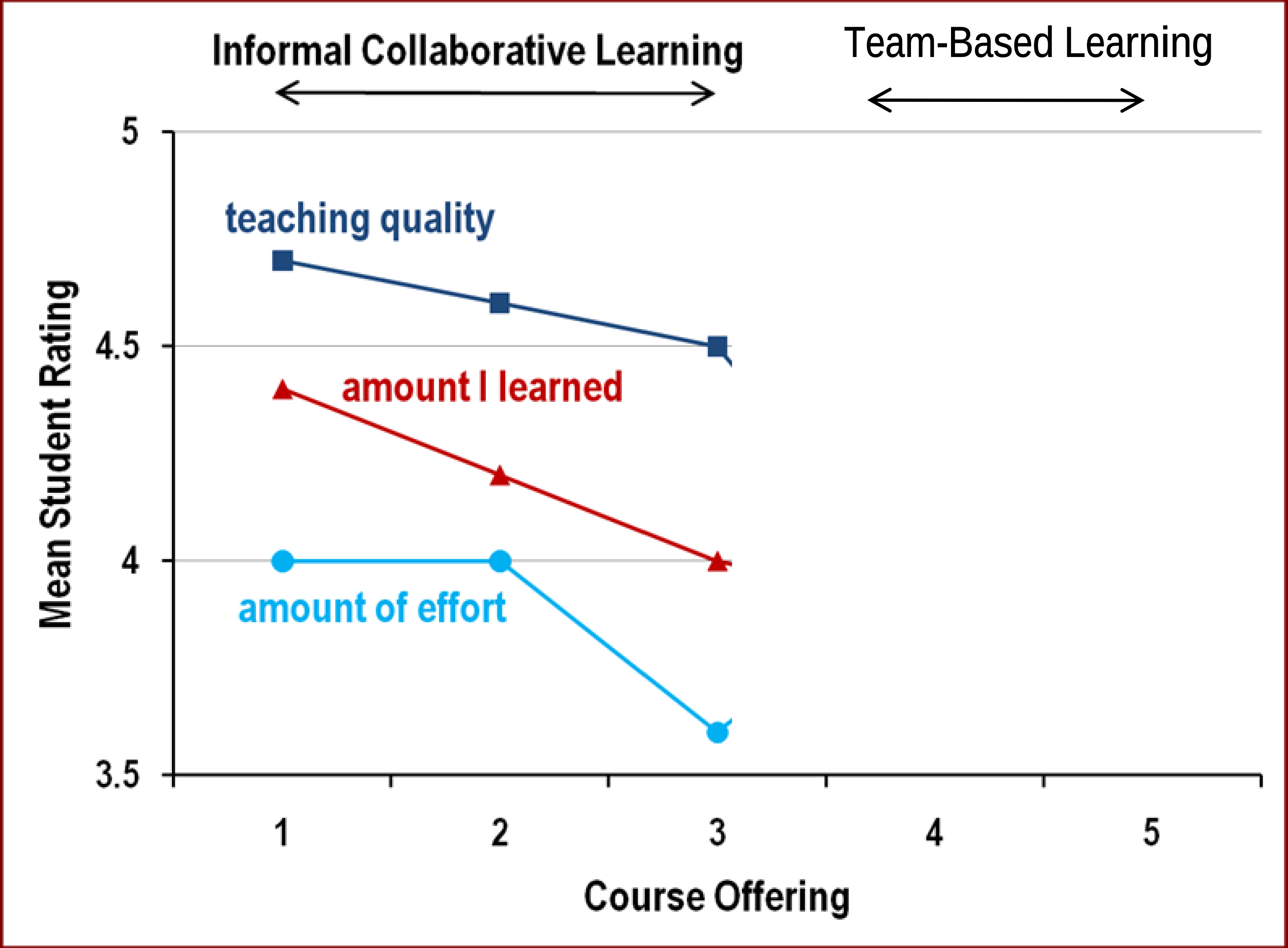


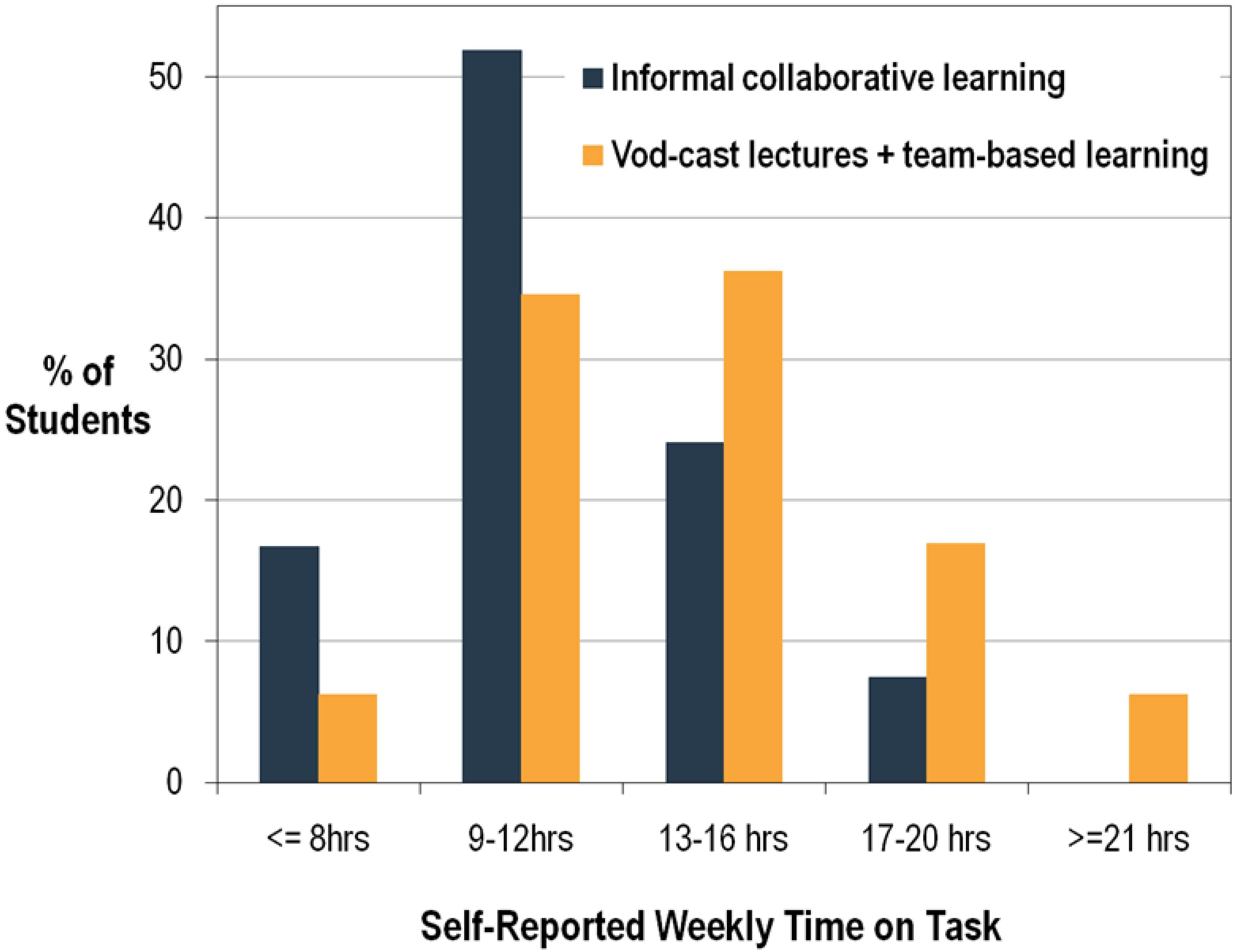
$F = 20,000$ lb.
$A = (2)(1) = 2\ in^2$
$\sigma = \frac{20,000\ lb}{2\ in^2} = 10,000$ psi

Elastic Modulus (psi)	Yield Strength (psi)	Tensile Strength (psi)	Ductility (%EL)	Fracture Toughness (ksi in$^{1/2}$)
30x10^6	45,000	55,000	10	35

a) Will the plate experience permanent deformation? ___Yes ✓ No

Provide justification:
With the given force and cross sectionall area we can get the applied stress (σ) which happens to be 10,000 psi. Since this stress is less than the yield strength no plastic deformation will occur.


Informal Collaborative Learning
Team-Based Learning
Mean Student Rating
5
4.5
4
3.5
teaching quality
amount I learned
amount of effort
1
2
3
4
5
Course Offering



Informal collaborative learning
Vod-cast lectures + team-based learning
% of Students
50
40
30
20
10
0
<= 8hrs
9-12hrs
13-16 hrs
17-20 hrs
>=21 hrs
Self-Reported Weekly Time on Task

Closing Thoughts

- Operate (mostly) within comfort zone and build
- Hold students accountable for class preparation
- Find supportive colleagues/ mentors with experience in active learning

Material Selection Challenges

1. Cable Ties for a Modern Bi-Plane
2. Material Failure Case Studies
3. Mirrors for Large Optical Telescopes
4. Materials for a Wiping Solder