Uses and limitations of epistemological surveys for informing course design

Timothy McCaskey, Andrew Elby, Edward F. Redish

University of Maryland

Epistemology

Rough definition: The beliefs our students have about knowing and learning, specifically in physics.

There's a difference between "personal" and "public" epistemology.

It matters! If a student thinks that physics is about memorizing equations, and you don't teach that way, there will be conflict!

Methods discussed

- The MPEX2: A multiple-choice survey that coarsely probes these beliefs in order to evaluate courses.
- A modified Force Concept Inventory (FCI) task designed to probe whether students view their formal physics knowledge as reconciled with common-sense ideas.

Research questions

- In general: What are some uses and limitations of epistemological surveys?
- What are necessary conditions for getting large MPEX2 gains?
- If MPEX2 is too crude, what can we do to probe more specific epistemological issues?

Context: We will be comparing different professors and their implementations of an introductory algebra-based course at UMD.

The MPEX2

The MPEX2 is a survey that charts what we would call “favorable” and “unfavorable” expectations *and* epistemology in physics courses.

It probes three clusters:

- Coherence (vs. “pieces”)
- Concepts (vs. “equations”)
- Independence (vs. “authority”)

MPEX2 items

Most are agree/disagree items on a five-point Likert scale. (agree-disagree)

> "Adept use of formulas is the main thing needed to solve physics problems effectively."

We also added contextual items (dialogues, hypothetical situations, etc.), and validated the items with a series of interviews.

> "Two students are discussing the value of group work…"

General MPEX2 Facts

It is adequate for evaluating the effectiveness of a course at fostering changes in targeted epistemological dimensions.

It is not

- Valid for assessing an individual.
- Factor analyzed.

(Why not? Our resource model disagrees with this method of survey design.)

Previous work

AAPT talks by Redish, McCaskey, and others have shown that large gains on MPEX are possible if

- the professor's goals include fostering epistemological development
- the professor has a stable, constructivist epistemology regarding his or her students
- the course materials support this goal

What if one of these conditions is missing?

Old evidence

One author (EFR) used to get losses* on the original MPEX even though

- he really wanted students to adopt favorable epistemological views
- he “taught to the test”!

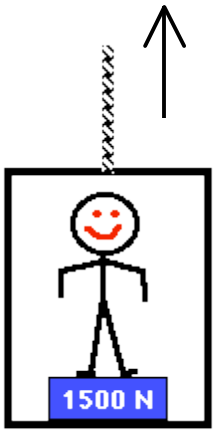
* Redish, Saul, Steinberg, AJP, 1999.

Having the goal of epistemological development is not enough.

The tutorials' epistemological focus

Our tutorials focused on reconciling and epistemological development.

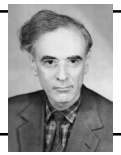
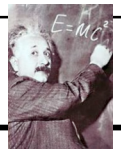
Example: "You can look at the net force on a person lifted at constant speed and see that it's zero. Why did you think the up force was greater?"



Also included reflection questions: "Why did we do that last page?" and the like.

Passing the course along

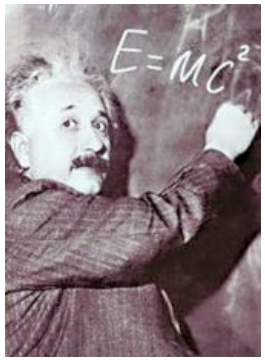
The course (PHYS 121 – intro algebra-based mechanics) was largely developed by Redish; he taught it for four years. ~120 < N < ~160

	A's tutorials	A's lecture slides	A's homework
* Prof. A 	✓	✓	✓
Prof. B	✓	✓	✓
Prof. C 	✓		

* Redish

More about B and C

B 

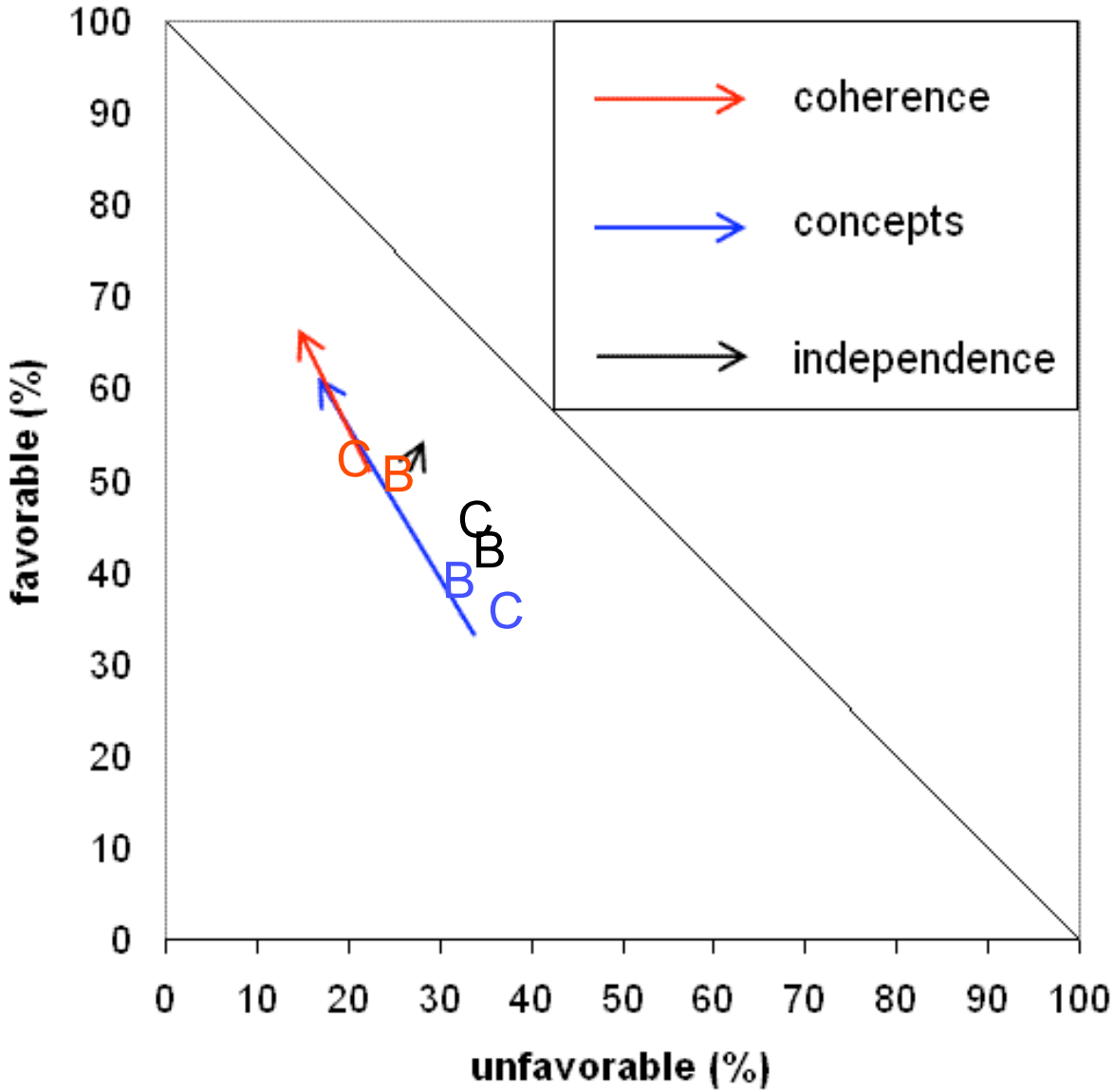


C

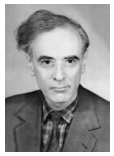
B had epistemological development goals and was interested in what we were doing in PER, but was inexperienced.

C didn't pay close attention to what our tutorials were doing (but is a distinguished lecturer).

With B and C post-test for comparison

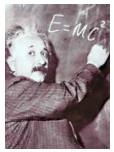


A



B

C



Differences in epistemological development between B and C's students

- We did not find statistically significant differences between their MPEX2 (and FCI) scores.
- What about a more sensitive probe?
  - Look at *reconciling* between physics concepts and common-sense ideas.
  - Our split task makes this possible.

Why did B's class reconcile more?

One possibility: Reconciliation-intensive Newton's Laws tutorials were taken more seriously by B's students.

- B's homework and exams explicitly included tutorial material. C's did not.
- Tutorial was optional for both instructors, but attendance was better in B's sections.

Our course is a complex system

Claim: These differences helped B's students in the epistemological "reconciliation" sense.

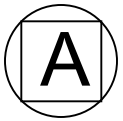
There are tests, homeworks, and lectures involved. Any of these could contribute to conceptual or epistemological results.

The FCI split task

We introduced this previously at AAPT (McCaskey, Elby, Dancy)

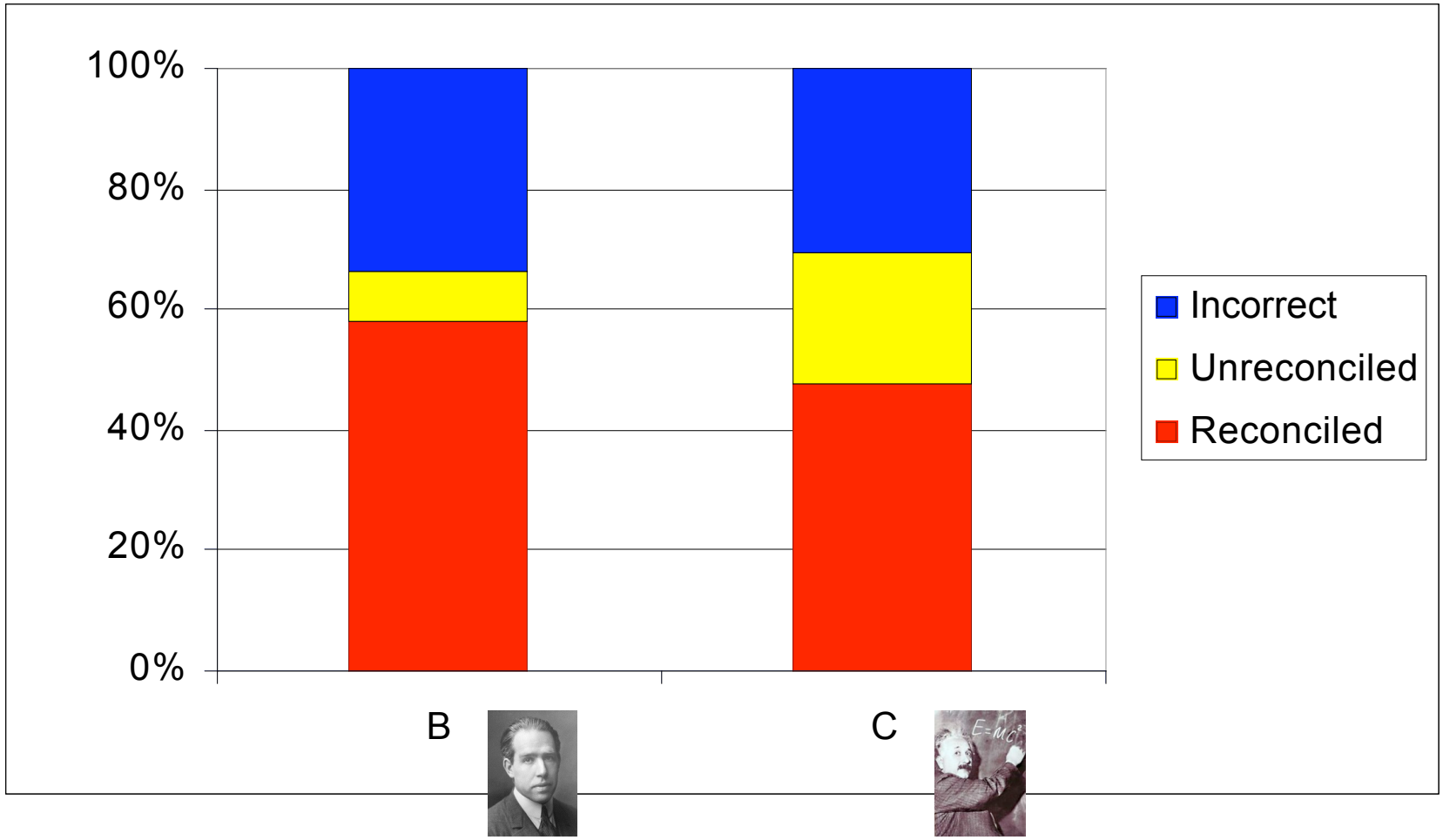
The task:

> Circle the answer that makes the most intuitive sense to you. Square the answer you think a scientist would give.



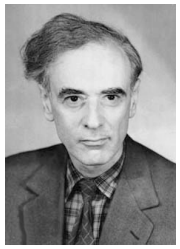
If these agree on a correct answer, that is evidence that students have reconciled.

B vs. C:
Reconciling Newton's Third Law

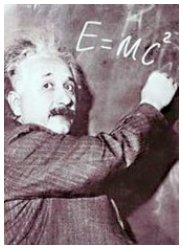


Other instructors and N3

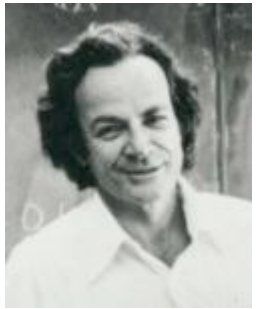
For comparison, let's look at four classes given the same task:



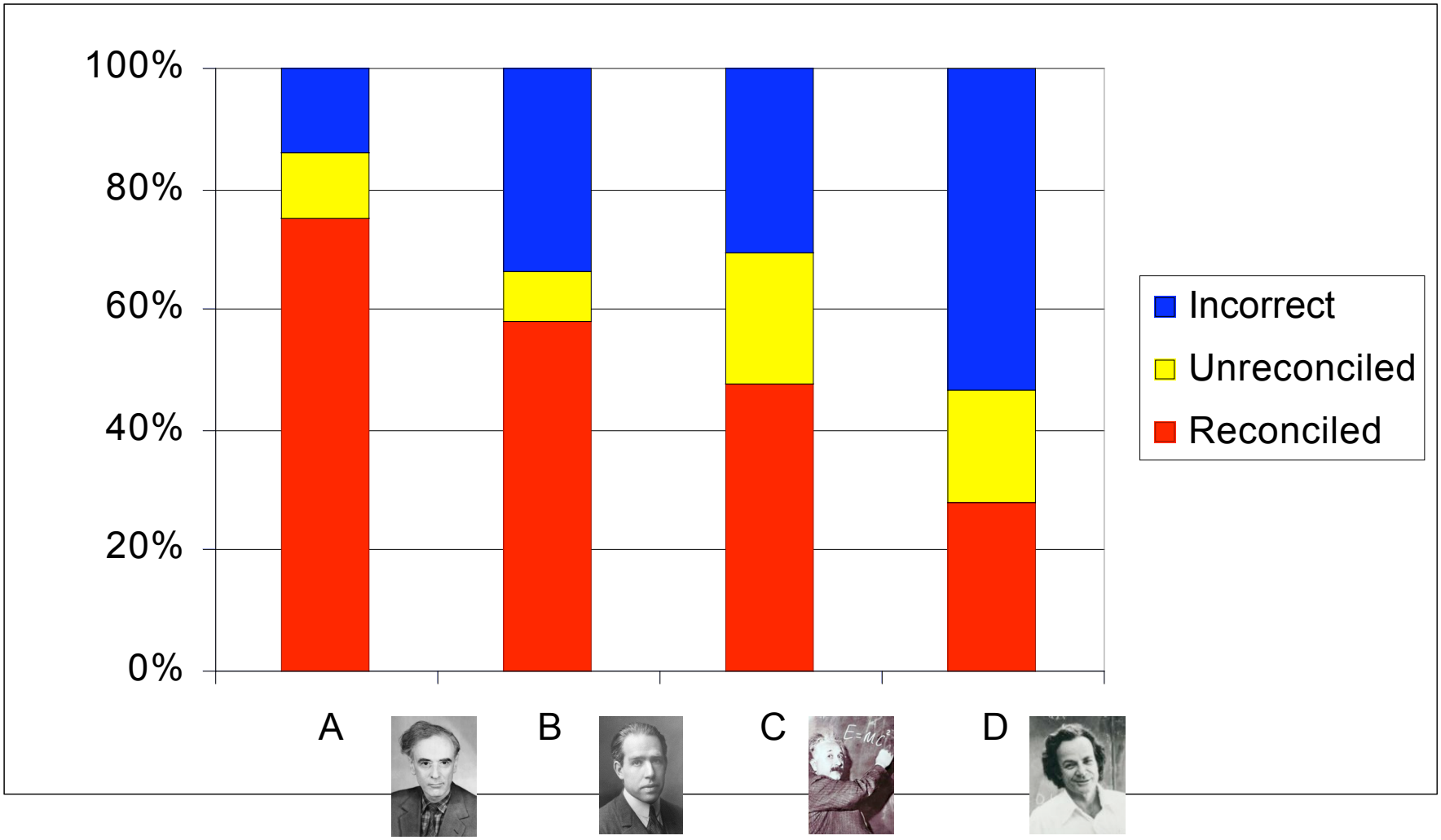
- Professor A, after having used epistemologized tutorials for years



- Profs. B and C, introduced already (the previous slide)
- Professor D, traditional, no tutorials



Reconciling Newton 3 (by prof)



Conclusions

- The FCI split task is more sensitive than the FCI (alone) or MPEX2 at detecting a particular aspect of student learning: reconciliation.
- The MPEX2 was too crude to separate Profs. B and C well. To learn about reconciliation specifically, we needed a new instrument.

A philosophical point

When we wanted to study a specific epistemological issue (such as attitudes toward reconciliation), the MPEX2 was too crude and broad in scope.

We sometimes need highly-targeted assessments to address highly-targeted research questions.

tim.mccaskey@gmail.com