Science Faculty Grading of Quantitative Problems: Are Their Values Consistent with Their Practice?

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ABSTRACT

Grading practices can send a powerful message to students about what is expected. Research in physics education has identified a mismatch between what college instructors value and their actual scoring of quantitative student solutions. This work identified three values that guide grading decisions: (1) a desire to see students reasoning (2) a reluctance to deduct points from solutions that might be correct, and (3) a tendency to assume correct reasoning when solutions are ambiguous. When values are in conflict, the conflict is resolved by placing the burden of proof on either the instructor or the student. In this qualitative interview study, we verified that this mismatch exists across science faculty more generally.

BACKGROUND

• Feedback from the instructor to the student, typically in the form of a grade, has a powerful effect on student learning (e.g., Black & William, 1998; Elby, 1999; Henderson, 1999). 
• Grading practices, therefore, can have a tremendous impact on what students do in a college course.
• Research in physics education has documented a tension between what instructors say they value in grading, quantitative-free response student problem solutions, and their actual grading practices (Elby, 1999; Henderson, 1999; Schoenfeld, 1988).
• Many instructors say they want to see reasoning in a student solution to make sure that the student really understands, but then give points for students who did not show their reasoning, or rewarding omitting clear reasoning.
• Henderson et al. (2004) propose that this tension exists because hidden internal values conflict with expressed values.

METHODS: Student Solutions

• Typical quantitative, free response problems encountered in an introductory, college-level course (electrochemistry, acids/ bases).
• Solutions are based on examples of actual student work.
• 5 student solutions that included the correct 5 physics solutions (Henderson et al., 2004).
• Student Solution E (SSE) shows student thinking, has explicit errors, has correct answer.
• Student Solution D (SSD) shows student thinking, has explicit errors, has correct answer.
• SSE could have made the same combination of errors as SSD, or could have done the problem correctly, the reasoning was ambiguous.
• SSE and SSD were designed to elicit conflicts between values.
• Obvious errors were verified by lettered comments.

RESULTS

• Same three values previously identified among physics faculty by Henderson et al. (2004) were present, plus a 4th value.

Value

Chemistry Example

Earth Science Example

Surprise

SSE

SSD

SSE

SSD

Difficulty

We surprised the student to because it does give me a chance to better understand what the student was thinking. They did not have a problem thinking about this because they are in need of some guidance. I think, is much easier. For student 

I appreciate student solution D because it does give me a chance to better understand what the student was thinking. They did not have a problem thinking about this because they are in need of some guidance.

When you look through this student [SSE] might actually be correct, balancing the reaction; they did these [compared moles] both correctly, but the reason that [the limiting reactant has smaller moles, they got that]. So they get 8 out of 10.

When you look through this student [SSD] had some issues I think, but he got the right number and it looks like they did everything correctly. I guess we've got no choice but to give them a 10.

2. Desire to deduct points from solutions that are clearly incorrect.

Instructor C7: “I appreciate student solution D because it does give me a chance to better understand what the student was thinking. They did not have a problem thinking about this because they are in need of some guidance. I think, is much easier. For student 

Instructor E3: “Well, this person [SSE] didn’t show their work, but when you look through this student [SSD] had some issues I think, but he got the right number and it looks like they did everything correctly. I guess we’ve got no choice but to give them a 10.”

3. Tendency to trend student reasoning to ambiguous solutions.

Instructor D1: “The student [SSE] complied with expectations but did not think through correctly… wrong numbers and wrong answer.”

Instructor E3: “Well, this person [SSE] didn’t show their work, but when you look through this student [SSD] had some issues I think, but he got the right number and it looks like they did everything correctly. I guess we’ve got no choice but to give them a 10.”

4. Value to use an organized solution with units clearly labeled.

Instructor C7: “I appreciate student solution D because it does give me a chance to better understand what the student was thinking. They did not have a problem thinking about this because they are in need of some guidance. I think, is much easier. For student 

Instructor E3: “Well, this person [SSE] didn’t show their work, but when you look through this student [SSD] had some issues I think, but he got the right number and it looks like they did everything correctly. I guess we’ve got no choice but to give them a 10.”

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

• Including 30 surveys and 6 interviews physics from Henderson et al. (2004):
• 49% of faculty could be viewed as providing students incentive for showing their work (e.g., graded SSE >= SSD).
• 34% of faculty could be viewed as penalizing students for showing work, and rewarding omission of work (e.g., graded SSD > SSE).
• 48% of faculty placed the burden of proof on the student, requiring students to prove knowledge in order to earn a grade.

• Chemistry were more likely than earth science or physics faculty to grade SSD > SSE. The nature of chemical problem-solving may account for this difference (Camnasio & Gross, 1999).

• This research can serve as a tool to promote cognitive conflict in faculty. This cognitive conflict can in turn lead to reflection on and changes in practice.

REFERENCES


• Yerushalmi, T., & Kuo, C. (2000). The Earth Science: An air parcel is forced to rise over a mountain to a height where the temperature is 84

• Camnasio, C, & Gross, N, 1999. Can show what's known, and most importantly, identify what's unknown."