

Successful Writing Portfolio Assessment at the University of Arizona's Electrical and Computer Engineering Department Improves Student Writing

Martha W. Ostheimer, Edward M. White
University of Arizona, Tucson, Arizona

***Abstract** — Industry and alumni consistently rank writing skills as the most important outcome in determining our engineering graduates' success. In response to this feedback, the Department of Electrical and Computer Engineering at the University of Arizona designed and began implementing a writing portfolio assessment process to evaluate student writing. Data obtained from five years experience have proven to be instructive for revising assignments, course goals and course content to improve student writing. Student attention to effective writing has also increased. Holistic scores on average have improved from 3.58, on a six- point scale with 6 being highest, in Spring 2002, to 4.3 in Fall 2003.*

Introduction

One major problem for engineering education has to do with student communication skills: every professional engineer and educator knows that strong communication skills, particularly the ability to write in the various modes required of engineers, are essential for successful engineers, yet instruction and assessment of that ability is rarely part of the engineering curriculum. Employers are well aware of the importance of communication skills for engineers; studies done by the Department of Electrical and Computer Engineering (ECE) at the University of Arizona show that engineering firms, as well as ECE graduates, rank writing ability as the most important skill in determining engineers' success, even above the much more obvious technical skills that are the focus of much engineering education. In fact, results cited in a Report on Surveys of Opinions by Engineering Deans and Employers of Engineering Graduates on the First Professional Degree, indicate that over sixty percent of the respondents ranked better communications as the #1 priority for curriculum revision ^[1].

Yet it is difficult for engineering schools to stress the importance of student writing to their students and their faculty. Schools of humanities or social sciences normally require substantial amounts of writing in the required course work their students complete, and professors in these fields are accustomed to responding to that writing, asking for revision as called for, and including grades on the writing as part of the overall evaluation of student work for the course. Students expect to produce term papers in advanced courses in non-technical fields of study and to have those papers graded. But the engineering curriculum is so crowded with necessary technical work that most engineering professors are unwilling to take time for attention to

student writing, even though, when questioned, these professors assert that such writing is crucial for their graduates.

Recognizing our graduates' need for strong communication skills, the ECE Department began teaching its senior-level capstone design courses as writing emphasis courses beginning in 1989. Writing projects integrated into these senior classes included a well-defined problem statement, a design proposal, a status memorandum, an engineering notebook documenting the design process, and a final technical design report. The department also hired a writing expert to design, develop and teach the communication component of these classes; thus alleviating the need for ECE faculty to direct and formatively assess student writing. After ten years of emphasizing writing, at least in the senior year of the ECE curriculum, and in response to the ABET 2000 requirement that program outcomes be measured, the department, in 1999, began developing plans to design an assessment process capable of evaluating how well the ECE curriculum was actually preparing our graduates to write for their future careers. In this paper, we will describe first the series of steps that led to the establishment of the assessment design, then present and discuss our observations from five years of this assessment.

Steps in Planning the Assessment Design

The first stage in any assessment procedure is to define its goals and ensure that the goals of the assessment process correlate with the educational goals of the curriculum. Therefore, it was necessary to convene engineering faculty to discuss and agree on the goals. In addition to ECE faculty, the membership of the department's writing assessment committee also included faculty from the rhetoric and English composition program at the University and practicing engineers from local engineering companies. These outside experts provided guidance in establishing the number of departmental objectives for student writing and in the formulation of measurable rather than conceptual goals statements. As the discussion of goals developed, it became clear that the department wanted to obtain data on the success of the curriculum at preparing students to meet departmental writing objectives, as well as data which would indicate where within the curriculum students were preparing writing. As no single examination could satisfy these goals, a portfolio assessment became the method of choice, as one that could assess the range of goals seen as necessary. Additionally, the development of the following set of goals, unanimously adopted by the committee, assured construct validity for the assessment.

Graduates of the ECE Department should be able to:

1. Document a procedure, how something works, how to perform an operation, or how to solve a problem.
2. Write a clear and succinct definition of an open-ended problem including a summary of known attempts to solve the problem.
3. Write a proposal to perform a project, undertake research, develop a program, solicit funding, or some combination of the above.
4. Write an abstract or summary of a technical document.
5. Write a letter or memorandum taking a clear position defending or selling an idea to an

audience.

6. Document a project in a professionally written design report.
7. Explain technical information to a non-technical audience.

The second stage of this process was intended to assure reasonable reliability in measurement, the principal problem for any portfolio assessment. Thus the development of a scoring guide for the engineering writing portfolios became the next step in the planning of the assessment. The scoring guide describes in some detail the criteria used in evaluating student writing, including organization, development expression and mechanics, and distinguishes between the characteristics of a highly skillful portfolio (6), a skillful portfolio (5), a competent portfolio (4), a minimally competent portfolio (3), a less than competent portfolio (2), and an unsatisfactory portfolio (1). The six-point scale has become a de facto standard for writing assessment, for its practicality and ease of use. It can be envisioned in two different ways: as an elaborated pass/fail scale based on the upper-half score of 5 and the lower-half score of 2, with the other numerical scores seen as plus or minus ratings for those two basic scores, or as an upper third (6-5), a middle third (4-3), and a lower third (2-1).

The following six-point scale score sheet was also developed for readers to assign each portfolio an overall holistic score, as well as outcome specific scores. This was done to meet the departmental goals of assessing both curriculum data and outcome-specific data.

ECE Score Sheet

Portfolio 1D# _____

This portfolio meets the following outcomes at the level of competence indicated

Persuasive Cover Letter /2pts

	Course #	Page #s	6 Highly Skillful	5 Skillful	4 Competent	3 Minimally Competent	2 Less than Competent	1 Unmet	0 Not Attempted
1. Procedural Document	_____	_____	_____	_____	_____	_____	_____	_____	_____
2. Problem Statement	_____	_____	_____	_____	_____	_____	_____	_____	_____
3. Proposal	_____	_____	_____	_____	_____	_____	_____	_____	_____
4. Abstract/Summary	_____	_____	_____	_____	_____	_____	_____	_____	_____
5. Persuasive Letter/Memo	_____	_____	_____	_____	_____	_____	_____	_____	_____

6. Professional Design Report _____
7. Tech. Explanation for Non-Tech. Audience _____

Please Circle the overall score you award this portfolio:

6 5 4 3 2 1

Rater's initials: _____

The last stage of the planning of the assessment design was to develop the writing portfolio assessment assignment, which is specific and detailed regarding the number of documents (4 maximum) and the organization of the portfolio. Students are also directed to select documents for inclusion in their portfolio only from course work produced within the ECE major program.

As an attachment to the assignment, students are also provided with the scoring guide and the score sheet to ensure that the assessment process criteria are as transparent as possible to the students. Research ^[2] points out that making assessment criteria transparent to students positively impacts student learning. The writing portfolio is a required assignment for the writing emphasis component of the senior-level capstone design classes and points for the assignment are made a part of students' grades in these classes.

The Portfolio Assessment Process

The ECE department has conducted portfolio readings at the conclusion of each semester for the last five years. Readers for the portfolio assessment have included faculty from the ECE department, faculty from other departments and colleges, and engineers and technical writers from several engineering companies.

Readers are provided with a packet of materials in advance of the reading, including the portfolio assignment, the six-point scoring guide and score sheet, and two "anchor portfolios," which received agreement in the scoring by two readers at the previous reading. The "anchor portfolios" include an upper-half anchor of a skillful portfolio (5), and a lower-half anchor of a less than competent portfolio (2). To prepare readers for the assessment process, we ask that they familiarize themselves with the materials in the packet and read the anchor portfolios, which are graded, prior to the reading.

During the reading and as a check on inter-reader reliability, each portfolio is read by two readers, with the second reader unaware of the first reader's score. We add the two scores for a possible range of 12 (two scores of 6) to 2 (two scores of 1). Adjacent scores are considered to be in agreement: thus two scores of 5 and 4 sum to a total score of 9, a legitimate score. But if

the two readers disagree by two points or more, that is a discrepancy that needs to be resolved by a third scoring.

Observations

Data obtained in the first three years of the portfolio assessment process were immediately instructive for revising assignments, course goals and course content to improve student learning and student writing outcomes specifically in the senior-level capstone design classes. The communications expert, in response to the findings of each semester's reading, significantly redesigned instructional materials as well as assignments to ensure that students were capable of meeting all of the department's writing outcomes with materials they produced as part of the two semester capstone design class. Another key finding early on in the assessment process indicated that engineering students approach writing as a product rather than as a process. In fact, unlike the iterative processes engineering students utilize to solve problems, students write "finished" documents in draft, submit them for a grade, and hope against hope that they'll be lucky enough to "win" a good grade. To address this finding, students over the last few years have been required to submit outlines and drafts of their documents, which are then peer- and self-evaluated. We would argue that students' ability to critically evaluate the quality of their peers' writing, as well as their own writing utilizing sound criteria, will also better prepare them to objectively assess their own work product. Students are also being encouraged to "buy into" the assessment process throughout the senior capstone classes by being given responsibility for developing appropriate criteria for assessing each assignment. The ability to develop this knowledge requires that students clearly understand the goals of the assessment process.

The outcome specific data were also encouraging as a number of other classes throughout the ECE curriculum were identified as containing writing. This was something that the department had not been aware of prior to the commencement of the portfolio assessment process, and has allowed the department to identify targeted writing opportunities throughout the ECE curriculum for curricular reform. However, with regard to repetitive effects between semesters to measure improvement over time, the data proved to be inconsistent as the value of the portfolio assignment, the scoring instruments and the process itself were continuously being refined over the course of the first three years to better meet the assessment goals.

In 2002, the assessment instruments and process were stabilized so that we could obtain data to determine whether the inter-rater reliability levels were acceptable in our portfolio assessment process. This was also done to ensure that consistent repetitive effects between semesters' data would allow us to analyze the data to determine if the data were statistically meaningful. Preliminary statistical analysis indicates that holistic scores on average have improved from 3.58 on a six-point scale with six being highest, in Spring 2002, to 4.3 in Fall 2003.

Conclusions

This portfolio assessment demonstrates several advantages frequently called for in theory but rarely made operational. In the first place, the assessment draws on existing material prepared by the students over a long span of time and for a variety of purposes, rather than generating new

assessment documents, with important economies in time and money for students and faculty as well as enhanced validity of measurement. Second, the evaluator in the first instance is the student preparing the portfolio, who must assess the degree to which the contents document achievement of program goals, thus inculcating metacognitive skills and self-assessment as the essential parts of the process. Third, the faculty and engineers' assessment of the portfolios is appropriately rigorous and generates reliable and valid information about each student's achievement. Fourth, the assessment also generates important program information for the faculty about the relative success of their students reaching goals that the faculty has determined to be important. And, fifth, the assessment has led to enhanced writing ability for the engineering graduates, fostered by faculty attuned to ways to encourage the uses of writing as part of their course requirements. This unusually rich result changes assessment from a mere rating of limited and often costly tests to a continuous, integrated, and appropriate activity directly related to learning itself, while at the same time, developing the data about student performance that any assessment design must produce.

While this kind of portfolio assessment may not be appropriate for every evaluation need, it does offer creative opportunities for much enriched assessment of additional engineering program outcomes including design and team skills.

Bibliographic Information

[1] National Society of Professional Engineers, "Report on Surveys of Opinions by Engineering Deans and Employers of Engineering Graduates on the First Professional Degree," no. 3059, pp.1-15, Nov. 1992.

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Biographic Information

MARTHA W. OSTHEIMER is a lecturer in the Electrical and Computer Engineering Department at the University of Arizona with fourteen years experience designing and teaching the communication component of the ECE curriculum. She is also the Chair of the ECE Writing Assessment Committee and a widely published poet.

EDWARD M. WHITE (emeritus professor of English, California State University, San Bernardino) is a visiting professor of English at the University of Arizona and the author or editor of eleven books on the teaching of writing and writing assessment.

