The first person to arrive at your table has a job.

• Look for an envelope containing colored cards and a piece of paper.

• Enter the requested information on the piece of paper, either a number or tally a “yes” or “no” for each question.

• When the proceedings begins, someone please add up the value in the “years teaching” category, and sum the tallies.
Research-based practices in STEM education: What’s the research, where is it from, where is it taking us

Christopher F. Bauer
Dept. of Chemistry
University of New Hampshire

Fostering Academic Success in STEM,
Ctr Excellence & Innovation in Teaching and Learning, Apr18
I started my life as an analytical chemist.

Colorado State Univ. PhD Chemistry, 1979

Nonmetal emission in helium microwave plasmas
I did research as an analytical chemist

Anal. Chem. 1986, 58, 176-182

Co-authors:
Natusch, Skogerboe, Andren, Grant, Jenkins, Kheboian, Wouters, Van Grieken, Linton
I taught as an analytical chemist

Quantitative Analysis
  Instrumental Analysis
  General Chem for Engineers

  Spectrochemical Methods
  Electrochemical Methods
  Electronics
  Statistics & Experimental Design
I make my lectures clearer every year, but the students aren’t getting it better.

Students must be getting dumber.

I need to get smarter.

Where is the state-of-the-art?
Young people are distracted with all the complexities of our modern life. Stone

Only a small percentage of our graduates will take more chemistry. Roe

It is not fair, he feels, if problems differ in the from those in the book. Wakeham

The average student in college freshman chemistry courses is arithmetically infantile. Scott
Young people are distracted with all the complexities of our modern life. 1924

Only a small percentage of our graduates will take more chemistry. 1930

It is not fair, he feels, if problems differ in the from those in the book. 1934

The average student in college freshman chemistry courses is arithmetically infantile. 1938
Laudan (‘84), via Duschl (‘90), via Abrams & Wandersee (‘95)

Theories  ←  Methods  →  Aims

Triadic model for the growth of scientific knowledge
Laudan (‘84), via Duschl (‘90), via Abrams & Wandersee (‘95)

Triadic model for the growth of **SCIENTIFIC EDUCATION** knowledge

Theories ↔ Getting better ↔ Methods ↔ Aims
• Web picture of children in canoe paddling in opposite directions
Laudan ('84), via Duschl ('90), via Abrams & Wandersee ('95)

Triadic model for the growth of scientific knowledge
If you want to get ahead, get a theory.
Karmiloff-Smith & Inhelder, 1975, Cognition 3(3), 195-212

Behaviorism

Constructivism

Developmentalism

Meaningful learning

Attitudes and beliefs

Social constructivism

Cognitive motivation theory
Hold up
Blue 7-8
Yellow 5-6
Green 3-4
Pink 0-2
What goes on inside students heads?

Cognition

• **Constructivism**
  – Knowledge is constructed within individual minds
  – Knowledge construction is mediated by social discourse

• **Information processing, recognition, recall**
  – Awareness and perception
  – Short-term memory capacity
  – Long-term memory structure
  – Pattern recognition