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

Jeffrey A. Barney, Jacinta M. Mutambuki, Heather L. Petcovic, Charles Henderson, and Herb Fynelewew

ABSTRACT

Grading practices can send a powerful message to students about what is expected. Research in physics education has identified a misalignment 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) an expectation that the student would demonstrate a level of understanding equivalent to that of student solutions that would be correct, and (3) a tendency to assume correct reasoning when answers are ambiguous. When values are in conflict, the conflict is resolved by placing the burden of proof on the student. This study extends previous research by involving chemistry and earth science instructors, and by including interviews and surveys. We found that chemistry instructors were more likely than earth science or physics faculty to grade SSD > SSE. The nature of their feedback also differed, with chemistry instructors more likely to use boxed comments to identify errors, and earth science instructors more likely to use direct feedback. This research may contribute toward a better alignment between values and practice in faculty development.

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 & Wiliam, 1998; Eby et al., 1988).
- Grading practices, therefore, can have a tremendous impact on what students do in a 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 (Eby, 1996; Henderson et al., 1999).
- Many instructors say they want to see reasoning in a student solution to make sure that the student really understands the problem.
- However, students may have gotten the correct grade and still not understand the problem at a level instructors perceive as sufficient.
- Researchers also note that hidden internal values conflict with expressed values.
- This study extends the construct of ‘burden of proof’ to explain how faculty resolved these conflicts (Henderson et al., 2004, p. 167).

METHODS: Student Solutions

- Student Solution E (SSE): does not clearly show student thinking, but has correct answer.
- Student Solution D (SSD): shows student thinking, has explicit errors, has correct answer.

METHODS: Interviews and Surveys

- Interviewed 30 surveys and 6 interviews with chemistry and earth science faculty.
- Instructors were asked to solve example problems and rate different solutions.
- Feedback from the instructor to the student, typically in the form of a grade, has a powerful effect on student learning (e.g., Black & Wiliam, 1998; Eby et al., 1986).
- Researchers also note that hidden internal values conflict with expressed values.

RESULTS

- Three values previously identified among physics faculty by Henderson et al. (2004) were present, with an overall +4 value.

Value

- Value 1: burden of proof
- Value 2: low grade
- Value 3: project tendency to correct ambiguous solutions

Chemistry Example

- Instructor C7: "I think the student [SSD] showed his ability to reason and do the math. I like the way he identified the point where the reaction should be stopped. He got the right number and it looks like he did everything correctly. I guess we've got no choice but to give him a 10."" 

Earth Science Example

- Instructor D3: "The student [SSD] has an organization, no units, and it's responsible to follow the logic. I always add up the math here much more carefully because I always say to do all work. There is a lot of logic, but [SSE] doesn't have any of the numbers together in head and get an answer. You have to show a plan, have to write a plan. It has to identify what they know, and it's obvious, identify what they don't know."" 

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

- Including 30 surveys and 6 interviews with physics faculty from Henderson et al. (2004):
  - 49% of faculty could be viewed as providing students incentive for showing their work (e.g., graded SSD > SSE).
  - 34% of faculty could be viewed as penalizing students for showing work, and rewarding omission of work (e.g., graded SSE > SSD).
  - 48% of faculty placed the burden of proof on the student, requiring students to prove knowledge that they may not know.
- Chemistry were more likely than earth science or physics faculty to grade SSD > SSE. The nature of their feedback also differed, with chemistry instructors more likely to use boxed comments to identify errors, and earth science instructors more likely to use direct feedback.
- 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.