How Learning Works: Useful Techniques for Future Teachers
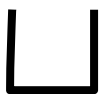
Brett Gilley, Diane Hanano, James Scoates, MAGNET Trainees
Earth, Ocean and Atmospheric Sciences

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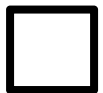
1	⌐	6	⌐
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4	⌐	9	⌐
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1	⌐	6	⌐
2	⌐	7	⌐
3	⌐	8	⌐
4	⌐	9	⌐
5	□	0	○

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Goals

- Discuss the use and usefulness of Research Based Instructional Strategies (RBIS)
- Describe three important ways that Experts differ from Novices
- Discuss lesson planning and student motivation with your peers
- Develop a plan for evaluating and improving your teaching

In many classrooms

We teach the way many of us learned

Lectures with little interaction

Retention after lecture?

Retention from lecture

Three studies

Lecture Retention

1) <u>E. F. Redish</u>

Students interviewed coming out of lecture "What was the lecture about?"

Vague generalities

2) <u>Hrepic, Zollman, Rebello</u> (2007)

18 students answer 6 questions. Told to get answers to the

6 questions from 14 minute lecture.

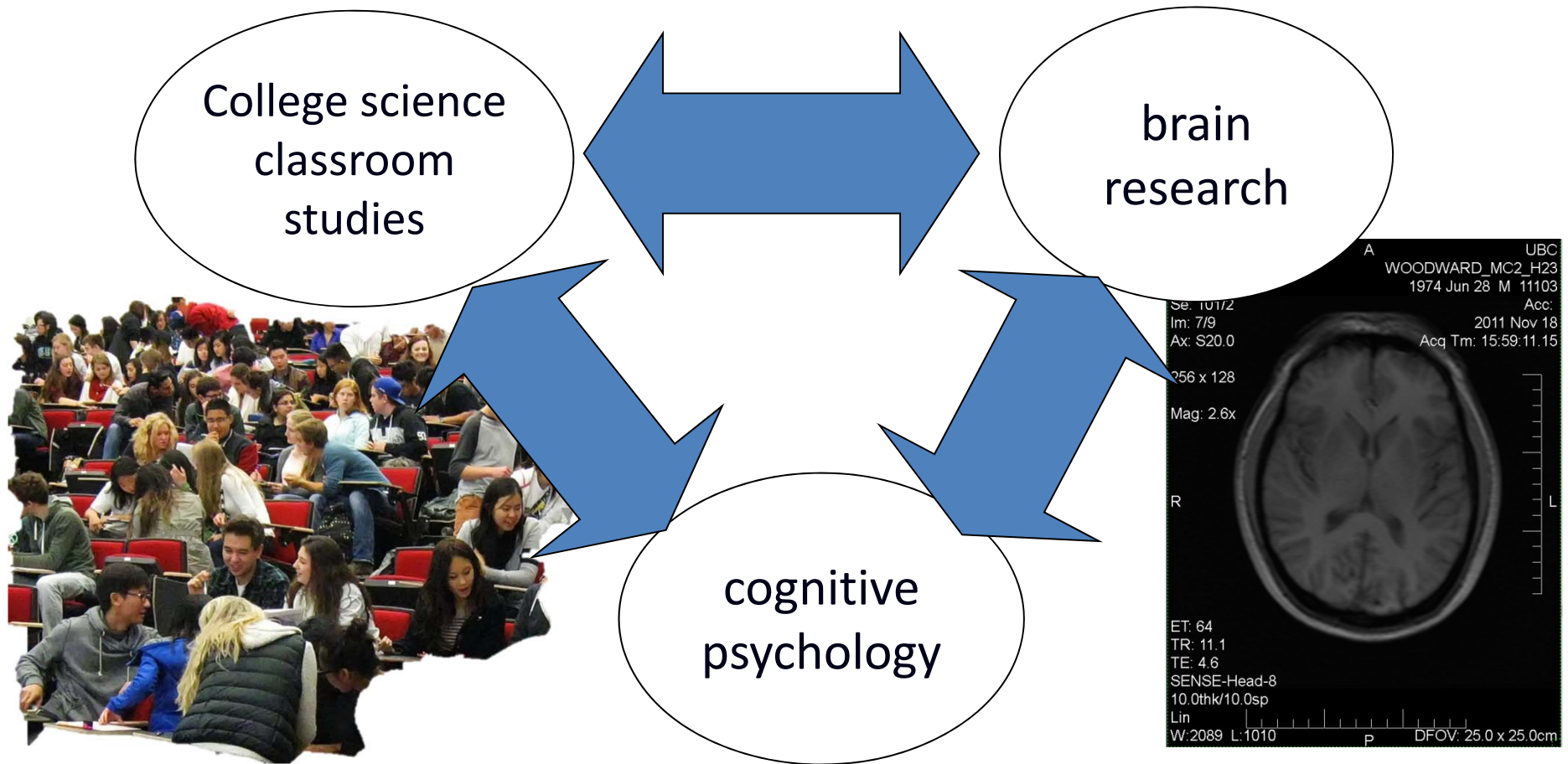Most questions, **1 student or less** able to get

answer from lecture.

3) <u>Wieman and Perkins</u>

Test students 15 minutes after told nonobvious fact in lecture.

<10% remember

Where are they learning?

Major advances past 1-2 decades
Consistent picture $\Rightarrow$ Achieving learning

Educational goal: thinking more like an expert, "greater expertise"

Expertise Research: Implications

New ways of thinking:

- Everyone requires many hours of intense practice to develop expertise

- Brain changes result.

- How you practice is important

- More on expert vs. novice later

Large Metastudy

Review of 225 studies comparing active learning to traditional lecture with exams or assessments
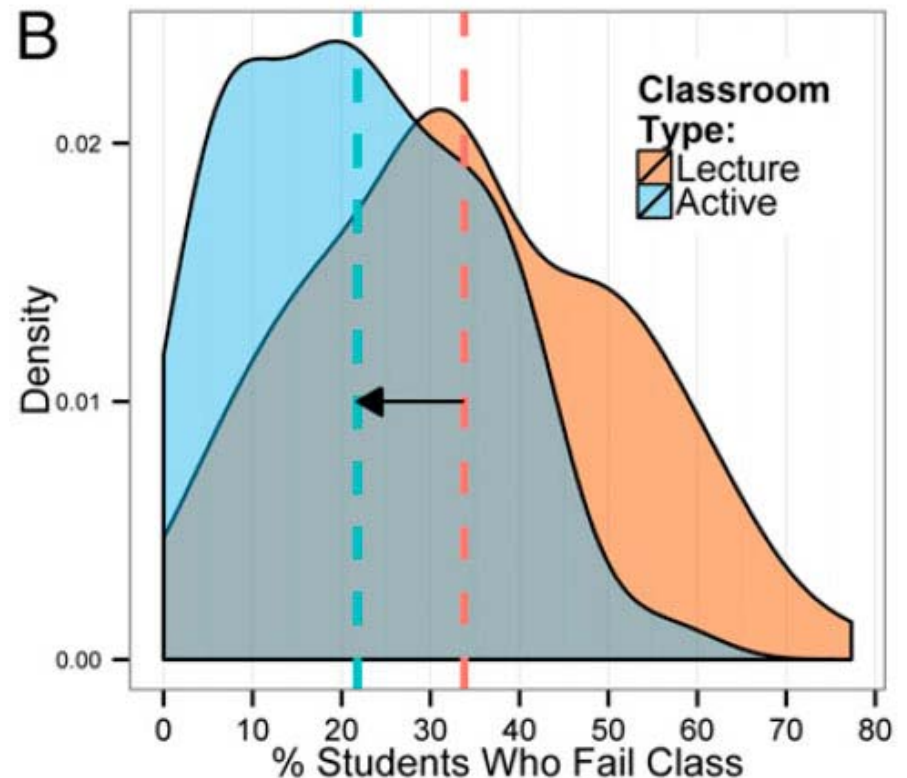
Findings:

Active learning

~0.5 SD improvement

Lecture

1.5 times more likely to fail

Freeman *et al.* 2014

Freeman *et al.* 2014

"If the experiments analyzed here had been conducted as randomized controlled trials of medical interventions... the control condition might be discontinued because the treatment being tested was clearly more beneficial."
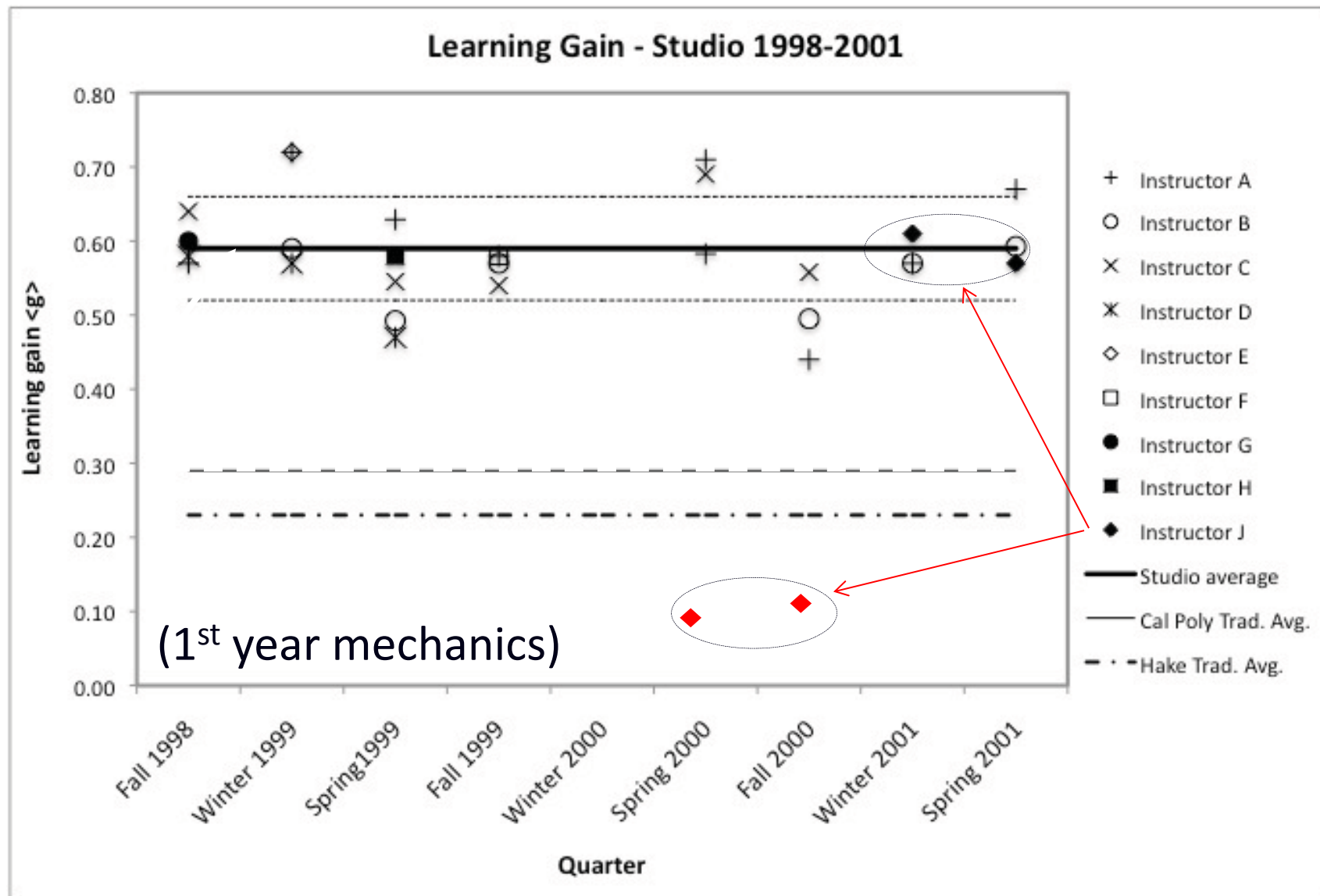
"Research-based" Instruction?

2012 US Nat. Acad. Sciences review:

"Discipline-Based Education Research: Understanding and Improving Learning in Undergrad. Sci. and Eng."

~ 1000 STEM research studies showing methods with consistently better results than traditional lecture.

Example: Conceptual learning in physics

- California Polytech Univ. study of "Studio Physics"
- Used standard widely-used test of 1st year mechanics concepts (FCI). Pre and post course test.

Learning Gain - Studio 1998-2001

(1st year mechanics)

9 instructors, 8 terms, 40 students/section.
Same prescribed set of in-class learning tasks.

Hoellwarth and Moelter,
Am. J. Physics

Research-based Instructional Strategies

You've heard:

"active learning", "student-centered", "collaborative learning", "flipped classroom"...

Underlying foundation is:

Disciplinary expertise

"Expertise-centered" classroom

"Good teaching" – use and transfer of expertise.

Will not make student an expert, just a step on the path (but as big as possible!).

Learning Expertise

Requires brain "exercise"

Challenging but doable tasks/questions
- Practice expertise with feedback and reflection
- Multiple modes of representation (not learning styles)
- Motivation is critical!

Subject expertise of instructor essential—
- designing practice tasks *(what is expertise, how to practice)*
- feedback/guidance on learner performance
- Why subject is worth learning

"Deliberate Practice", A. Ericsson - research

Accurate, readable summary in "Talent is over-rated" (Colvin)

Experts and Novices

Useful framework

What are some differences?

Your list

Example Activity

Jigsaw

How People Learn

Expert groups:

Make sure everyone understands the concept

Discuss these questions

- How is this important to learning?
- How is it important from the teacher's perspective?
- What are some things you might do in a classroom to take this idea into account?
- What problems might you see with this concept?

How People Learn

Mixed groups:

Summarize discussion from your expert group

- How is this important to learning?
- How is it important from the teacher's perspective?
- What are some things you might do in a classroom to take this idea into account?
- What problems might you see with this concept?

Answer any questions your colleagues have

Don't change topics until instructed

Conclusions from research

Effective teaching develops expertise.

Practice thinking like a expert with feedback essential for learner.

Many methods based on this have demonstrated (i.e. with evidence) improved learning in undergraduate science courses.

Baseline level of instructor expertise essential *(much more so than in straight lecturing).*

Discussion Groups

Lesson planning - BOPPPS

Bridge/hook

Objectives/goals

Pre Assessment

Participatory learning (Practice! And a little lecture)

Post Assessment

Summary

What are the benefits/drawbacks of each of these?

Motivation

What motivates you?

How is that different than your students?

How do you motivate students?

Your teaching

How could you measure success in your teaching?

How can you develop your skills?

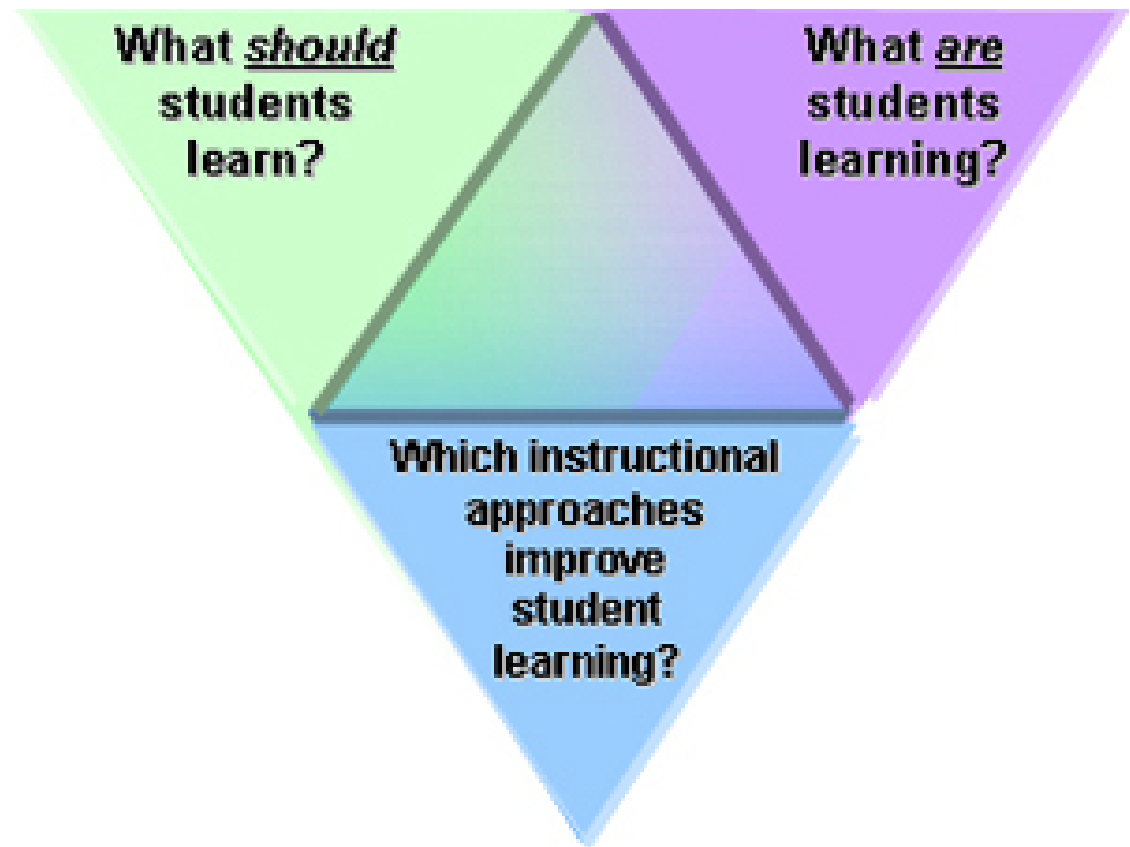What simple things could you do in the next year?

Is there someone, a "teaching partner" or group you could work with?

Overview of CWSEI

Apply research about how people learn in university classrooms.

Measure effects.

Share new results.

Summary

Expertise in teaching

Experts and Novices → Hindsight bias

Measurement

Any Questions?

Feedback

What parts of today helped you learn?

What would you change?

Any other comments?

Some Useful References

- How People Learn: Brain, Mind, Experience, and School (expanded edition), edited by J. Bransford, A. Brown, and R. Cocking (National Academy Press, 2000).

- Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M. K. (2010). *How learning works: Seven research-based principles for smart teaching*. John Wiley & Sons.

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