AC 2009-405: ENGINEERING EDUCATION: ORAL AND VISUAL COMMUNICATION USING ENHANCED CALIBRATED PEER REVIEW

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Engineering Education: Oral and Visual Communication Using Enhanced Calibrated Peer Review

Abstract: Calibrated Peer Review™ (CPR) is a web-based application that enables students to critically review other students' written assignments anonymously, but only after they have achieved a successful calibration level via online critiques of standardized assignments. The current project expands and enhances this widely used "learning by writing" tool to a more comprehensive "learning by communication" model that includes graphical/pictorial and oral tools. The principal intellectual contribution is the development of new learning materials and teaching strategies coupled with evaluation studies that contribute to reform-driven engineering education. The project seeks to develop a flexible application both for STEM and for non-STEM disciplines that can be directly available to the existing community of registered CPR users (over 950 colleges and universities).

BACKGROUND

It has long been recognized that simply developing technical expertise in a discipline does not adequately prepare a graduate for future success in a professional setting. Employers have insisted that graduates in engineering must also have mastered requisite communication skills in order to become a valued member of their organizations.[3] This view has been implemented into Criterion 3 of the Accreditation Board for Engineering and Technology (ABET) Program Outcomes and Assessment; that is, "the necessity for engineering graduates to demonstrate the ability to communicate effectively."[5]

At LSU, this criterion is addressed through a university-wide program initiated in 2004 that focuses on improving students' communication skills in four modes: written, spoken, visual, and technological. The LSU CxC program relies on three key elements: Communication-Intensive (C-I) Courses, the LSU Distinguished Communicator (DC) Certification for Students, and discipline-specific Communication Studios.[7]

It is increasingly evident that better tools are needed to help integrate communication skills into an already busy engineering curriculum, both to facilitate learning and to improve those skills. Since writing is arguably the most critical of the communication skills, a number of tools have already been developed to leverage resources and improve student learning. Calibrated Peer Review™ (CPR) is one such tool that was developed at UCLA and has been successfully implemented in engineering curricula at Rose-Hulman Institute of Technology.

CPR (http://cpr.molsci.ucla.edu/) is an online application that enables students to critically review other students' written assignments as a learning tool for their own written work. Central to the success of CPR is a process that calibrates a student's ability to critically review a written assignment by having that student evaluate example writing assignments of varying quality. Only after a student has achieved a successful calibration level is that student allowed to proceed to the anonymous peer review of other students' assignments. Studies have shown that in addition to improving written skills, the CPR process also enhances student learning of the underlying technical content.[4, 6]

The CPR tool was successfully implemented by Rose-Hulman Institute of Technology (RHIT) for providing student-generated feedback on written works in engineering courses.[2] The CPR tool and process was found to be a particularly useful as a cognitive tool enabling students to

learn problem solving at a higher level. The development of CPR and its implementation at RHIT were both funded in part by NSF grants.

Building upon the well established and successful Calibrated Peer Review pedagogical tool and process for improving learning through writing, the current collaboration develops a web-based infrastructure to achieve improved learning through the development and use of effective oral and visual communication skills (while retaining the original writing element). The enhanced CPR tool (Version 5) will be used and its efficacy assessed as a part of the Louisiana State University (LSU) Communication across the Curriculum (CXC) Program and as part of a senior engineering design sequence at Rose-Hulman Institute of Technology.

PROJECT OBJECTIVES

The basic objective of the project is to enhance the original CPR "learning by writing" model to a more comprehensive "learning by communicating" model which retains the discipline, size, and level independence of CPR. To achieve this objective, the investigators partner with a member of the original UCLA development team and several faculty members who are currently at the forefront of CPR implementations nationally-one of which is in engineering. Five objectives guide this collaborative effort:

1. Create an enhanced version of CPR^{TM} (Version 5), which both allows for the input and review of visual and video components by students and also permits the expansion of this functionality to the 2500 assignments that have already been developed by the 100s of faculty in the 950 institutions who have current CPR accounts on the UCLA server.

2. Develop pedagogically driven assignments for seven core engineering courses.

3. Train engineering faculty in the development and use of CPR visually rich assignments.

4. Assess the impact of the integration of writing and visual communication on course development, student performance, and student confidence in communication skills.

5. Offer a suite of faculty training workshops on the use of the CPR tool and process at national and regional ASEE conferences as a means to build a community of users in engineering.

EXPECTED LEARNING OUTCOMES

Using Bloom's Taxonomy as a means to establish the desired cognitive and affective levels of learning, we focus on students gains in three proficiencies:[1]

1. Students will demonstrate an ability to **evaluate** the effectiveness and quality of oral and visual presentations through direct comparisons with the results of expert and peer reviews.

2. Students will demonstrate that they can **synthesize** *(this encompasses composition, writing, rewriting and, by implication, speaking and preparing/revising visual presentations)* the results of their work in oral and visual presentations that achieve a minimum score of 80 (on a 100 point scale) when judged against criteria for quality and effectiveness (i.e., a rubric)

3. Students will demonstrate that they have **internalized the values** of self evaluation and continual improvement in their communication skills

Our guiding intent for the project is to further develop currently available materials and to propagate the methods for using CPR as a means of using active learning as a feedback loop for both student and instructor in engineering design. Although currently limited to the written mode of communication, CPR lends itself well to the higher learning objectives reached with a feedback loop. This process is shown below in Figure 1.
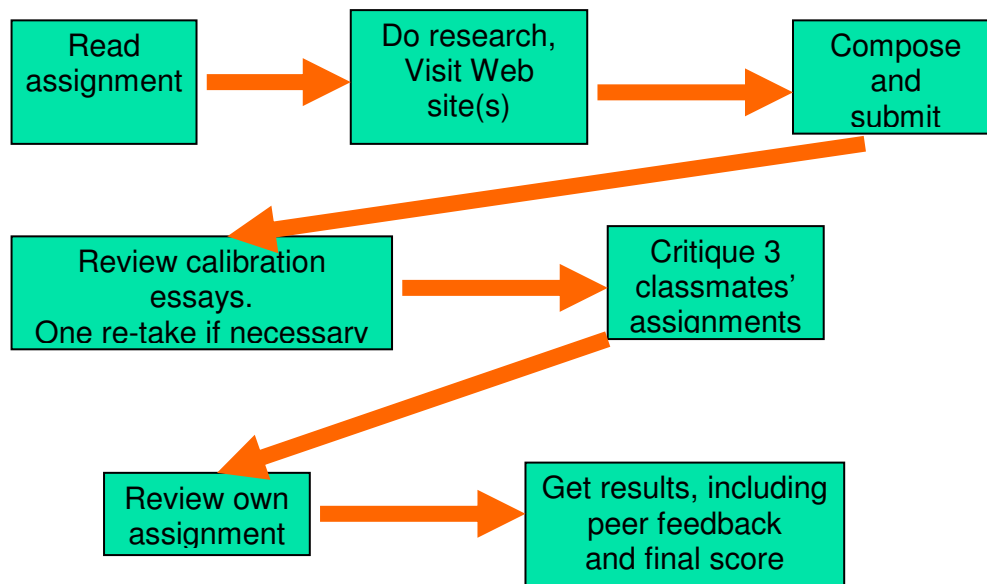

Figure 1: Learning Task "Episodes" Tracked in CPR Session (from CPR Training Materials, Arlene Russell and Tim Su)

ASSESSMENT

Effective formative and summative assessments by a well-qualified outside evaluator will help to ensure the effectiveness and universality of the enhanced CPR model. Dianne Raubenheimer serves as the project external evaluator. She is currently the Director of Assessment for the College of Engineering at North Carolina State University. She will guide the team through a well-planned agenda of assessment tasks:

1. Develop revised evaluation rubrics for assessing student's written, oral, and visual communications products starting from rubrics currently being used in the Communication across the Curriculum (CxC) program, and building a focus on anticipated student learning outcomes, with due consideration of the reviews and recommendations of the Project Advisory Panel, the Engineering Communication Advisory Council, and the External Evaluator.

2. Develop surveys for assessing student perceptions and opinions about the program with due consideration of the reviews and recommendations of the CPR Project Advisory Panel, the CXC Advisory Panel, and the External Evaluator.

3. Develop surveys for assessing student self-confidence in achieving the anticipated learning outcomes. Ultimately this data will be triangulated with data from the rubrics and focus group interviews with students.

4. Collect baseline assessment data before implementation of the new program (using revised rubric and survey results) for written, oral, and visual communications in sophomore design courses and senior capstone design courses.

FINAL OUTCOMES

Anticipated results from the project fall into four categories:

- **Development of new teaching materials and learning strategies:** This project will upgrade the CPR web-based software to include oral and visual communication components, while also developing new teaching assignments in existing engineering courses.

- **Development of faculty expertise** will be achieved at both the local and national levels through workshops designed to train faculty members on the effective use of this innovative tool. These workshops will be conducted at the lead institution and at the Annual American Society for Engineering Education Conference.

- **Implementing Educational Innovations**: The enhanced CPR tool will be implemented at LSU, the lead institution, in the Department of Agricultural and Biological Engineering, Civil and Environmental Engineering, and Mechanical Engineering, primarily in project design courses. Concurrently, the Electrical and Computer Engineering Department at RHIT will pilot a set of similar CPR modules within a senior design sequence. Result from these field-tests will be widely disseminated.

- **Assessing Student Achievement:** The external evaluator will help project faculty develop CPR assessment instruments for their courses and will help to determine overall student achievement. These materials will be made available to a broad range of constituencies.

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