

Metacognitive Intercessions in Student Conceptions

or...

The funny thing that happened while
talking to my psychologist...

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Conclusions

- A. Metacognition and conceptual change are not just about content, but about disciplinary disposition and perspective taking.
- B. More researchers / teachers should have lunch with psychologists.

Preface:

Lessons from 1000 traditional problems

Students do not overcome conceptual difficulties after solving 1000 traditional problems

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(Received 28 March 1998; accepted 24 August 2001)

The relation between traditional physics textbook problem solving and conceptual understanding was investigated. The number of problems a student solved, as estimated by students themselves, ranged from 300 to 2900 with an average of about 1500. The students did not have much difficulty in using physics formulas and mathematics. However, we found that they still had many of the well-known conceptual difficulties with basic mechanics, and there was little correlation between the number of problems solved and conceptual understanding. This result suggests that traditional problem solving has a limited effect on conceptual understanding. © 2002 American Association of Physics Teachers.

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What are the odds?

- Equivalence is an abstract concept.
- The ratio-bias test: select between two explicitly equivalent sets of odds: 1-in-10 vs. 10-in-100.
- Learners “dual process” — they may have a preference even as they recognize the logic of not having one.

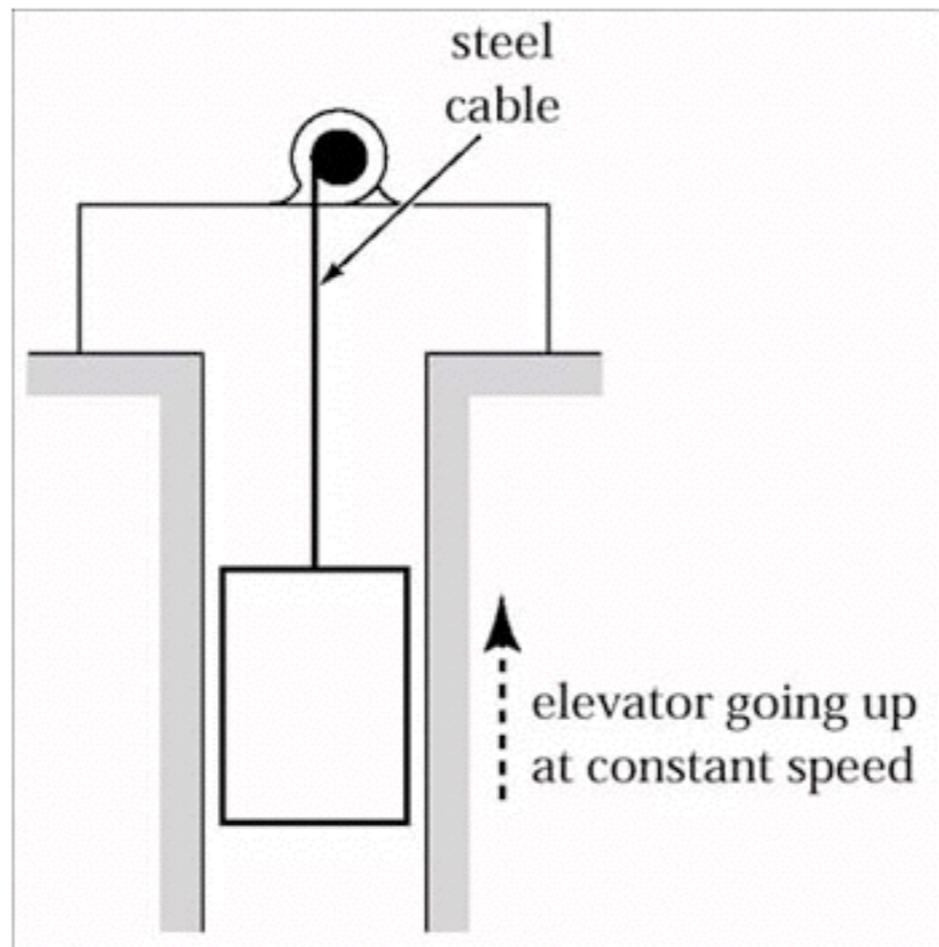
Amsel, E., Klahr, P. A., Johnston, A., Bench, S., Close, J., Sadler, E., Walker, R. (2008). A dual-process account of the development of scientific reasoning: The nature and development of metacognitive intercession skills. *Cognitive Development*, 23(4), 452-471.

Duel of dual perspectives

- What if we prompted students to take on a specific role;
i.e, suggest a metacognitive task?
- “Psychology as Science” questionnaire
- “Professor” versus “Self” conditions
- Results: students are more scientific when they take on a professor’s perspective

Amsel, E., Johnston, A., Alvarado, E., Kettering, J., Rankin, R., & Ward, M. (2009). The effect of perspective on misconceptions in psychology: A test of conceptual change theory. *The Journal of Instructional Psychology*, 36, 289-296.

Lunch with my
psychologist ...



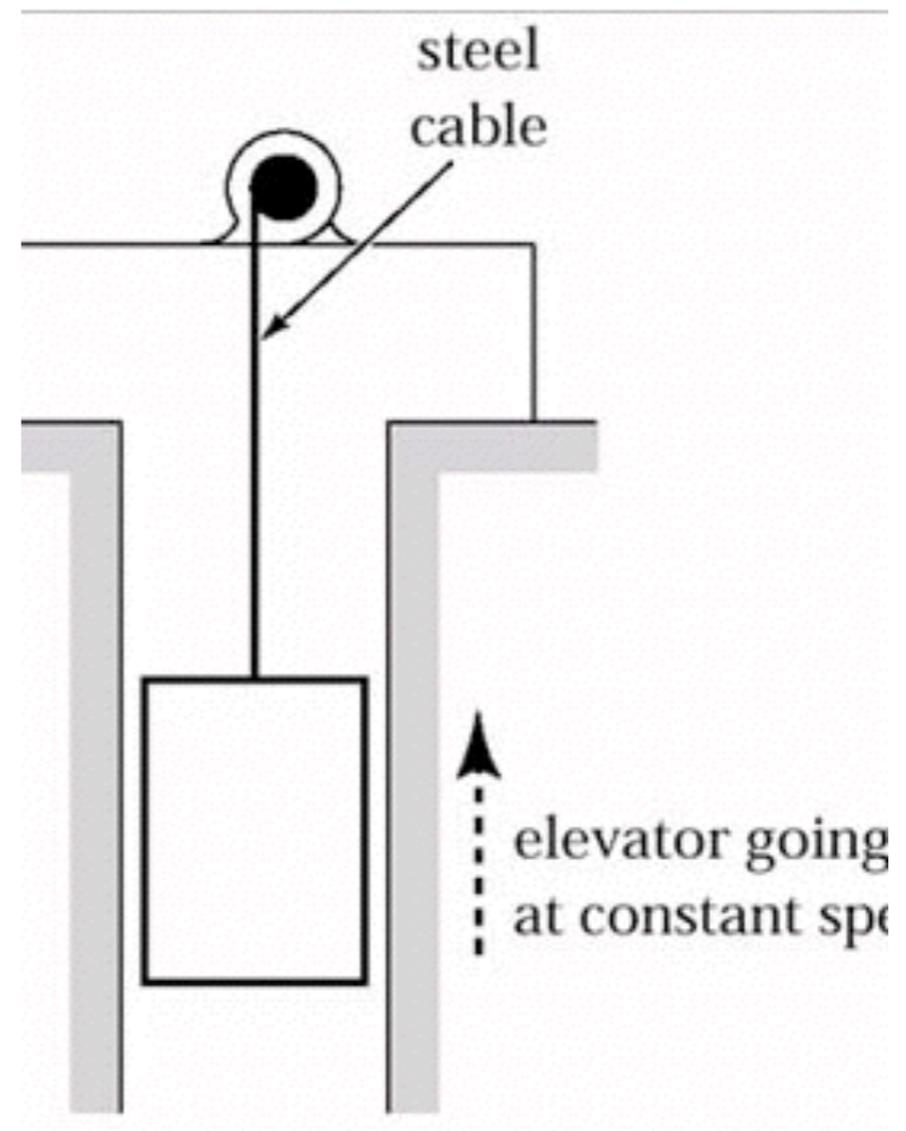
17. An elevator is being lifted up an elevator shaft at a constant speed by a steel cable as shown in the figure.

All frictional effects are negligible. In this situation, forces on the elevator are such that:

- A. the upward force by the cable is greater than the downward force of gravity.
- B. the upward force by the cable is equal to the downward force of gravity.
- C. the upward force by the cable is smaller than the downward force of gravity.
- D. the upward force by the cable is greater than the sum of the downward force of gravity and a downward force due to the air.
- E. none of the above. (The elevator goes up because the cable is being shortened, not because an upward force is exerted on the elevator by the cable).

Elevated Perspectives

- A student is more likely to get this question right if taking the class in person vs. online.
- When answering *incorrectly*, a student is more likely to say “the professor will answer B” [correctly] if taking the class in person.
- *And*, the ability a traditional *classroom* student to predict the professor’s answer correctly better correlates with overall course performance than the student’s *own* answers.



What happens if we effect a perspective?

- We know that learners dual process. But, we also know that they can metacognate and/or inhibit certain processes in certain conditions.
- Can we prompt metacognition...
 - in psychology and in physics,
 - and does doing so change a student's expressed understanding?
 - (and what would it mean if we could???)

Induction

Paying attention?

Please answer the following questions about the video to the best of your ability.

1. An electric current can be created with the use of a magnet

a) true

b) false

2. The flashlight in the video did not require a battery. Instead, it required which of the following features?

a) a magnet

b) a shaking motion

c) a coil of wire

d) all of these

3. Induced electric currents in the wire within the flashlight move

a) in one direction only

b) in either direction, back and forth

c) in both directions at the same time

d) none of the above – electric current does not move

Prompting / Intercession

The pairs of statements listed below are opinions regarding electricity and magnetism. Read each pair carefully. Use the scale by circling how much you agree with one statement of the pair as opposed to the other. For example if you moderately agree with the statement on the left, circle *moderately agree* on the left hand side. However, if you slightly agree with the statement on the right, then circle *slightly agree* on the right hand side. Circle *neutral* if the statements are equal to you. Please circle only one option.

Rate all the items...

- **according to what you believe. (Belief Condition)**

OR

- **by thinking like a physicist. (Professor Condition)**

Understanding?

The current induced by a magnet never changes in direction.

Strongly Agree

Moderately Agree

Slightly Agree

Neutral

Slightly Agree

The current induced by a magnet changes in direction.

Moderately Agree

Strongly Agree

The energy for electric current comes from the steady magnetic field.

Strongly Agree

Moderately Agree

Slightly Agree

Neutral

Slightly Agree

The energy for electric current comes from a magnet's motion.

Moderately Agree

Strongly Agree

Magnetic field transforms into an electrical current.

Strongly Agree

Moderately Agree

Slightly Agree

Neutral

Slightly Agree

Magnetic field induces an electrical current.

Moderately Agree

Strongly Agree

Electricity is created by placing a coil of copper wire next to a magnet.

Strongly Agree

Moderately Agree

Slightly Agree

Neutral

Slightly Agree

Electricity is created by moving a coil of copper wire near a magnet.

Moderately Agree

Strongly Agree

A moving magnet should speed up as it's causing a bulb to emit light.

Strongly Agree

Moderately Agree

Slightly Agree

Neutral

Slightly Agree

A moving magnet should slow down as it's causing a bulb to emit light.

Moderately Agree

Strongly Agree

In electromagnetism energy is created.

Strongly Agree

Moderately Agree

Slightly Agree

Neutral

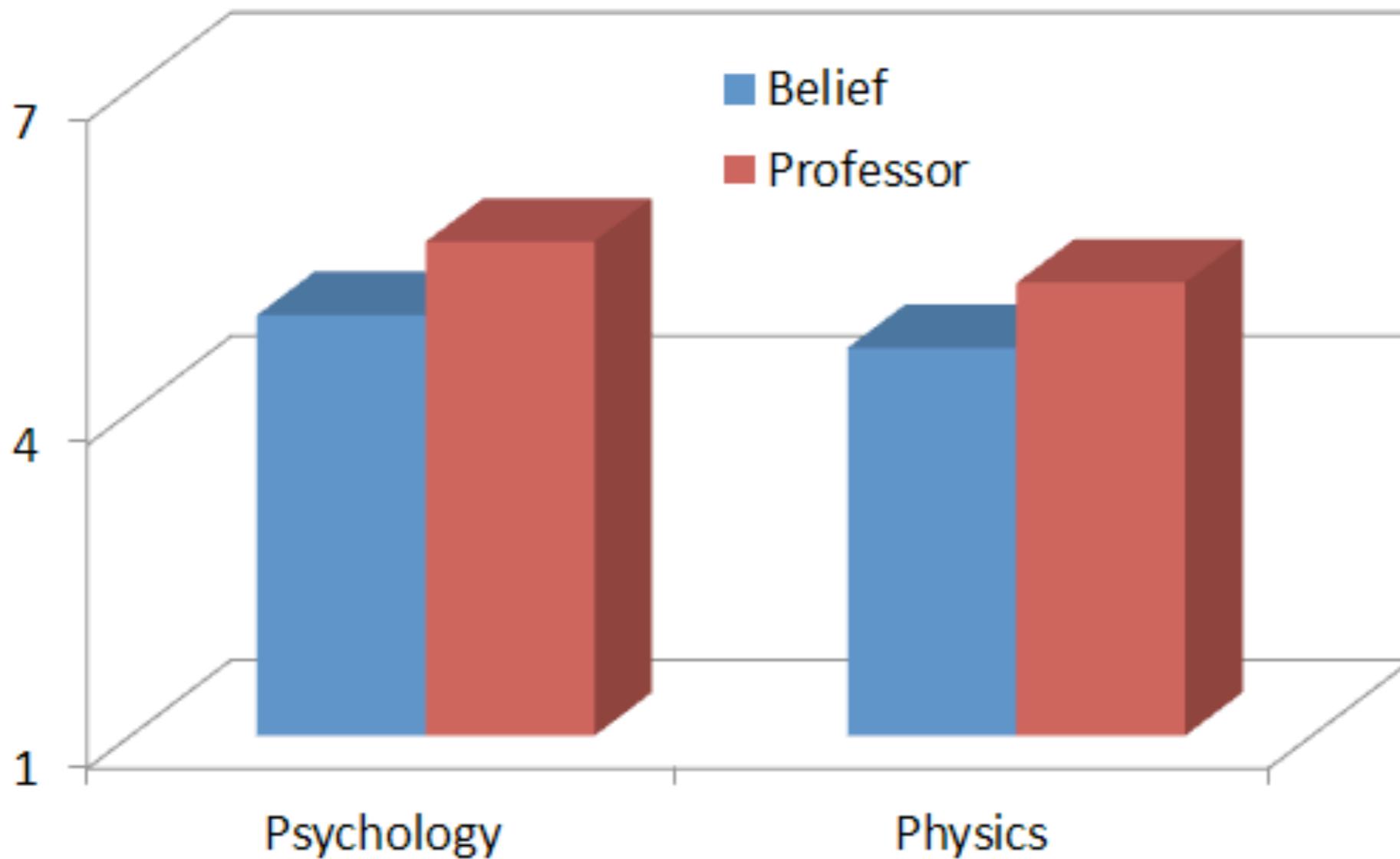
Slightly Agree

In electromagnetism energy is conserved.

Moderately Agree

Strongly Agree

Results



Differences between “self” and “professor” condition are significant, with no other interactions (course, gender, program of study, etc.)

Discussion

- *We need more data.*
- But:
 - What if we can effect perspective taking?
 - How would that interact with “belief” over time?
 - How do we integrate disciplinary perspectives into our courses and other learning environments (e.g., undergraduate research)?

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