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Assessment of Conceptual Understanding

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Conceptual Knowledge

- Conceptual knowledge: “understanding of principles governing a domain and the interrelations between units of knowledge in a domain” (Perkins, 2006)
- Organization of conceptual knowledge: (Ozdemir & Clark, 2007)
 - Knowledge as theory
 - Knowledge as elements
- Misconceptions, misconceptions, misconceptions...

"It's not what you don't know that hurts you.

It's what you know that ain't so!"

Mark Twain

Concept Inventories

- First developed in physics to assess conceptual understanding of force and motion
 - Mechanics Diagnostic (Halloun & Hestenes, 1985)
 - Force Concept Inventory (Hestenes et al 1992)

“Conventional physics instruction produces little change in [common sense misconceptions about mechanics] ... independent of the instructor and the mode of instruction”
(Hestenes et al 1992)

- Since the Force Concept Inventory, concept inventories have been developed in a wide-range of topics: statics, thermal & transport sciences, circuits, statistics, material science, ...
- Recent work has also suggested several ways to improve the usage of concept inventories (e.g. Steif & Hansen 2007)

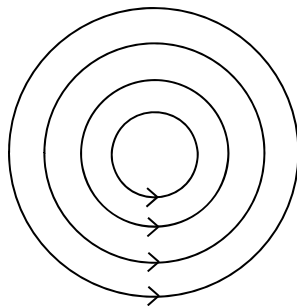
Oral Interviews and Exams

- Oral interviews (formative) or exams (summative) can provide rich information about how a student is thinking
- Useful to help identify misconceptions (important tool for the development of concept inventories)
- Can be time consuming and difficult to scale to large classes
- Improves likelihood of an accurate assessment by its dynamic nature
- Valuable, authentic experience for students
- Approximately half of our department's undergraduate courses use some form of oral assessments

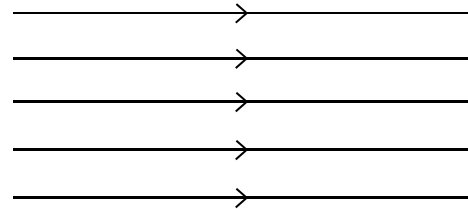
Concept Questions & Peer Instruction

- Concept questions:
 - Focus on a single concept
 - Typically multiple choice
 - More than one plausible answer based on common misconceptions

An example from fluid dynamics on the concept of irrotationality:



(a)

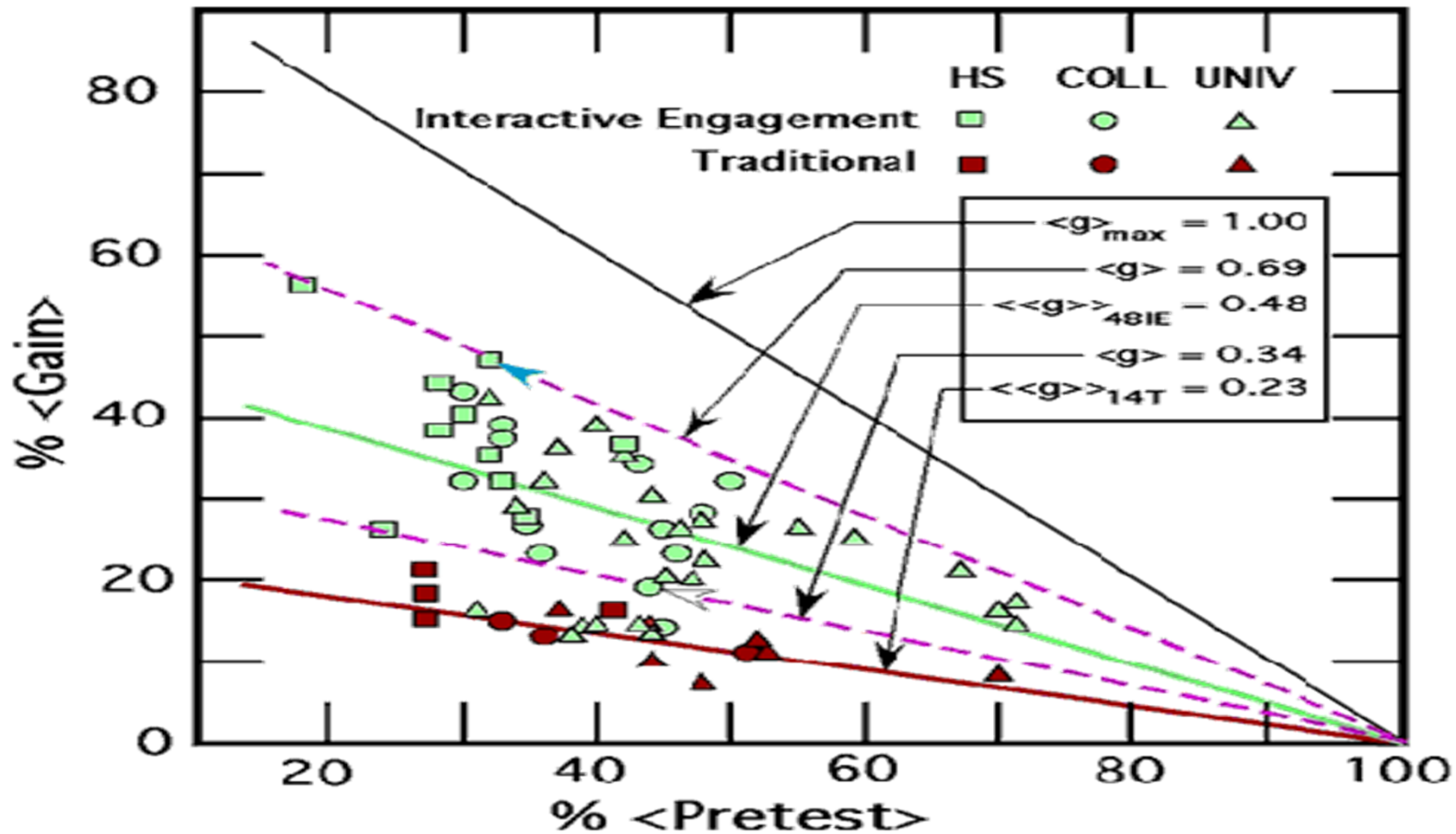


(b)

Which of these flows are irrotational?

- Concept-based active learning (Peer Instruction, Mazur, 1997)

Active Learning: Twice As Effective as Lecturing



Hake, R., "Interactive Engagement vs. Traditional Methods", Am. J. of Physics, 1998.

Student Preparation: Look-ahead Homework

(Darmofal, 2005)

- Initial implementation of concept-based lectures only gave reading assignments
- Switched to look-ahead homework due prior to discussing concepts in lecture

Typical student comments:

“I was initially opposed to the idea that I had to do reading & homework before we ever covered the subjects. Once I transitioned I realized that it made learning so much easier!!”

“Doing homework before the lectures is good... makes actual learning in lectures possible.”

End-of-semester course evaluation data

