BESM Talk

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KSU REU Summer 2013

The problem we are trying to solve is how do we make students “think like a physicist”.

What is Thinking Like a Physicist (TLP)?

Using physics like a physicist and approaching problems like a physicist would.

TLP

- Thought should reflect technical and social aspects
- Thought markers should generalize well across physics content/courses/problems

- We want to see thought in vivo (not merely research labs)
- We're looking for student development, so we need to look at students in upper level courses (neither novices nor experts, but journeymen)

TLP and Our Data

Our data is in vivo dialogue

This means we are looking at verbal markers from the students as to how they are thinking.

This led to the idea of looking at what students were saying in regards to their thinking (in a brief, embedded, spontaneous kind of way).

What is BESM Talk?

Brief, Embedded, Spontaneous, Metacognitive talk

Metacognitive because a person is thinking about thinking.
Spontaneous because they are not directly being told to reflect.
Embedded because it is a part of a larger conversation.
Brief because it is typically a short statement.

Two Categories of BESM

- Expectations
  - The stuff physicists think about.
  - More related to the content of physics

  Types (SCU):

  Spotting Inconsistencies

  Confusions

  Understanding

- Self-Efficacy
  - Students positions in regards to the stuff

Categories of BESM Talk

Category of BESM Talk	Specific Examples
Expectations	"We expect it to be…" "It should be…" "As it should be…"
Spotting Inconsistencies	"I've done something silly.." "I missed something here…"
Confusion	"I don't understand.." "This doesn't make sense…" "I've gotten stuck on…" "I guess…" (in some cases)
Understanding	"I get it…" "That makes sense…" "There we go"
Self-Efficacy	"I guess I don't know enough" "I'm pretty good at…"

Case Study 1: Julie

- Julie is a student in classical mechanics
- The following conversation is from a homework help session where a group of students get together with a TA to discuss homework problems.
  - [Julie:] [The professor] said "blows up" and I was thinking, when I think blow up I think like you know (explosion sound effect)... [it's] funny to be like what the heck and then ask him and he's like oh I mean this and I'm like oh okay.
  - [TA:] ... pretty much everybody in physics uses "blows up" to mean the exponential gets really big.
  - [Julie:] Well... I don't know enough physics apparently.

Julie shows strong signs of negative self-efficacy

Bill's Problem

$$F = -cv - kx$$

Bill is also a student in Mechanics and a part of a homework help session where he was trying to solve the problem of a force on a spring moving left and right.

What Bill is working on is trying to explain why both the cv and the kx are negative.
He first focuses on his explanation of the sign of cv and builds that up by using his hands to show that when the block is moving to the right, the force goes to the left and when the black moves to the left the force is going to the right, showing that the force is always opposite of the motion.

Bill's Explanation

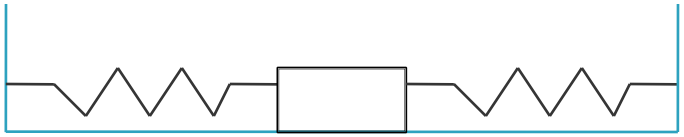
Bill now tries to explain the kx portion of the equation.
This explanation was built much quicker than his explanation for the damping force.

> [Bill:] When this is always positive, it's always, it's always positive on [the right] side and the force is always negative, as it should be. So it should always be negative since K is positive and X is positive. And then when it's on [the left] side, the force is always going to be in the positive direction and then this is the (unclear)... force... Okay.

Bill is showing strong signs of expectation as well as weak signs of understanding.

Case Study 3: Zeke

Zeke is a student also in mechanics, and is struggling with a problem very similar to Bill but as a part of a larger problem in an oral exam.



[Zeke:] Let's see if this makes sense, so if m goes this way [pointing right] we have a positive x displacement we expect positive x, this [the force] is negative, this [the force] points that way [to the left] that makes sense. We've got a positive x this is negative points that way that makes sense…. No I've done something silly…. No negative there because positive x displacement…. No I was right, it was this [arrow for force] that's making it confusing, this should be pointing this way. Alright so positive x displacement, negative kx points that way. That's what we want. Positive x displacement…[to himself] positive x displacement, negative kx points that way, positive x displacement positive kx, no because we want it to push back. Kay. I'm happy now.

Zeke shows strong signs of Spotting Inconsistencies, Confusion, and Understanding.

How BESM relates to TLP

- Julie's obvious negative statement of Self-Efficacy show that she is rejecting being like a physicist.
- Bill's sense of expectation show that he has some content knowledge that this makes sense and is able to make comparisons to previous work.
- Zeke's ability to spot a problem in his work shows that he has an idea of what it should be and he is able to spot exactly why he was confused and fix it to a point where he is happy with the work that he did.

In Conclusion

- We had this problem of how to make students think like a physicist and how to measure whether they are thinking like a physicist or not.
- We provided a solution with the idea of BESM Talk.
- So far we've found that it works pretty well.

What's next for the Project?

- The paper I've been working will be finished and sent to Metacognition and Learning
- Two more papers are to come about other aspects of BESM.
- Longitudinal Studies of BESM
- More data in different settings to get a better sense of comparisons.

Acknowledgements

- I would like to think my research team
  - Dr. Eleanor Sayre
  - Paul Irving
  - Ying Chen
  - Xian Wu

  As well as
  - Dr. Kristan Corwin
  - Dr. Larry Weaver