Student Development of Grading and Assessment Criteria

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Abstract

Faculty at Ohio University increasingly use rubrics to simultaneously grade student work and assess student learning. One tenet of this "Criterion-Based Grading" system is that the basis for grading is known to the students, allowing them to evaluate their own work before submitting it. Beyond making such self-evaluation possible, we wish to actively encourage it. We consider the ability to evaluate one's own work to be an essential skill and habit of a practicing engineer. However, we have learned by experience that even when students are provided with the rubric, they seldom evaluate their own work effectively. In an effort to counter this, students in a sophomore-level "Energy Balances" course are asked to help develop a rubric that will be used to grade and assess a team project in the course. The mechanism for including student input in rubric development and assessing the ability of the students to use the resulting rubrics for self evaluation will be discussed.

Introduction

The chemical engineering curriculum at Ohio University requires students to complete open-ended assignments in a team environment at the sophomore, junior, and senior levels. The deliverable in these assignments is typically a report, either oral or written. Grading and assessment of this work is complex, involving both the quality of the technical content and the quality of the presentation. This type of work also provides a high density of assessment information because of its complexity. Rubrics provide a framework for structuring and quantifying this assessment information. Rubrics, if made available to the students, should also give students a rationale for the grades they receive and an opportunity to evaluate and improve their own work prior to submission. (See, for example, Walvoord & Anderson, 1998[1].)

Grading in our senior Unit Operations Laboratory is now entirely rubric-based.[2] We have been pleased with the rubrics as a foundation for assessment in this course. In some respects, the rubrics have also resulted in notable improvement in the reports. For example, reports are now more concise, focusing on the important traits of the reports as defined by the grading rubrics. On the other hand, students struggle to effectively use the descriptions in the rubrics to assess their own performance. For example, one of the traits graded for a prelab report is the pro posed statistical analysis of the results, and the description of an "A" performance begins with the phrase, "Uncertainties for all values stated." The description of an "F" performance begins with "Uncertainties not given for most values." Still, students submit reports in which the vocabulary of statistics features prominently, yet the method for quantifying the uncertainty on important

experimental results, or the uncertainty value itself, never appears. When surveyed, students say the wording in the rubric is too vague. Many couple this with a request for experiment-specific sheets, suggesting they want to be told exactly what to do and graded on their execution rather than having to determine what to do themselves. Students have also objected to the rubrics on the grounds that "When I get a job, no one will check my work with a grading sheet like this."

Although constructs like the grading sheet may not be visible "in the real world", anyone evaluating work does so by determining whether the essential information is present, and whether the quality of that information meets or exceeds expectations. We would like students to critically evaluate their own work, so that grades become feedback for improvement rather than an arbitrary number assigned based on unknowable criteria. This will also prepare them to evaluate the work of others, which will undoubtedly be one of their job functions in the future. Building a "grading sheet" is a formalized procedure for defining the elements of good work.

However, because students are human, they are resistant to change. It is easier to think of a grade as something external imposed upon them by the professor than as something that they could control by critically reviewing and revising their own work. This resistance is obvious in our current seniors, because the idea of the rubrics is new to them. We hope that our current sophomores will have a different attitude when they are seniors, having been exposed to the rubrics earlier in their academic career. However, it seems prudent to develop exercises that specifically challenge the attitude that their grades are not their responsibility, and thus to develop their ability to evaluate their own work and others'. To this end, sophomores in the "Energy Balances" course in Spring 2002 are asked to help develop three grading rubrics. Some prior experience in this course suggests that this may be a productive strategy for improving the quality of the projects. For example, students have made better oral presentations in this course when the instructor moderates an in-class brainstorming session in which students define characteristics of a good presentation.

Goals and Objectives for Class Participation in Rubric Development

- Students will practice developing a formalized procedure for evaluating their own work and that of others.
- Students will practice formal, critical evaluation of their own work and that of others.
- Practice in critical evaluation will lead to students who take more responsibility for the quality of their own work, reading critically and revising work before submission.

Strategy for Class Participation in Rubric Development

The structure of the Energy Balances course is discussed in detail elsewhere.[3,4] Students work in teams to prepare a report describing a particular manufacturing process, to argue for or against the siting of a plant employing such a process in their community, and to complete a relatively simple design related to the process (e.g., specifications of utility streams). In the past, these projects have been graded without a formal rubric. The intent here is for students to participate in selecting the "Primary Traits" for evaluation and in defining the levels of performance on each trait that lead to grades of A, C, and F. The goal is for them to actively consider what distinguishes excellent work from adequate, and adequate from unacceptable. Because they have

little or no previous experience in designing rubrics, their participation must be carefully structured, and the instructor must reserve the right to revise and adjust the rubrics to maintain acceptable grading standards.

Students will be guided through rubric construction in three phases. (1) Review course learning objectives and decide which are addressed by this assignment. (2) Select a limited number of "Primary Traits" that are essential to the project and that are related to the project learning objectives. (3) Describe an excellent ("A"), an adequate ("C") and an unacceptable ("F") performance for each trait. Because no more than one class period is to be devoted to construction of each rubric, it is anticipated that the students will arrive at some (but not all) of the Primary Traits, and will describe levels of performance for only one or two. The instructor will complete the rubric and will allow a brief comment period, after which the instructor will publish the final rubric.

As noted above, the grading of team projects is a complex task. This is because team projects frequently address several course and curriculum objectives. For example, in preparing a report describing a manufacturing process, course learning objectives include identification of the names and functions of chemical engineering process equipment and identification of energy transformation and transfer in a process. Curriculum learning objectives include practice at functioning as part of a team, practice at the research skills necessary for lifelong learning and practice at producing written communication that is professional in tone, format and style. Such an assignment is too complex for students to begin with.

Students will first practice the three-phase development of a rubric on a simpler assignment: a textbook problem. During a recitation period (110 minutes), students will work in teams to solve a problem from the text. Then, the instructor will lead the class in designing a grading rubric for the problem, using the three phases described above. A textbook problem early in the quarter will probably have only one or two Primary Traits, that is, one or two key chemical engineering concepts that must be applied to solve the problem. Finally, teams will trade solutions and grade one another's work. This practice in identifying the key principles required for problem solution should also benefit students by getting them to think about the problem, not just about putting numbers into a calculator.

The next practice session will follow the first exam, which typically occurs in week 4 of the 10-week course. In a 50 minute class period, the instructor will lead the class in designing a rubric to grade the exam (not the solutions to the exam). The students will define the objectives of the exam (e.g., to test whether students can apply the mechanical energy balance to analysis of an unfamiliar process) and grade the success of the exam in achieving them. A copy of the course learning objectives will be referenced frequently during the exercise. Within a day or two of this exercise, their first team project will be returned, graded using a rubric designed by the instructor. This should motivate the students for the final session of rubric construction training.

A few days before the second team project (oral arguments for and against) is due, a 50 minute class period will be devoted to developing a rubric. The instructor will moderate a brainstorming session about the elements of a good oral presentation, and remind students to refer to the course learning objectives in defining the "Primary Traits" to be evaluated. The final rubric will be

largely based on what the class produces, though the instructor will revise it to ensure that essential traits for assessment are included. Both students and the instructor will evaluate the presentations using the rubric. Because the project is worth a small portion of the course grade, the quality of the rubric and the student assessment will have little effect on final grades.

The definition of performance level will likely be one of the most controversial parts of developing rubrics with students. Many students seem to think that an "A" should be awarded if a lot of effort was expended (even if it was ineffective) or if they met the minimum requirements of the assignment. Instead of starting with descriptions of "A", "C" and "F", it will probably be more productive to ask them to describe "Excellent", "Adequate" and "Unacceptable" performance.

Assessment

The short term success of this strategy will be assessed in two ways. First, performance on the team projects as assessed using rubrics will be compared. Students will be provided with copies of the rubrics in advance, including the instructor-developed rubrics for the first and third projects. We know from our rubric use in Unit Operations Laboratory that student performance on some primary traits is unacceptable or only adequate because students are unable to effectively use the rubrics for self-evaluation and improvement. Past experience in this course shows no significant trend towards improvement from the first to the third project. A significant improvement in the second project over the first will suggest that students are better able to use rubrics to evaluate their own work when they participate in developing them. Significant improvement in the third project over the first will suggest that some of the critical thinking involved in assessment has been internalized, and students are improving in general in their ability to be self-critical. Second, students will be surveyed to determine whether they found it useful to participate in rubric development, and how they used the rubrics to evaluate their own work prior to submission. The survey will be part of the anonymous end-of-course evaluation administered by the college, and results will not be available until final grades are submitted. Survey questions of this type have already been used in Unit Operations Laboratory.

Long term, we will compare the attitudes towards the rubrics of these students as seniors with the attitudes of earlier classes in our unit operations laboratory.

Results are not available at the time of paper submission, but short term assessment results will be presented at the meeting.

References Cited

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Biographical Information

VALERIE L. YOUNG has been assistant professor of chemical engineering at Ohio University since fall 1996. Her research area is atmospheric chemistry. She most enjoys teaching Energy Balances, and has been active in increasing the teamwork component of the curriculum and developing new assessment tools at Ohio University. She is the winner of the Joseph Martin Award for best paper in chemical engineering at the 2001 ASEE meeting.