The Critical Need for Professional Development for Physics Teachers

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Outline

- Physics and the need for Professional Development
- What do we know about cognitive issues in Physics Education?
- An example of active learning in Physics: Some aspects of Buoyancy
- Evidence for Active Learning in Physics
- Conclusions

Why Professional Development in Physics?

- Physics is a core discipline for progress in a host of fields of science and engineering
- Physics teaches logical, quantitative thinking
- There is a commitment in Texas to raising the level of science education - this means more students will take physics
- We must insure that physics instruction is standards-based

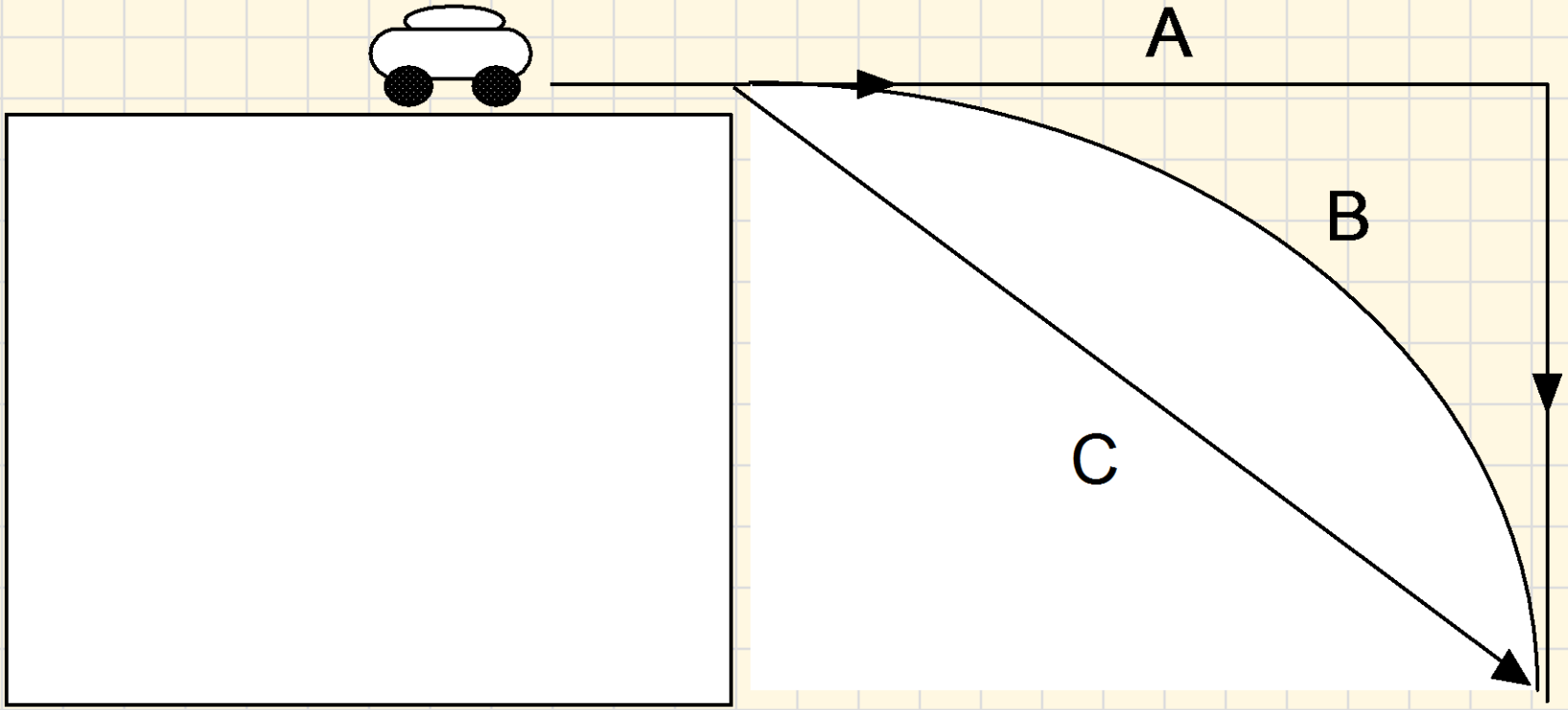
Physics and the need for Professional Development

- At your table discuss the need for Professional Development for Physics teachers - Make a brainstorming list
- Determine the top 3 needs for Physics Teacher Professional Development. Write these on the index cards provided.
- Take 6 minutes to do this. You will get a 2-minute warning.

What do we know about cognitive issues in Physics Education?

- It is well known that many students hold misconceptions about physics
- There are generally good reasons for these misconceptions - the constructivist theory of learning in practice
- Considerable research exists about misconceptions, especially in Mechanics

Which is the most correct trajectory?



The Aristotelian Complex

- Aristotle explicitly stated that force was proportion to velocity
- Most students hold this naïve conception since it matches their everyday world
- Newtonian Mechanics is non-intuitive, and many students never abandon their naïve conceptions

Experts and Novices

- Research has been done into the difference between Experts and Novices
- Main difference is the way that knowledge is organized
- For example Novices might group problems involving inclined planes together, even though some are statics problems, and others are energy conservation problems
- We should aim to produce more expert-like understanding in students

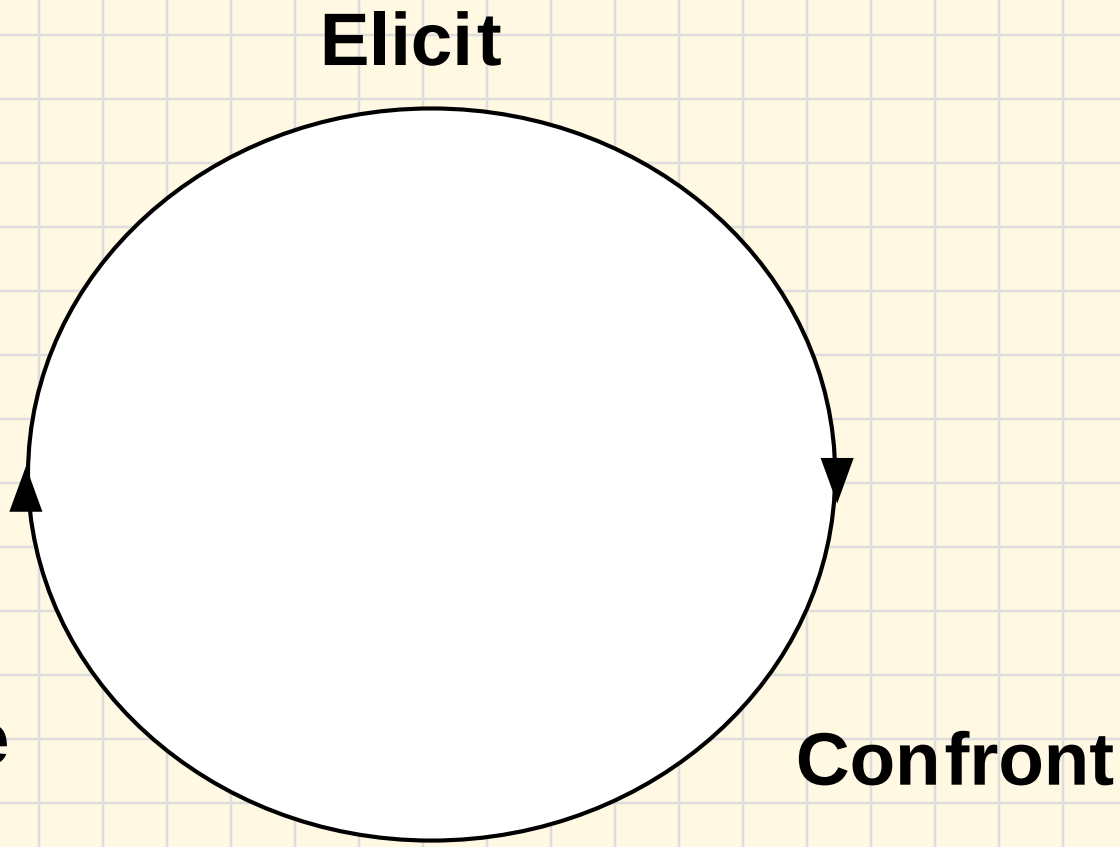
Conceptual change

- A key aspect of conceptual change is that the learner commits to something at the outset
- The learner the confronts an experience in the context of the prior commitment

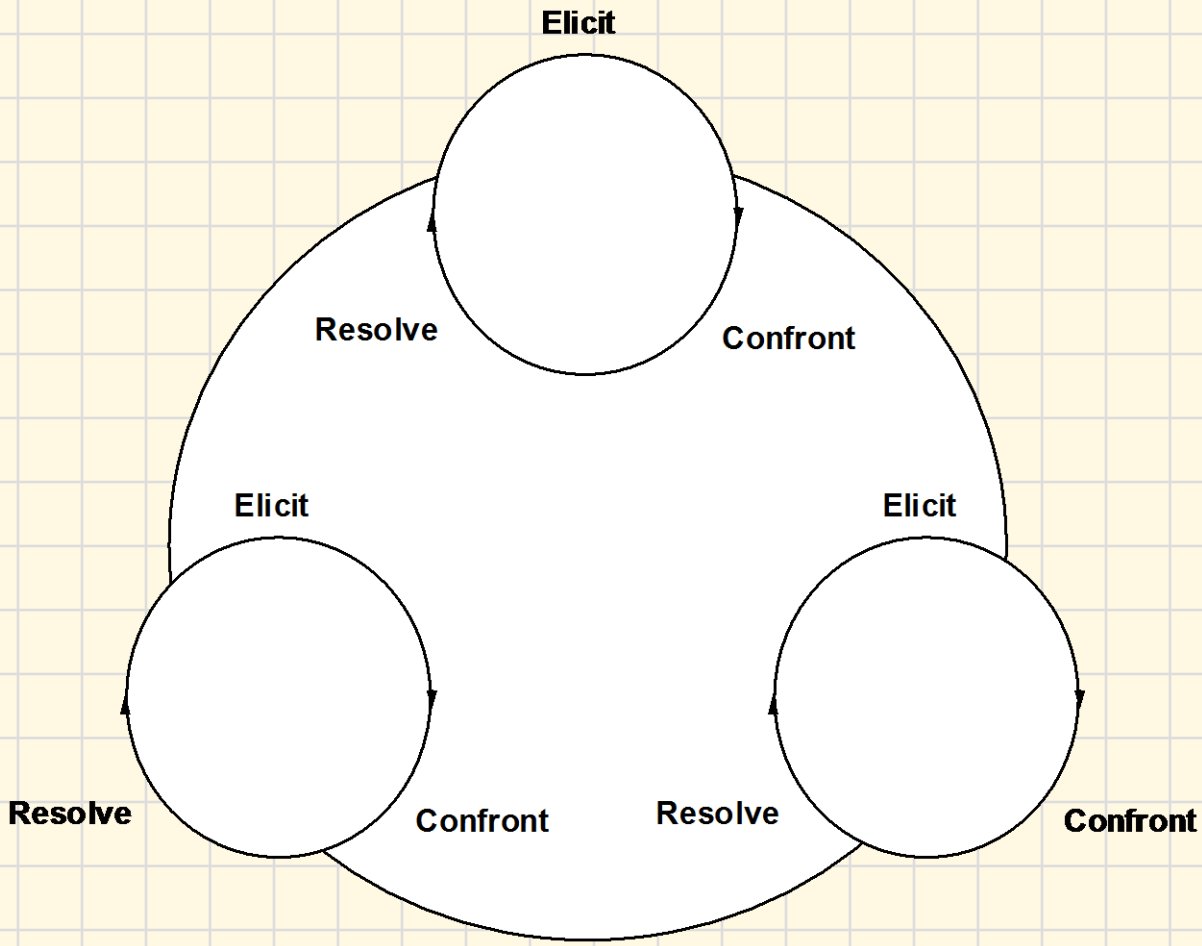
Developing Concepts - The Learning Cycle

- A pedagogical framework for developing concepts is the Learning Cycle
- Structured phases force students to commit to, then examine, their own concepts
- When specific misconceptions are known, discrepant events can be provided

Developing Concepts - The Learning Cycle

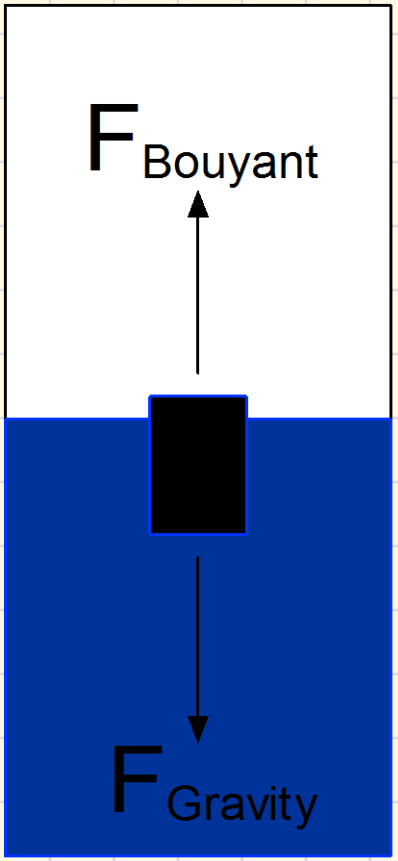


Developing Concepts - The Learning Cycle



An example of active learning in Physics:
Some aspects of Buoyancy

A Floating Cylinder



- As it floats, the cylinder does not accelerate up or down because there is no net force on it.
- The upward force is called the Buoyant Force. It is produced because the cylinder displaces liquid, which pushes back on the cylinder

The buoyant force

- An object immersed in a fluid feels an upward force equal to the weight of the volume of fluid displaced
- Objects sink if, when fully immersed in a fluid, the upward buoyant force is less that than the downward force of gravity on the object

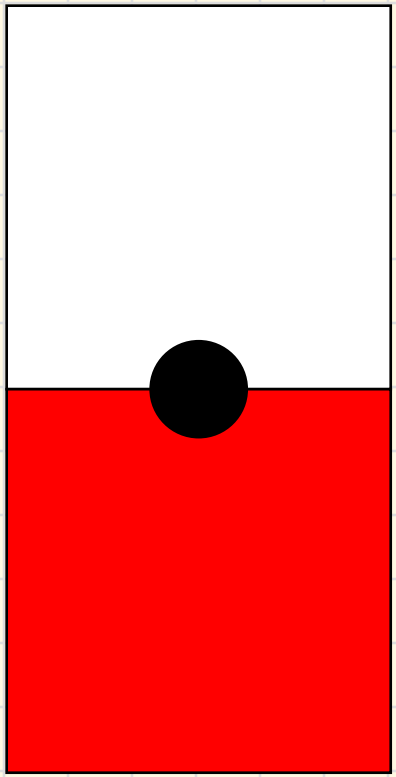
What do things weigh underwater compared to in air?

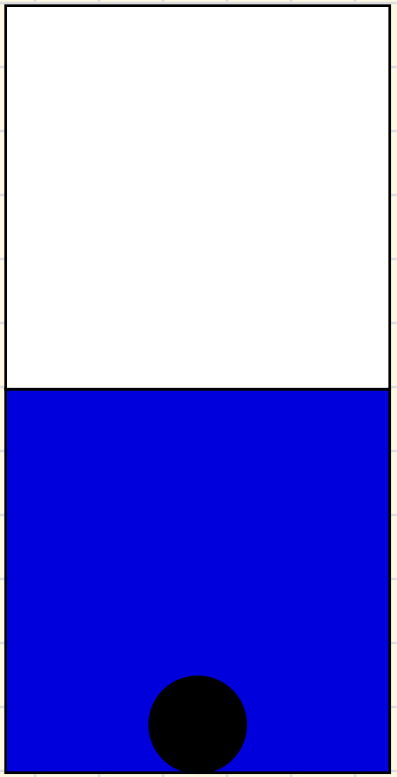
- At your table discuss this question
- If you immerse an object in water, does it
  A. Weigh the same as in air
  B. Weigh more than in air
  C. Weigh less than in air
- Take 2 minutes to discuss this

Exploring the Buoyant force

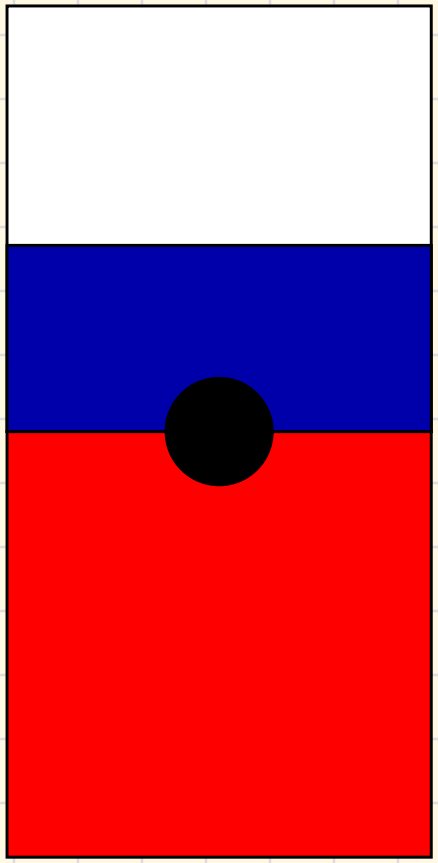
- At you table there is a spring scale and two cylinders
- Weigh the cylinders in the air and completely immersed in water
- Do you notice any systematic variation?
- Did you change your answer to the question on the previous slide?
- Take 4 minutes to do this

Ball sink in blue fluid, floats in red





When we add blue fluid to the ball floating in red -



1. The ball goes down
2. The ball goes up
3. The ball stays put

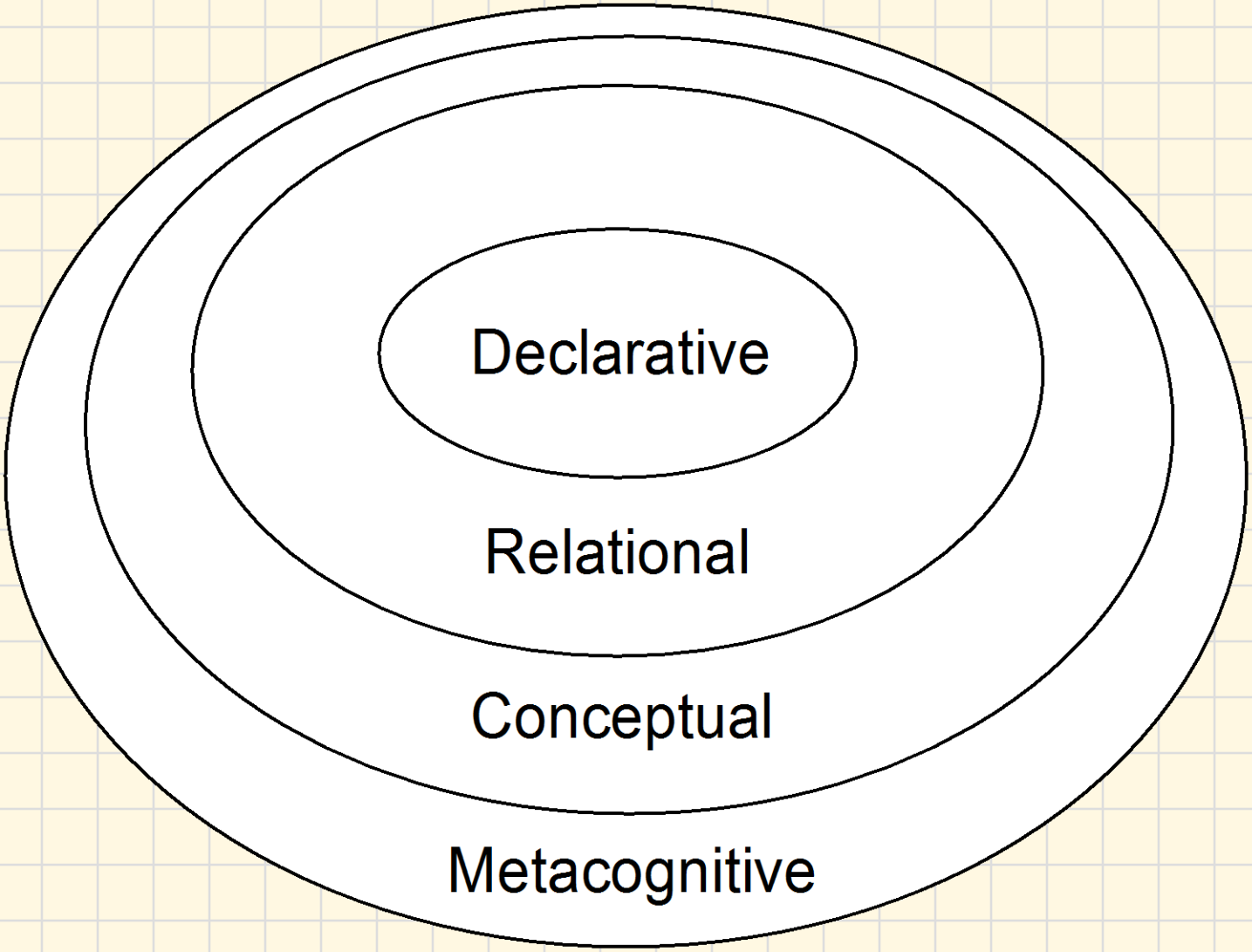
Conceptual Issues

- Distinguishing between mass and weight
- Recognizing the magnitude of the force applied on a floating object
- Misconceptions about the isotropic nature of pressure

Pedagogical Structure

- Organized along a Learning Cycle based on knowledge of Conceptual Issues - Thus inquiry is structured
- Multiple representations used
- In Professional Development there must be an explicit reflection on all of these factors along with scientific content

Hierarchies of knowledge



Evidence from Physics Education Research

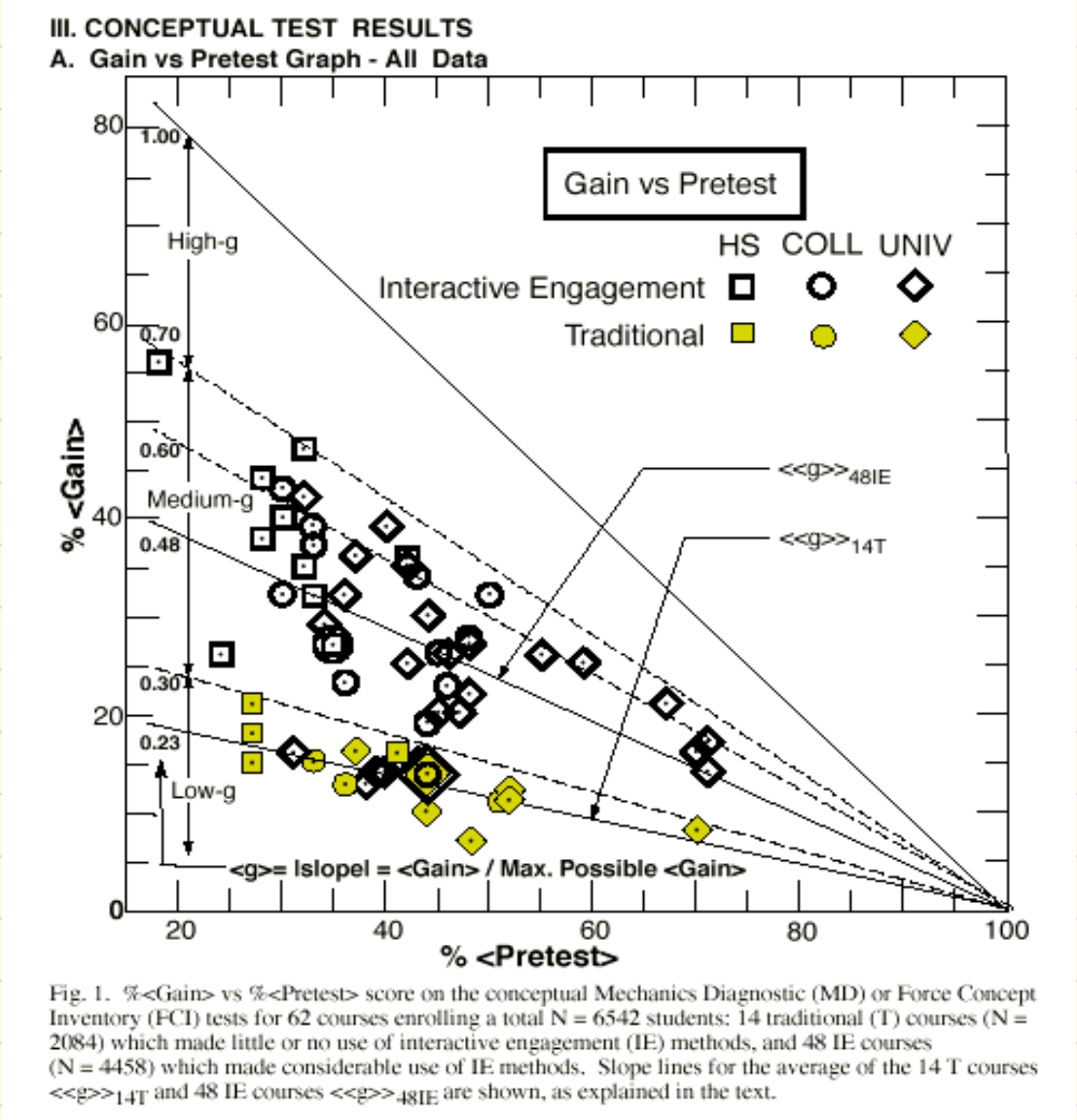


Fig. 1. %<Gain> vs %<Pretest> score on the conceptual Mechanics Diagnostic (MD) or Force Concept Inventory (FCI) tests for 62 courses enrolling a total N = 6542 students: 14 traditional (T) courses (N = 2084) which made little or no use of interactive engagement (IE) methods, and 48 IE courses (N = 4458) which made considerable use of IE methods. Slope lines for the average of the 14 T courses $\langle\langle g \rangle\rangle_{14T}$ and 48 IE courses $\langle\langle g \rangle\rangle_{48IE}$ are shown, as explained in the text.

What Kind of Professional Development is needed?

- Two areas of content knowledge at play
  - Scientific content knowledge
  - Pedagogical content knowledge
- Effective professional development must embody both areas, with more or less emphasis on either area, depending on the audience and circumstances
- PD cannot stand on it own without Materials, Materials Support, Aligned Assessment, and Community and Administrative Support