INSTITUTIONAL LEARNING OUTCOMES

PROGRAM LEARNING OUTCOMES

COURSE LEARNING OUTCOMES

AiA - Assessment in Action

Improving Engineering Writing Outcomes

EME 150A - Mechanical Design; EME 107A - Experimental Methods

UWP 102E - Engineering Writing

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Mike Hill and Brad Henderson teamed up to address the challenge of improving engineering writing outcomes in three upper-division courses. Hill saw an opportunity to improve students' ability to produce clearly written, professional quality, industry-specific documents in his upper division engineering courses, and better align the complementary writing program class with engineering students' needs. Henderson and Hill received an ASK grant to assess student learning and identify ways to improve writing outcomes in courses taught both in the Mechanical Engineering Department and the UWP. Beginning with Program Learning Outcomes for Mechanical Engineering, they identified sets of Course and Assignment Learning Outcomes for the targeted classes.

Program Learning Outcomes (PLOs) Addressed:

Mechanical Engineering: an ability to communicate effectively (meets ABET g).

UWP: produce varied types of writing, including essays, reports, proposals, arguments, and technical documents.

Step 1. Defined Course Learning Outcomes (CLOs)

In collaboration with the Assessment Coordinator, Henderson defined Course Learning Outcomes for UWP 102E (Engineering Writing):

1. Knows why engineering communication is important.
2. Can assess audiences and aim messages.
3. Can write concise, clear and correct sentences.
4. Can identify discipline-specific document structures.
5. Can deliver effective oral presentations.

Step 2. Assessment

Hill and Henderson undertook three levels of assessment, based on the evaluation levels identified by Donald Kirkpatrick, Professor Emeritus at University of Wisconsin's Management Institute:

1. Reaction: self-reported change in competence.
2. Learning: Measurement of ability to identify common errors in engineering writing.
3. Behavior: Holistic review of student writing samples before and after delivery of learning modules, measuring the extent to which students apply learning.

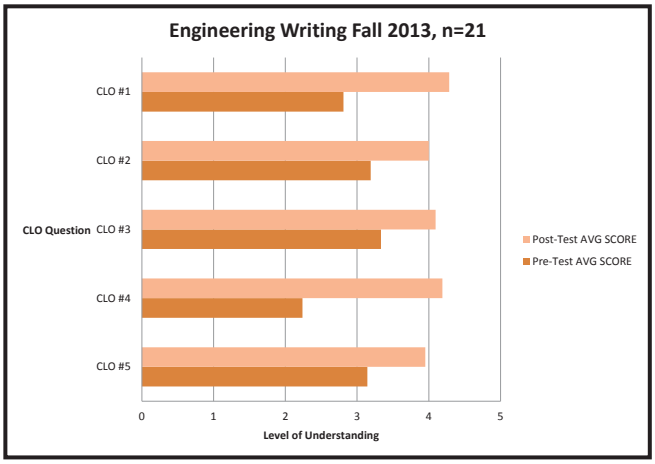

Figure 1 - Change in Self-Reported Understanding of CLOs Pre-and Post Course. CLOs referenced in the graph correspond to those listed at left.

Level 1 Assessment:

Self-Reported Change in Competence

Henderson's students were asked to rate their abilities for each of the five course-level student learning outcomes on a 1-5 scale.

The pre- and post-course self-assessments were administered via SmartSite to facilitate distribution, reporting and data collection.

Students reported increases in each of the learning outcomes, with the strongest gain in CLO #2 "Can assess audiences and aim messages" *(Figure 1)*.

Level 2 Assessment:

Measuring Change in Students' Ability to Identify Common Errors in Writing

CLO #3: Can write concise, clear and correct sentences.

Assignment LO: Can identify common sentence errors.

Precision is essential in engineering writing. In 102E, Henderson administered pre- and post-tests asking students to identify 20 errors embedded in a selection of engineering writing, based on the seminal research of Stanford professor Andrea Lunsford on the most common errors made in college-level writing. Results identified improvement in all but one category, with 91% improvement in identifying lack of pronoun-antecedent agreement *(Figure 2)*.

n = 18	Lunsford's 20 Common Errors Made by College Undergraduates*	Total Class Score, % Success, Error I.D.s, no repeats		Δ
		Pre-Test	Post-test	
	Lack of agreement between pronoun and antecedent	6%	100%	94%
	Sentence fragment	44%	93%	49%
	Unnecessary shift in pronoun	44%	86%	42%
	Missing comma in a series	38%	79%	41%
	Vague pronoun reference	19%	57%	38%
	Wrong tense or verb form	56%	93%	37%
	Ave. Individual Score (20 Possible)	10 out of 20 identifications	15 out of 20 identifications	

Figure 2 - Sample Results showing pre- vs. post-class assessment of sentence-level errors detected, UWP 102E, Spring 2013 - see http://bcs.bedfordstmartins.com/everyday_writer/20errors/default.asp

Level 3 Assessment:

Reviewing Student Writing Samples Using a Rubric, Pre-and Post-Training Modules

Hill's Engineering Design and Experimental Methods courses require students to write four status report memos and a final report. Hill identified five criteria for evaluating the quality of student writing; improving performance in these criteria defined course and assignment learning outcomes. Hill and Henderson created a holistic rubric for evaluating overall student improvement, and quantitative rubrics for grading each memo assignment. *(Figure 3)* .

Hill and the project TA reviewed the first memo assignment using the rubrics. Henderson created two Just-in-Time (JIT) teaching modules based on those results: how to write a status report memo, and sentence-level writing for engineering. He delivered the two JIT modules to Hill's classes during the quarter. Finally, the team reviewed the fourth memo using the custom rubric. Henderson A/B tested two versions of both JIT modules to different sections, delivering a shorter and relatively informal set, which saw greater improvement in each of the criteria than the longer, more formal version.

CRITERIA	Five Top-level Criteria for Evaluating the Quality of Engineering Status Report Memo	M1, EME 150A, Sprg 2013, Memo 1 of 4, n=14	M4, EME 150A, Sprg 2013, Memo 4 of 4, n=14	M1 vs. M4 Δ %, with ***informal JIT (shorter)***	M4* EME 150A, Fall 2013, Memo 4 of 4, n=12	M1 vs. M4* Δ %, with ***formal JIT (longer)***
1	Completeness	2.8	3.3	17.9%	3.1	10.7%
2	Quality	2.6	3	15.4%	3	15.4%
3	Velocity	3	3.1	3.3%	2.9	-3.3%
4	Noise	3	3.4	13.3%	3.2	6.7%
5	Packaging	2.5	2.9	16.0%	2.7	8.0%

Figure 3: Example results showing pre- vs. post JIT assessment of student papers, two EME 150A sections, subjected to two different JIT versions

Results

1. Articulating CLOs sharpened the teaching focus: each assignment was deliberately linked to measurable improvement in CLOs. Students in turn became more accountable for their learning. In each case, writing was measurably improved.
2. CLO-based rubrics streamlined and normalized grading. Project TAs reported achieving more accurate and consistent paper grading outcomes using project's new rubrics. Rubrics reduced paper grading time for engineering TAs and faculty.
3. TAs noted that the project improved their own skill-level.

"We were able, through the lens of assessment, to see things we hadn't seen before."

A Solution to Explore: JIT Modules

In this pilot phase, students responded well to JIT instructional modules threaded into engineering classes. When modules were integrated into the teaching plan, less time overall was spent on improving students' writing, while outcomes improved. The instructors believe it is possible that auxiliary writing classes such as UWP 102E might be effectively replaced by fully integrating discipline-specific writing instruction into engineering design and lab series classes.

See Henderson's paper presented at the 2014 ASEE national conference: http://www.asee.org/public/

Plan

Henderson and Hill collected results over two quarters in AY 2013-14. Initial success of this pilot trial has yielded plans for a more rigorous assessment with a larger sample size. Future plans include:

- Continuing collaboration on front-end design and testing of outcome-driven writing instruction and evaluation for engineering students, particularly those majoring in mechanical engineering.
- Continuing to refine and optimize threaded JIT modules on applied engineering writing and discipline-specific report forms for engineering design classes and lab classes.
- Charter UWP's WAC team with the continuation task of collecting and analyzing more samples of student work in engineering classes, and with assisting engineering faculty with further development of CLO-driven grading rubrics, assignment writing guidelines, and paper grading guidelines, in order to achieve statistically significant results.