03 The Story of PER

Wednesday, August 14, 2013   12:37 PM

Next topics:
Why active learning? The Story
Alignment of assessment to learning objectives
Concept question/ clicker pedagogy best practice
List of other active learning techniques

Module LOs:
Participants will write an activity to assess their LO
Participants will appreciate assessment in the context of course design

The Story of P.E.R. (Physics Education Research)

Take notes! I'll ask you to exchange them at the end.

Chapter 1: The Instrument
1985: Instructors at Arizona State University

Halloun, Ibrahim Abou, and David Hestenes. "Common Sense Concepts about Motion." *American Journal of Physics* 53, no. 11 (November 1985): 1056–65. https://doi.org/10.1119/1.14031.
Found that students were not understanding basic Newtonian physics, even if they could solve quantitative problems.

Started developing the Force Concept Inventory. Administered pre- and post- course.
% of concepts learned was ~15%.

The accompanying diagram depicts a semicircular channel that has been securely attached, in a **horizontal plane**, to a table top. A ball enters the channel at "1" and exits at "2". Which of the path representations would most nearly correspond to the path of the ball as it exits the channel at "2" and rolls across the table top.
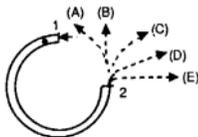
Hestenes, David, Malcolm Wells, and Gregg Swackhamer. "Force Concept Inventory." *The Physics Teacher* 30, no. 3 (March 1, 1992): 141–58. https://doi.org/10.1119/1.2343497.
"Specifically, it has been established that
(1) commonsense beliefs about motion and force are incompatible with Newtonian concepts in most respects,
(2) conventional physics instruction produces little change in these beliefs, and
(3) this result is independent of the instructor and the mode of instruction."
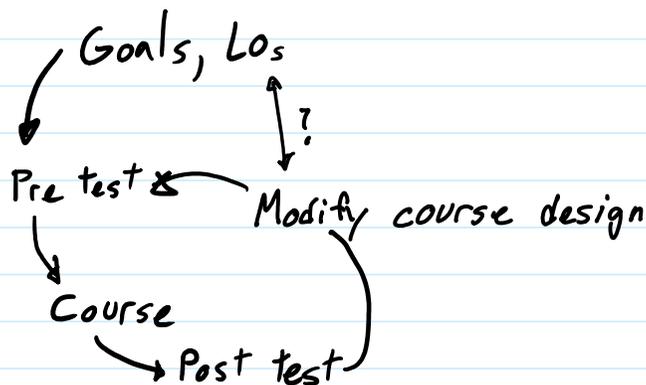
FCI was a 'validated instrument', capable of measuring the efficacy of 'teaching interventions'

Chapter 2: Successful intervention

Eric Mazur, an award winning physics lecturer at Harvard, started using the FCI and found that even the best students with the best instructor only learned 15% of concepts.
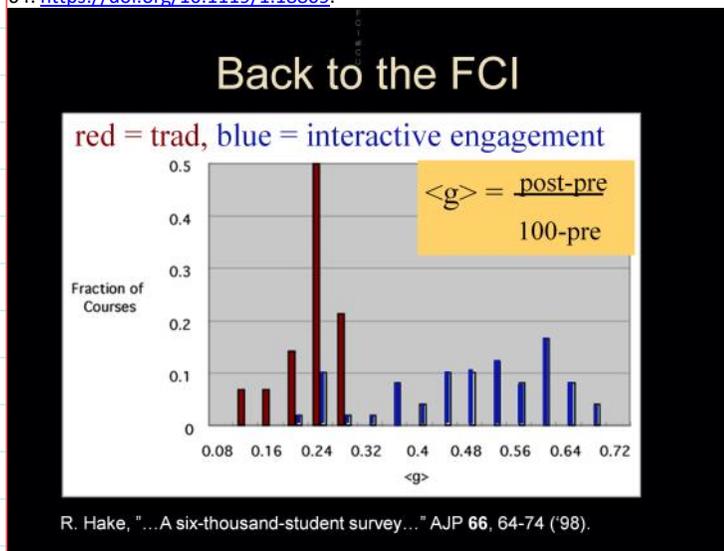
Started developing 'active learning techniques': Peer Instruction, ConcepTests. Early 1990's.
Mazur, Eric. *Peer Instruction: A User's Manual*. Upper Saddle River, N.J.: Prentice Hall, 1997.
Qualitative multiple choice questions, in class, with students discussing answers with each other.

Chapter 3: The Proof

Hake, Richard R. "Interactive-Engagement versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses." *American Journal of Physics* 66, no. 1 (1998): 64. https://doi.org/10.1119/1.18809.

Back to the FCI

red = trad, blue = interactive engagement

$$\langle g \rangle = \frac{post\text{-}pre}{100\text{-}pre}$$

R. Hake, "…A six-thousand-student survey…" AJP **66**, 64-74 ('98).

Chapter 4: The Birth of a Research Community: PER which Spawned DBER

Research by disciplinary 'hard' scientists: Discipline-Based Education Research.
Believable quantitative results; bridged gap to and repaired reputation of education research.
Range of interventions
Extension to engineering, chemistry, biology, all STEM topics. Exploration of best methods to teach each topic.
Education sessions at professional society research meetings. Devoted journals: Phys Rev PER, JEE, JChemEd,

Both theoretical and applied (practice oriented) research. Gaining recognition as a valid area of scholarship within STEM disciplines. Collaboration with schools of Ed, educational psychology, neuropsych, anthropologists, etc. is encouraged.

## Chapter 5: Why does this work? Theory
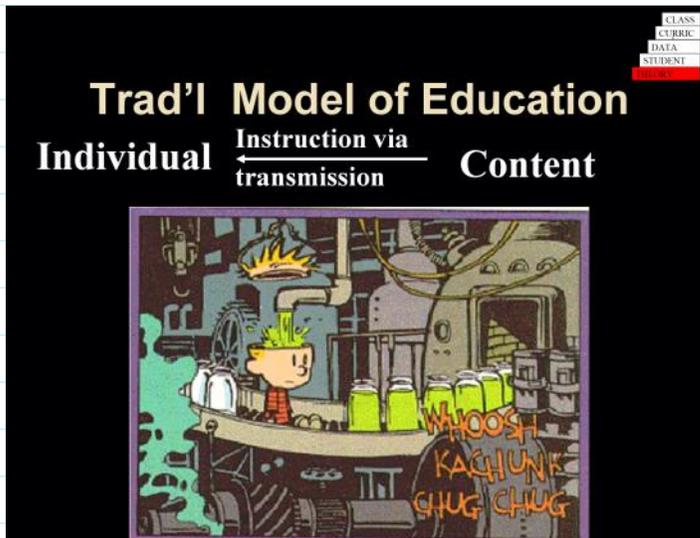
Sage on the stage	Traditional approach	Teacher -centered
Vs		
Guide on the side	Constructivist approach	Student-centered

Jean Piaget's (1936) theory of cognitive development explains how a child constructs a mental model of the world. He disagreed with the idea that intelligence was a fixed trait, and regarded cognitive development as a process which occurs due to biological maturation and interaction with the environment.

From <https://www.simplypsychology.org/piaget.html>

Lev Vygotsky's (1934) sociocultural theory of human learning describes learning as a social process and the origination of human intelligence in society or culture. The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of cognition. Vygotsky believed everything is learned on two levels. First, through interaction with others, and then integrated into the individual's mental structure.

From <http://www.ceebl.manchester.ac.uk/events/archive/aligningcollaborativelearning/Vygotsky.pdf>

Figure 1[1]: Vygotsky's Zone of Proximal Development
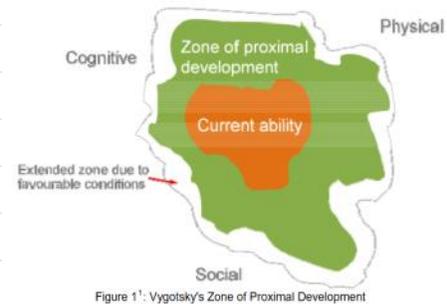
Practice oriented text: Bransford, John D., Ann L. Brown, Rodney R. Cocking, and others. *How People Learn*. Washington, DC: National Academy Press, 2000. http://csun.edu/~SB4310/How%20People%20Learn.pdf.

Chapter 6: Hot Topics Today
Why such a big range; what are the best active methods?
Why do faculty not adopt evidence based methods?
What happens to diverse students?

Activity: Exchange/compare notes with a neighbor.
What did you agree was important? Did you miss anything? Did you catch something your neighbor missed?