What Differences in Students' "Belief" and "Understanding" May Mean



Tim McCaskey UMD PERG 12/17/03

Outline

- Discussion of prior study
- Motivation for the interview project
- Interviews (subjects and protocol)
- Patterns in the interview data
- Pre/post quantitative results
- Summary / future ideas

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Research Questions

- Do students taking standardized physics tests really believe the answers they put down?
- What happens when students are asked to distinguish their belief and understanding?
- Are there any gender effects?



Our Populations

Two large classes from Univ. of Maryland (UMd) – a large, public university
One small class from Davidson College (DC) – a small, private school

All students were introductory (algebra-based) physics students. UMd took this as a pretest, DC as a posttest

Our FCI Study

We had students go through the FCI once in the standard way. After that, we had them make a *second* pass with the following instruction:

Please circle the answer you really believe.Please draw a square around the answer you think scientists would give.



The Student Task - Splits

- 4. A large truck collides head-on with a small compact car. During the collision:
- (A) the truck exerts a greater amount of force on the car than the car exerts on the truck
- (B) the car exerts a greater amount of force on the truck than the truck exerts on the car
- (C) neither exerts a force on the other, the car gets smashed simply because it gets in the way...
- (D) the truck exerts a force on the car but the car does not exert a force on the truck
- (E) the truck exerts the same amount of force on the car as the car exerts on the truck



Unusable Data

We had to throw out the following data:

- All data from students who left more than five blanks on any one of the three FCI passes
- Any split caused by a blank space in any of the passes



- Scores are higher for males than females, and the gap closes on "scientist answers."
- The number of splits is higher for females in every category.
- Depending on the school, males and females had different distributions with regard to their first pass agreeing with "belief" or "scientist"

The number of splits...

Splits on FCI



Further Questions

- Low splitters: are they authority driven?
- High splitters: do they distrust "scientist answers" such that they don't reconcile?
- Why do women split their answers more often, and do men and women split for the same reasons?
- What does all this say about FCI validity?
- Would this have any implications for teachers?

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Why Do The Interviews?

- Maybe the number of splits can tell us something about a student's epistemology.
- Is it possible to get at the cause of the gender effect (women split more?)
- Why do they say they split? Are they following my directions?
- What's their attitude toward reconciling?

Answer Key to Previous Slide

- Number of splits alone won't tell you much.
- Women may split more simply because they score lower, and lower scorers tend to split more.
- They split for a variety of reasons, one of which is they don't follow the letter of my instructions.
- Many low *and* high splitters believe they can reconcile in the context of tutorials.

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New Procedure

- Given to FS03 PHYS121 class (UMD).
- No first pass given
- Also given at the end of the semester (first pre-post implementation)



Subjects

I interviewed nine people for a half hour each. These are current PHYS 121 students, and the dates ranged from 10/10/03 – 10/24/03.

Initially, the goal was to interview people that didn't split at all, only split once or twice, or split a lot (>10 times).

General Protocol

- What's your major/year in school?
- Why are you taking this course?
- Had you had physics in high school?
- If so, do you feel you got a lot out of the class?
- How do you know someone is an expert? (*)
- What do you do when experts disagree? (*)
- How do you know when you understand something? (*)

Questions marked (*) from Belenky, WWK

Specific Protocol

- Here was the task we gave. Before going into it, did it seem to make sense that we were asking you to do this? Why or why not?
- (for frequent splitters) Why do you believe the answer you circled? Why do you think scientist would give the square answer? Is it worrisome that there's a difference? Do you think the scientist could be convinced to see your point of view? What would it take? Do you think you could be convinced of the scientist's view?

Specific Protocol

- Low splitters got the same questions as some of the high splitters. We also asked if there was anything special about the ones they split on.
- People that don't split at all had less to answer.
 I found some questions they had gotten wrong to see if they had changed their mind since instruction.

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General Data Patterns

- People who don't split don't see why one would.
- Often, a "split" acted as a "hedge," a way to indicate your two top choices without having to pick only one.
 - Corollary: We did not see cases where a split indicated belief in "two correct answers" or "both answers are equally true."
- Scientists "make things complicated," and their "scientist answers" reflected this belief.

More Data Patterns

- The expertise question gave evidence that students have multiple, contextdependent epistemological resources.
 – Different "kinds" of experts?
- What they thought of as "understanding" varied:
 - Sometimes is not consistent with behavior!

Why Bother Splitting?

Sarah: The only thing I didn't like was that every time I thought an answer would be right, I figured that's what a scientist would say too, so a lot of them ended up being a circle and square around the same one.

Why Bother Splitting?

Christine: It was confusing in a lot of them, because if you're looking for the *right* answer...

- I: Mmmhmm.
- C: You know, what you believe, then you're gonna assume that the scientist is gonna give a right answer too. So, if you're really confident in your answer, it seems sometimes repetitive.

Splits as confidence indicators

Emily: "Yes. And then for the ones where my circle and square were on different choices, I thought maybe it was just my intuition-based answer, so then a scientist might say something different because it wouldn't... they would be basing their answer on... facts, I guess."

Splits as confidence indicators

- Leila: "Because there are some things that I was like, OK, I have no physics, so this is what I think, but somebody with more physics would probably... you know... you know how sometimes you narrow things down to two answers?
- I: Yes.
- L: So, I picked the one I would pick, and I squared the one that might be the right answer, you know what I'm sayin'?"

"Sarah" on relativism

"Sarah", a low-splitter, discussed her opinion on questions she *might* split on.

- I: Would that be worrisome to you...? That there was a difference between those two things?
- S: Yeah!
- I: Why is that?

"Sarah" on relativism

S: Well just because then I wouldn't know which was correct, or anything, and I'd wanna know which one was, you know? There can't be two different answers. Well, I know that... I know that there's two different ways... if you can explain things and support your answers, I know there can be two different answers, but I would prefer to be saying the same thing.

Scientists Confuse Things

Jackie: I mean, I know by the end of it I was kind of circling what I thought was right and squaring a technical one. I mean... what I thought scientists would say sounded more technical to me.

Scientists Confuse Things

Christine: It is true, if you listen to a scientist talk, a lot of times, you don't understand everything, and so if I didn't understand everything in the answer, it seemed like a plausible scientist explanation.



Leila: Expertise context

Leila was asked what she'd do if experts disagree.

- L: Well, if they're disagreeing, I would, you know, mentally outline their points or something and try and see which one I agree more with, so it would just be personal.
- I: OK.



Leila: Expertise context

- L: Which one is more tailored to... well, see, it depends on what the field is, but if it's something like physics, I have no clue, but if it's something like where values and stuff are...
- I: ethical or political, maybe?
- L: Yeah, so I guess I'd be inclined to kind of, according to my values, my background, my... everything.



Leila: Two expert types

L: There's two ways, because somebody can give you this answer to a question... through these big words, specific jargon that they use, and then you think, oh wow, they must know what they're talking about or a really good person will tell you the same stuff but in layman's language, and you'll be able to maybe connect with them in that sense, and I think that probably shows somebody who's more of an expert in what they do.

Another pattern I mentioned:



The attitude people have toward expertise and understanding can differ from their behavior in class or their responses to other questions.

"Amy" on her previous class

- I: OK. Why did you hate it so much?
- A: Because I didn't get it. It didn't make *any* sense to me at all. I could plug things into equations, but I had no idea what I was doing [OK]. Ended up with an A in the class, and I remember none of it.
- I: You got an A and didn't feel you got an A's worth...
- A: Right. I could plug things into equations successfully, apparently.

How do you know you understand?

Amy: "I guess for me it's being able to understand... uh, the concept well enough to pick out an equation to use to solve a specific situation. But with these equations that he's been talking, I wouldn't know which one to use for anything."

Amy on Expertise

"I guess that's what I'm defining as an expert, when you truly understand this, then it's sort of obvious. When it makes absolute sense and you don't have to think about it, you don't have to wonder if your intuition is wrong, and you don't have to wonder if you're missing something, when you just look at a situation and you go 'well, obviously, this is what's going on with it.""

N3 Afterthought

A bunch of the interviews took place after the N3 tutorial.

Everyone I asked got the right answer (circle and square) for the N3 questions, and believed they reconciled it well.



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Split Totals – F03



McCaskey PERG talk - 12/17/03



Splits - Bad News

- It seems that the split reduction is just what you'd expect from getting higher scores on the FCI.
- There may be a "floor effect" at work.
- Future plan "Fun With Excel"

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Future Plans

- For PHYS122 (next semester), reword the question so:
 - they circle their intuition
 - they square their scientist answer

This way, we can compare with this semester's data with the old instructions.



Future Plans

- Do a pre-post on a "traditional reform" class for comparison
- In future semesters, give a version of this task pre and post, and also:
 - periodically interview a small number of students to see how their attitudes toward reconciling change over time
 - watch video of them in tutorial to see if their actions agree with what they say