When active learning fails: How faculty beliefs and intentions inform their teaching and influence student outcomes

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Center for Advancing Mathematics, Science & Engineering Education

Acknowledgements

Rachael Baiduc | Denise Drane | Gregory Light | Su Swarat

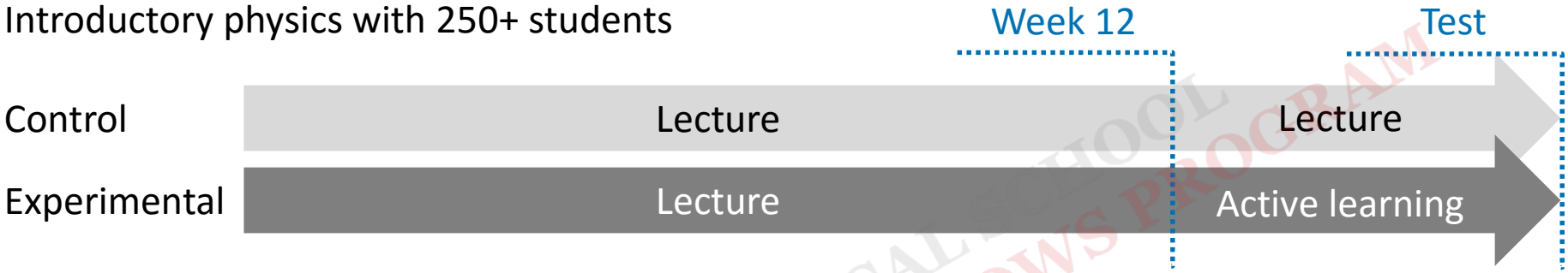
Warm-up question: What is active learning?

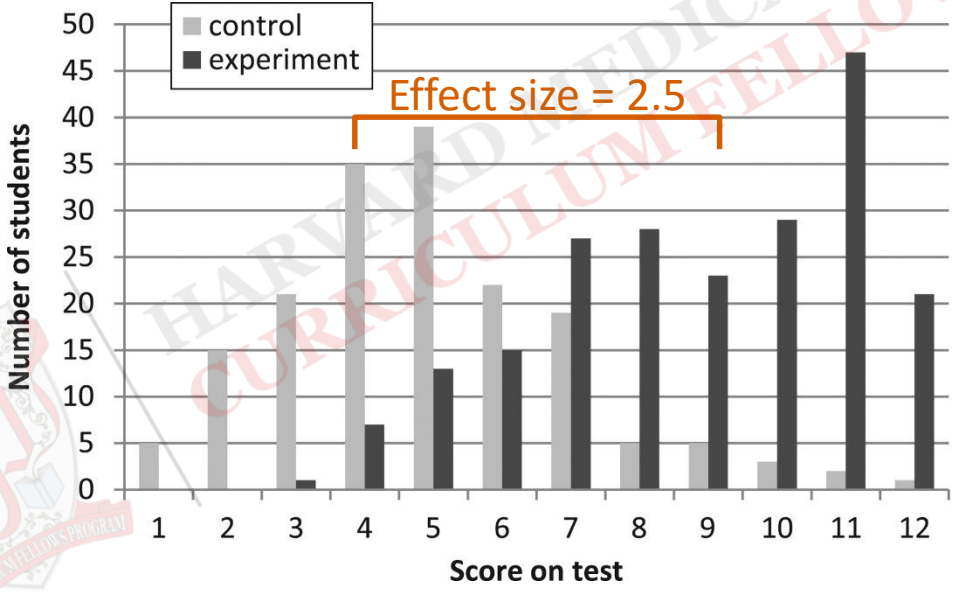
Which one of the following scenarios best describes active learning?

a. Flipped course with video lectures before class
b. Independent research in faculty laboratories
c. Laboratory course with hands-on experiments
d. Lecture course with clicker questions in class
e. Seminar course with discussions of primary literature

An experiment on active learning

Introductory physics with 250+ students

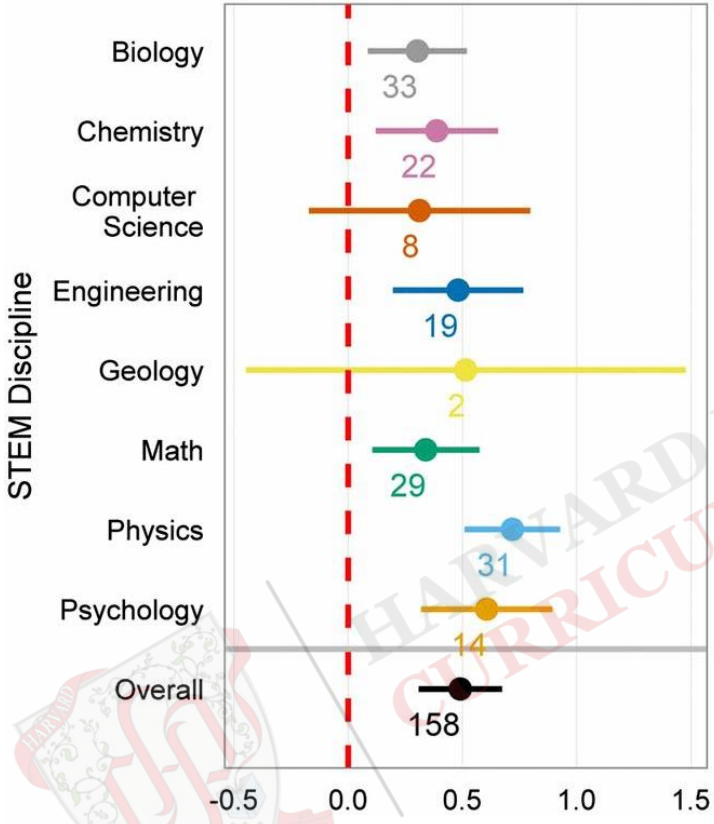




$$\text{Effect size} = \frac{\text{Exp - Control}}{SD_{\text{Control}}}$$

Deslauriers et al (2011) Science 332: 862-864

Evidence: Active learning improves student outcomes



General meta-analyses

- Science (2011) 331: 1269-1270
- Review of Educational Research (1999) 69: 21-51

Disciplines: Chemistry and engineering

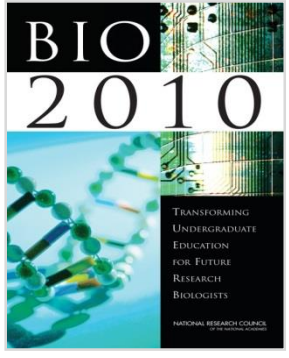
- Journal of Chemical Education (2000) 77: 116-119
- Journal of Engineering Education (2004) 93: 223-231

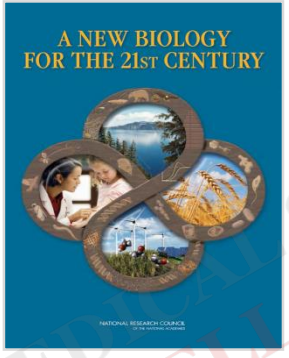
Methods: Problem-based learning

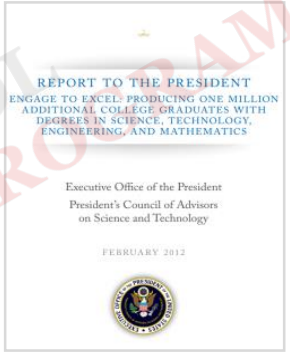
- Review of Educational Research (2005) 75: 27-61
- Academic Medicine (1993) 68: 550-563

Freeman et al (2014) PNAS 332: 862-864

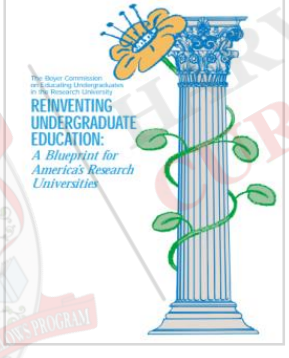
Calls for change in undergraduate education

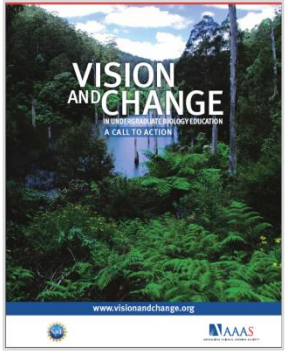






1989 1998 2003 2009 2011 2012



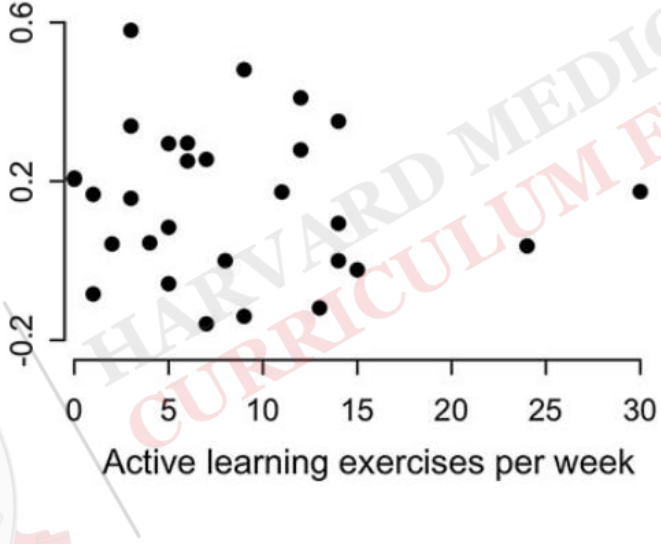


AAAS 1989 | Boyer Commission 1998 | NAP 2003, 2009 | HHMI, AAMC 2009 | NSF, AAAS 2011 | PCAST 2012

Active learning not always correlated with student outcomes

- 33 instructors and biology courses
- Pre/post assessment on evolution concepts

$$\text{Effect size (ES)} = \frac{\text{Post - Pre}}{SD_{Pre}}$$

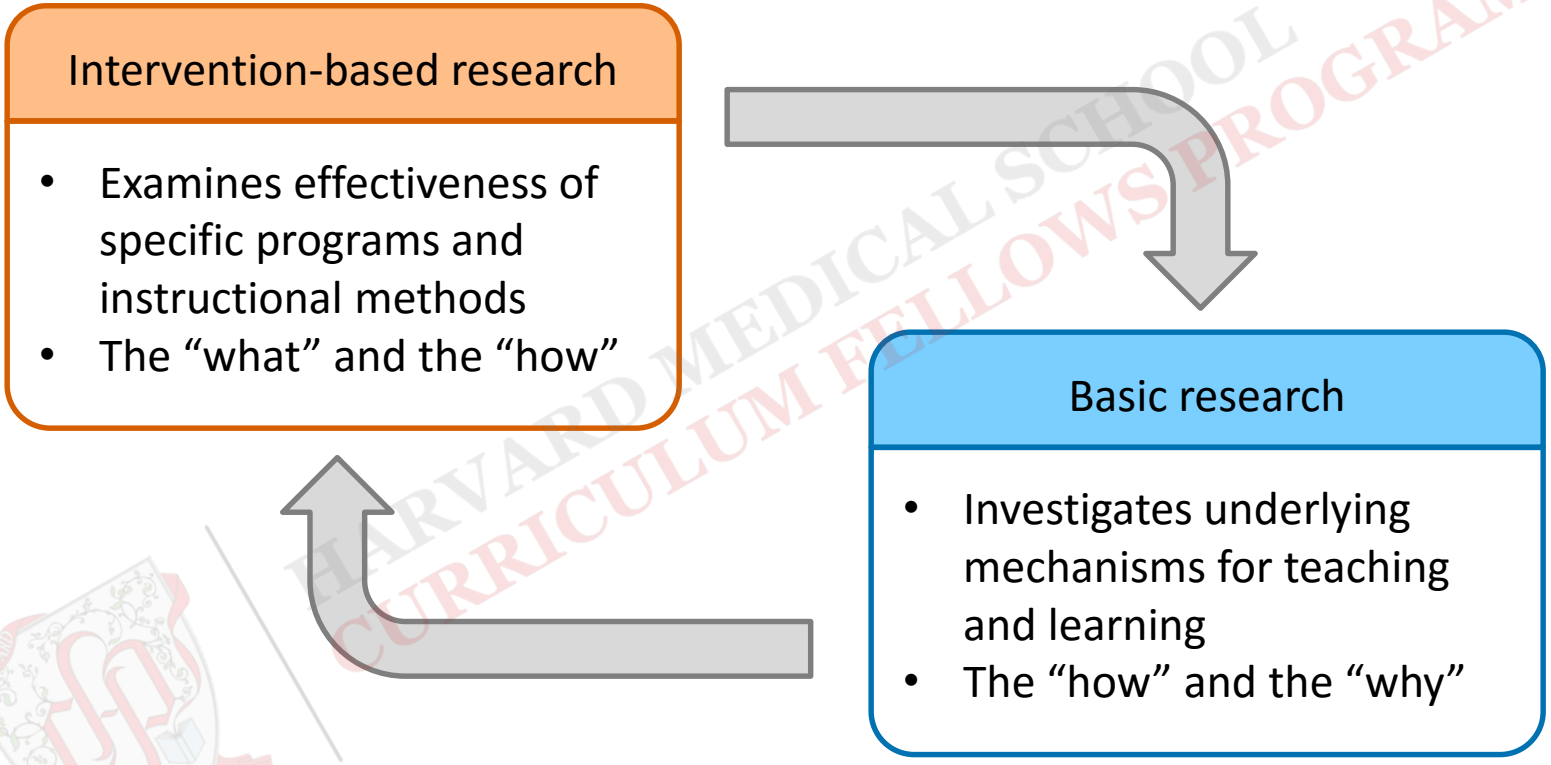


From K-12 literature

- Journal of Research in Science Teaching (2012) 49: 281-304
- Educational Researcher (2006) 35: 15-24
- Science Education (2003) 87: 564-573
- Review of Educational Research (2002) 72: 433-479
- Harvard Educational Review (1996) 66: 1-26

Andrews et al (2011) CBE Life Sciences Education 10: 394-405

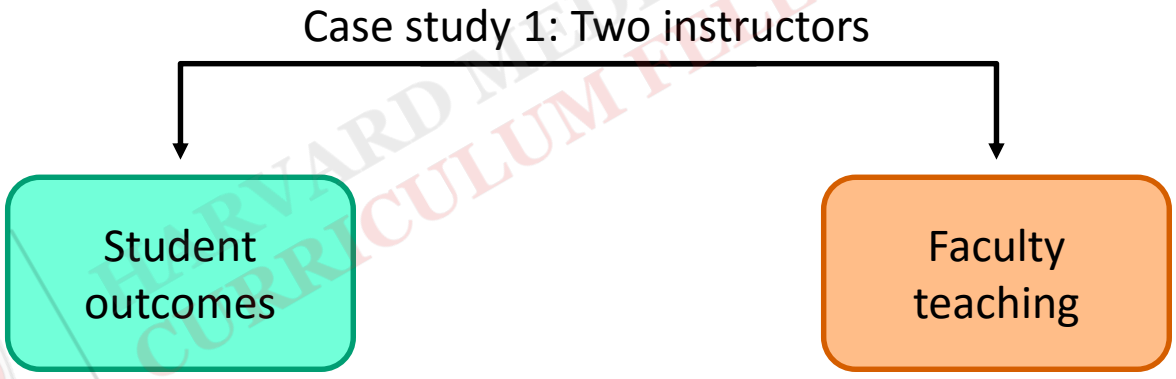
Discipline-based education research (DBER)



Case studies on faculty teaching and student outcomes

Case study: In-depth examination of distinct, single instances of a phenomenon

- Unusual cases to probe problematic situations (case study 1)
- Maximum variation to explore a range of different settings (case study 2)



Case study 2: Three instructors

Case study 1: Connecting faculty teaching and student outcomes

Two sections of an Intro Bio course with 250-300 students per section

- Developed collaboratively by two instructors
- Included active learning: clicker questions and group activities
- Common syllabi, lecture slides, learning materials, exams
- Similar students: Equivalent cumulative GPA, SAT, demographics
- Similar time of day: MWF 10 am vs MWF 11 am
- Same physical space: lecture room with stadium seating

	Adam	Phillip
Gender	Male	Male
Ethnicity	Caucasian	Caucasian

What was different: Classroom observations by COPUS

Classroom Observation Protocol for Undergraduate STEM (COPUS)

- Record instructor and student actions in 2-min intervals

Instructor actions	Student actions
• Lecturing	• Listening
• Posing question	• Asking question
• Answering question	• Answering question
• Extended discussion	• Thinking individually
• Clicker question	• Clicker discussion
• Follow-up information	• Group work
• Moving in groups	• Whole-class discussion
• Waiting	• Presentation

Smith et al (2013) CBE Life Sciences Education 12: 618-627

Why they were different: Semi-structured interviews

Interview questions

- In general, how would you define teaching?
- What does teaching mean to you?
- What would you describe as your ideal teaching situation?
- What are the key components of teaching?
- What makes a good teacher?

Data collection and analysis

- Two interviews out of larger data set (16 total interviews)
- Transcribed verbatim and blinded
- Analyzed using existing framework
- Two independent raters: 88% agreement

Conception, approach, and practice of teaching

Conception
- Attitudes and beliefs
- The “why”

Approach
- Intentions and strategies
- The “how”

Practice
- Actions and behaviors
- The “what”

Strips organization: What are different conceptions of teaching?

Conceptions of teaching: Combination of attitudes and beliefs about teaching, what someone sees as the purpose of teaching, the "why" of teaching

"Sometimes you have to not push them through it but lead them through the forest a couple of steps ahead the first time. (…) You're guiding them. (…) And then the hope is that they do this and learn from that. But then they have to be able to try to go through the forest on their own (…)."

"[I]t's about learning how to solve their own problems or the problems they encounter, so teaching for me is enablement. (…) Enabling an individual to encounter new problems and self-solve them. That's teaching to me."

"I provide them with all of the basic information that they need to learn the material, and there are many complaints because they say the exams are at a much higher level, but that's their job."

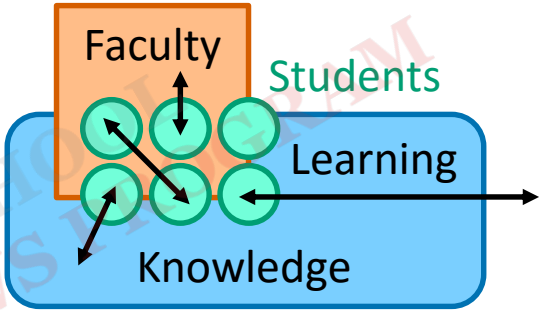
"Fundamentally, [teaching is] changing someone's understanding of the world by making it deeper and in-line with the scholarship of what is rigorously true according to our scientific methods."

"But it's not that important for you to understand how those facts were arrived at or those systems were developed. You just need to learn them. And in that case I think it's important for people to be presented with those systems."

"[Y]ou can't really teach people. You can facilitate that, but they have to do it. And so I see my place as more of a facilitator now. (…) I would want them (…) to still remember the core principles that were taught in the course…"

Arrange excerpts into different conceptions of teaching based on any categorization

Development conception of teaching



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Development
Facilitate construction of knowledge
Teaching is by-product of learning
Teaching as two-way conceptual exchange
Focuses on learning

Summary: Conception, approach, and practice of teaching

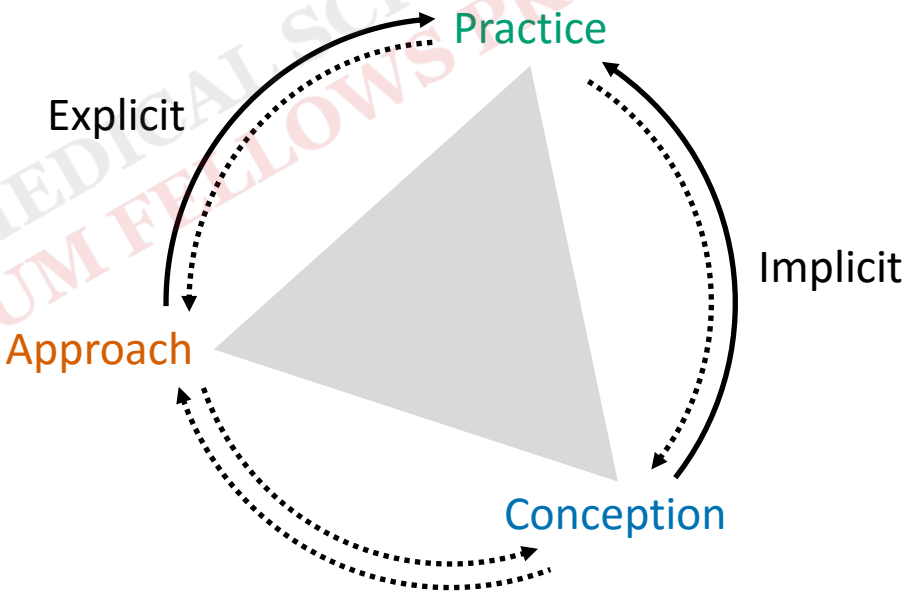
Existing model in literature

Conception
- Attitudes and beliefs
- The "why"

Approach
- Intentions and strategies
- The "how"

Practice
- Actions and behaviors
- The "what"

Our current hypothesis



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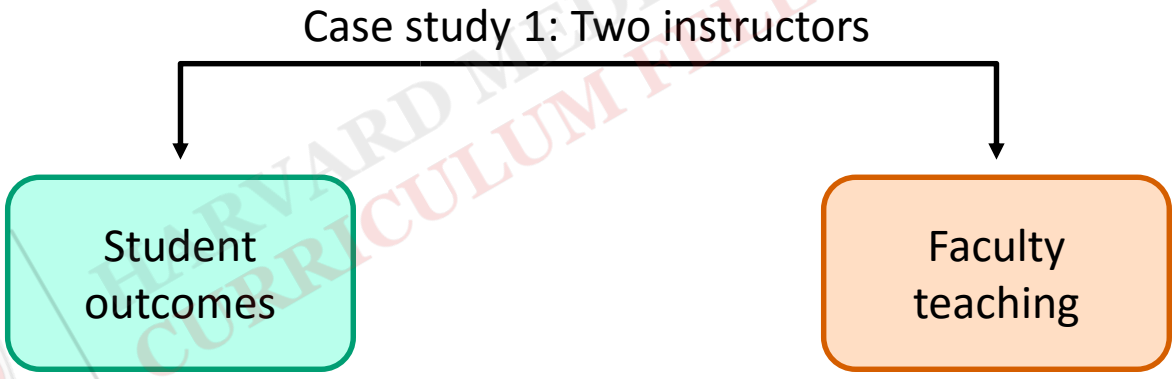


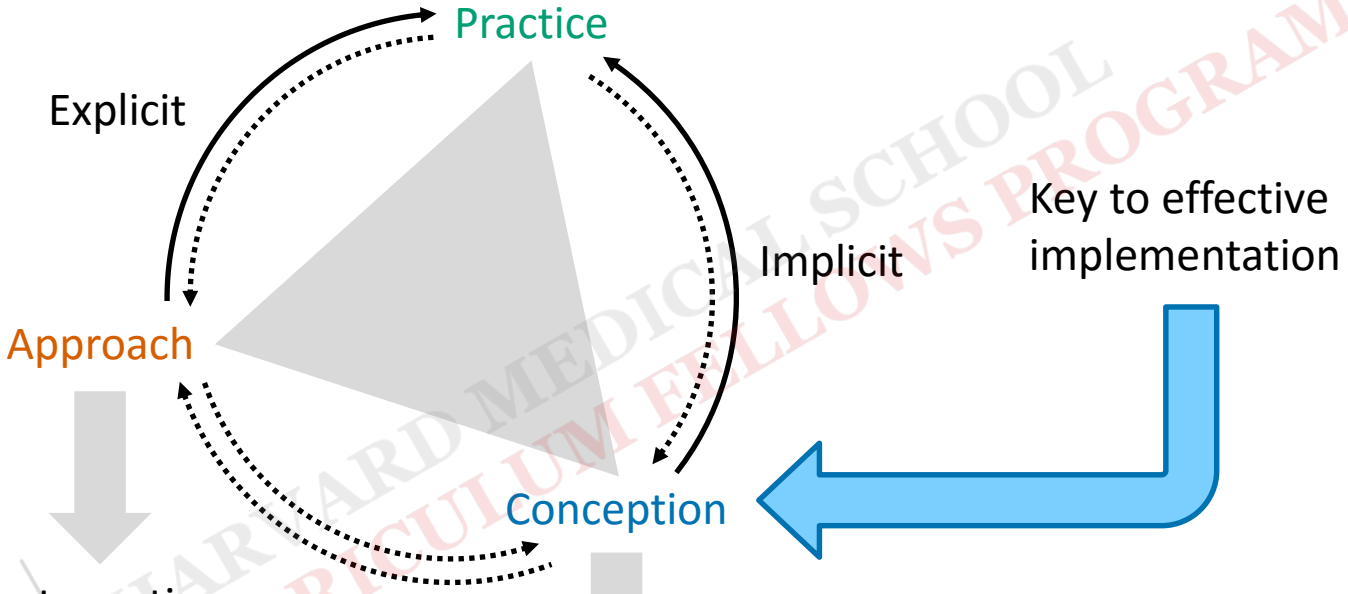
Case study 2: Three instructors

Case study 2: Dissecting faculty teaching

- Three different Intro Bio courses with 200-300 students
- Active-learning approaches: clicker questions and group activities

	Phillip	Adam	Charles	Luke
Gender	Male	Male	Male	Male
Ethnicity	Caucasian	Caucasian	Caucasian	Caucasian
Active leaning approaches	Clickers Groups	Clickers Groups	Clickers	Groups

Our current model: What makes active learning effective?



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