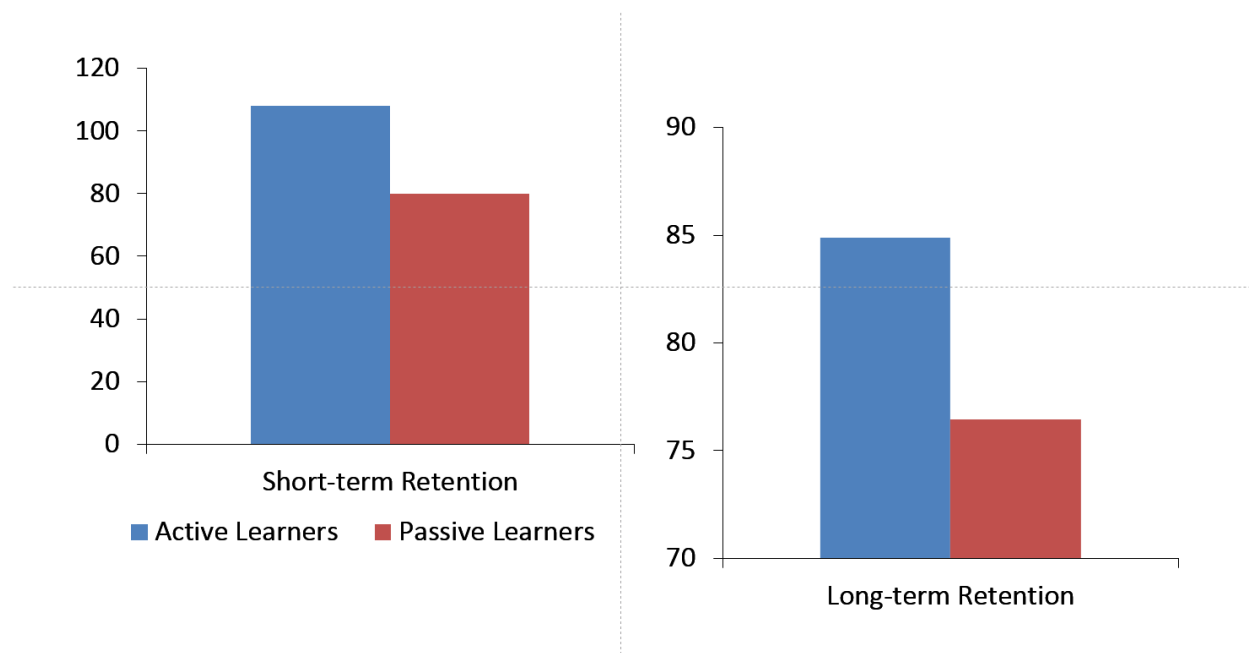


There are decades of research showing that providing opportunities for active learning is a key part of successful teaching. The three studies presented below provide you with some of the evidence supporting the use of active learning as a foundational teaching method.

Study 1: Ruhl *et al* (1987)¹

Active learning during lecture increases retention of lecture material.

- Course with 45 minute lectures, taught by an experienced professor who had been teaching the class for several years.
- n=72, 2 semesters
- During 5 lectures, 3 two-minute breaks were incorporated, where students paired up and clarified their notes (these are the “active learners”)
- Short-Term Retention: at the end of each lecture, students wrote down everything they could remember (results below – average number of facts recalled by students)
- Long-Term Retention: 1.5 weeks after the 5 lectures with pauses, students were given a 65 question multiple choice exam. (results below – average exam performance)

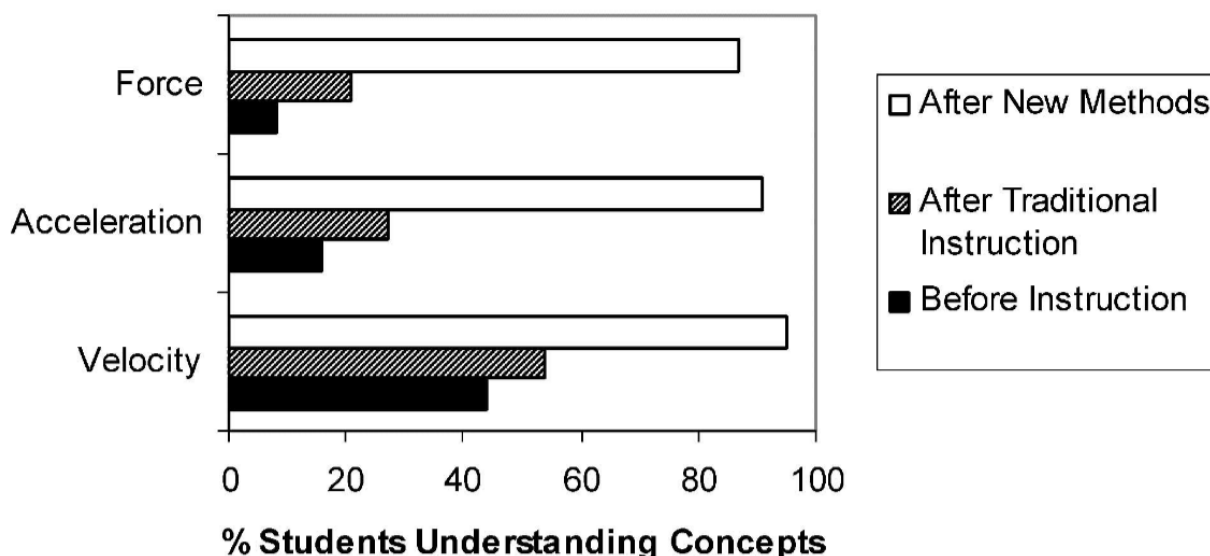


¹ Ruhl, K., Hughes, C. & Schloss, P. (1987). Using the Pause Procedure to Enhance Lecture Recall. *Teacher Education & Special Education*. V 10: pp. 14-18.

Study 2: Laws *et al* (1999)²

Active learning during class increases student understanding.

- Used data from thousands of university students in America who took the *Force & Motion Conceptual Evaluation*



Understanding the Figure

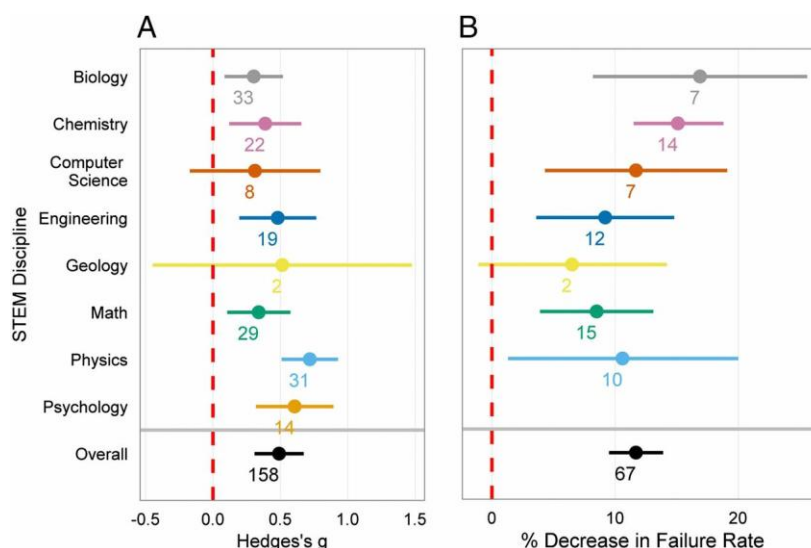
- Before Instruction:** results for students before taking an introductory physics class
- After Traditional Instruction:** results for students after taking a class using traditional instruction methods (e.g., lecture)
- After New Methods:** results for students after being taught as active learners: an interactive demonstration where students discussed what was happening and made predictions about what would happen (articulating their reasoning as they went)

² Laws, P., D. Sokoloff, and R. Thornton (1999), Promoting Active Learning Using the Results of Physics Education Research. *UniServe Science News*. Vol. 13.

Study 3: Freeman *et al* (2014)³

Active learning increases student performance in STEM classes.

- Meta-analysis of 225 studies of active learning in undergraduate STEM courses
- Upshot:
 - exam scores increased 6% with active learning (and more for concept inventories)
 - student in traditional lecture formats were 1.5x's more likely to fail than active learning students
 - effect shows up in all class sizes, but is best for $n \leq 50$



Understanding the Figure

- red vertical line represents performance in class with traditional lecture
- each dot represents the aggregate performance across all studies in that discipline, when active learning was incorporated; extended line represents error/range
- number listed with each dot represents number of studies included in that dot
- A: exam performance change
- B: Failure rate
- in both A & B, having a dot to the right of the vertical line indicates a positive impact for active learning

³ Freeman, Scott, Sarah Eddy, Miles McDonough, Michelle Smith, Nnadozie Okoroafor, Hannah Jordt, and Mary Pat Wenderoth (2014). Active learning increases performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America*. 111: 3 (8410-8415).