Metacognition Homework

Objectives

To help students develop more sophisticated beliefs about teaching and learning ("epistemological beliefs"), because these beliefs can affect students' studying habits and learning outcomes. This activity is excerpted from the published article cited to the right.

Activity

In the article, Dr. Elby describes several homework and in-class problems designed to foster reflection about learning. He bases grading on completeness, not content, of the answers. Example questions are shown below.

1. Think about the material you learned for last week's quiz.
   (a) What role did memorization play in your learning of the material?
   (b) What makes the material "hard"?
   (c) What advice about how to study would you give to a student taking this course next year?

2. On last week's circular motion lab, there were experiments, conceptual questions about those experiments, and "textbook-like" summaries. In each case, the summary came *after* you attempted to answer some questions about the material covered in the summary. But on other labs, I've put the summaries *before* the related questions.
   (a) When it comes to helping you learn the material, what are the advantages of putting the textbook-like summaries *before* the conceptual questions about that same material? Please go into as much detail as possible.
   (b) When it comes to helping you learn the material, what are the advantages of putting the textbook-like summaries *after* the conceptual questions about that same material? Please go into as much detail as possible.

3. In lab last week, most people seemed surprised to find an apparent contradiction between common sense and Newton's 2nd law (Fnet = ma), for a car cruising at constant velocity. But the night before the lab, you read a textbook section about Newton's 1st and 2nd laws. Why didn't you notice the apparent contradiction while doing the reading? I'm not "yelling" at you or blaming you; I know you're careful, conscientious readers. That's why it's *interesting* to think about why the apparent contradiction went unnoticed. What could you and/or the textbook have done differently to help you discover—and possibly resolve—the apparent contradiction?

Along with these assignments, Dr. Elby used two non-traditional policies to help students view homework as an opportunity to learn the material: Grading was based on effort (not correct answers), and he handed out detailed solutions with the assignment (receiving no credit for copied work). A graded mini-quiz on the material provided additional accountability for learning, and penalized copying.

Author

Andrew Elby (2001). "Helping students learn how to learn," Am. J. Phys. 69, S54, http://scitation.aip.org/content/aapt/journal/ajp/69/S1/10.1119/1.1377283

Materials & Resources

None, but see article above

Classroom Context

Small to medium sized high school students.

Time Requirement

10 minutes

About this Project

This is one of a set of materials compiled for instructors to draw upon in order to frame non-traditional modes of classroom teaching for their students. Our hope is that these materials can help reduce any student resistance to such techniques.

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Other materials available online at www.colorado.edu/sei/fac-resou

Effectiveness

Elby indicates that student responses helped him to understand their views, which helped him to plan subsequent classes, and nudge individual students. Students who copied the homework tended to do poorly on tests, but those who wanted to learn the material tended to be able to focus more on learning the concepts instead of the right answer, due to his grading policies. Homework and test questions also emphasized explanation, providing additional accountability for deeper learning.

Going further: Metacognition labs

Dr. Elby wove metacognitive strategies throughout the course in this article, but one that may be of use to instructors using activities or labs in their course are the metacognitive activities developed for labs, problems, and class discussions. In the article, he describes two force labs designed to help students understand that learning physical laws involves refining one's intuition.

For example, in a Newton's 2nd law lab, he asks students to explain their intuition of what will happen (regarding the force on a moving car), complete some calculations, and then answer a question designed to help them identify their reasoning:

> **3.** Most people have—or can at least understand—the intuition that the forward force must "beat" the backward force, or else the car wouldn't move. But as we just saw, when the car cruises at steady velocity, Newton's 2nd law says that the forward force merely *equals* the backward force; *F*net = 0. Which of the following choices best expresses your sense about what's going on here?
> (a) *F*net = *ma* doesn't always apply, especially when there's *no* acceleration.
> (b) *F*net = *ma* applies here. Although common sense usually agrees with
> physics formulas, *F*net = *ma* is kind of an exception.
> (c) *F*net = *ma* applies here, and disagrees with common sense. But we
> shouldn't *expect* formulas to agree with common sense.
> (d) *F*net = *ma* applies here, and appears to disagree with common sense. But there's probably a way to reconcile that equation with intuitive thinking, though we haven't yet seen how.
> (e) *F*net = *ma* applies here. It agrees with common sense in some respects but not in other respects.

After leading them through some additional reasoning, he asks them:

> **7.** OK, here's the punch line. Most people have the intuition that, if an object is moving forward, there must be a (net) forward force. Explain in what sense that intuition is helpful and correct, and in what sense that intuition might seem misleading.

Post-lab discussions helped to bring home the epistemological point of the lab.

An additional example is provided in the article.