AC 2012-3917: IMPROVING ENGINEERING EDUCATION WITH ENHANCED CALIBRATED PEER REVIEW ASSESSMENT OF A COLLABORATIVE RESEARCH PROJECT

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Improving Engineering Education with Enhanced Calibrated Peer Review – Assessment of a Collaborative Research Project

Abstract:

Calibrated Peer Review (CPR^{TM}) is an online application that was developed to enable students to critically review other students' written assignments as a learning tool for their own written work. This paper describes the results of a project to create an enhanced version of CPR, both to allow for the input and review of visual and spoken (video) components by students and also to permit the expansion of this functionality to the 2500 assignments that have already been developed. The primary objectives of this project grant follow:

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

- Train engineering faculty at the collaborating institutions in the development and use of visually rich CPR assignments.

- Develop pedagogically driven assignments for a set of core engineering courses.

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

Development of CPR (Version 5) was completed to accommodate input and access to visual tools. This version was beta-tested and revised, allowing for existing assignments in version 4 to be modified to accept graphical and visual input.

Complications in uploading student work and accessing calibration artifacts, as well as difficulties in the assignment authoring process, suggest a need for upgrades to the interface between the central assignment database and the enhanced version of CPR. Despite these challenges, however, participating engineering faculty successfully completed the development and implementation of assignments, and students were able to calibrate and participate in online peer review of communication assignments in core engineering courses. While faculty encountered obstacles when attempting to seamlessly integrate video components, videotaped oral presentation assignments were shown to be adaptable to the CPR format. Students also completed technical poster assignments and dimensioning assignments involving engineering graphics.

Improving Engineering Education with Enhanced Calibrated Peer Review™ – Assessment of a Collaborative Research Project

Introduction:

Calibrated Peer Review (CPR), an internet-based instructional tool developed at the University of California, Los Angeles (UCLA), enables faculty to include discipline-based writing and communication skills in any class. The program has been widely adopted by over 1600 institutions and is used primarily in large classes, particularly in the STEM disciplines.

We present here observations and findings from an NSF grant (Project # 0817515, 0816859, and 0816660) awarded to a consortium of educational institutions including UCLA, Rose-Hulman Institute of Technology (RHIT), Louisiana State University (LSU) and the Louisiana Transportation Research Center (LTRC). The goals of this collaboration were

- To re-code the original CPR software to include visual and oral forms of communication;
- To develop and field-test engineering communication assignments;
- To contribute these assignments to a central library (maintained at UCLA), accessible to all CPR users;
- To assess the impact of the integration of visual communication on course development, student performance, and student confidence levels in visual communication skills.

Re-designed through successive iterations during the grant period, CPR5 extends the platform's capability to allow for the creation and evaluation of student work, be it graphics, visuals, oral presentations, movies, or posters.

<u>Basic Features of CPR:</u> Four structured workspaces perform in tandem to create a series of activities that reflect modern pedagogical strategies for using writing in the learning process. A separate instructor interface and student interface provide customized reports on performance for individual assignments (see Figure 1).

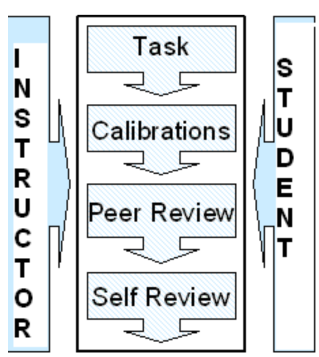


Figure 1: A Dynamic, Multi-staged Learning Environment

- *Task*: Students are presented with a challenging communication task, with guiding questions to act as scaffolding for the demanding cognitive activities. Web-linked resources (e.g., tutorials, samples, guidelines, or other handouts) may be embedded at this point.
- *Calibration*: Students examine three "benchmark" samples and assign each a score based on a series of evaluative questions (a rubric). The program assigns students a "reliability index" from 1 to 6, based on their demonstrated competency in these exercises. The index is used later in the scoring algorithm at the end of the assignment. This calibration or training segment mitigates the common objection to peer review in the undergraduate classroom: that the experience reduces itself to the blind leading the blind.
- *Peer Review*: After becoming a "trained evaluator" – and being assigned a credibility weighting – students examine and provide written feedback on three anonymous peer submissions using the same calibration rubric. Students also assign each submission a holistic score from 1 to 10.
- *Self-Assessment*: As a final activity, students evaluate their own submission. As with calibration and peer review, students use the same rubric (set of performance standards for the task). Having trained on benchmark samples, and then applied their expertise in evaluating peer text, students engage in a reflective, final activity by assessing their own work. Through self-reflection, students gain a deeper understanding for the assignment its requirements and its outcomes.

<u>Assessing Learning Outcomes with CPR:</u> CPR captures and stores performance data - *in situ* - for each student at crucial junctures in the peer-review process. Observations from six categories measure dimensions of the process of learning for individual students or for aggregates of students. Table 1 explains the nature of these six measurements, how they are represented, and why they are useful as formative feedback, both for instructors and for students.

Table 1: Data Collected *In Situ* by CPR

Workspace	**Data Measurement**	**Use**
Text/Submission Rating	Quality of the Artifact (TextRate)	Expressed as a number from 1 (low) to 10 (high); this score is the weighted average of the holistic evaluations made by three peer reviewers.
Calibration	% Correct	The percent of correct answers to the rubric questions for three benchmark examples.
	Average Deviation (CalDev)	The average difference between student ratings and answer-key ratings for all three samples given in the calibration workspace.
	RCI (Reviewer Competency Index)	Based on overall performance in the calibration exercise, students are given a "reliability" score of from 1 (lowest) to 6 (highest).
Peer Review	Average Deviation (RevDev)	The average difference between student ratings of peers' text and the weighted ratings of the three peer reviewers of the same text.
Self-Review	Average Deviation (SADev)	The average difference between student self-rating and the weighted average ratings from all three peer reviewers.

In addition to empirical data, the CPR system also stores (and displays to an instructor on request) all the peer-provided, qualitative-based commentary for each student, from each session. Based on the instructor's preference, CPR results may be used either as formative or summative evaluation. In other words, CPR lends itself to mediating revision or to providing a student-awarded final grade. The implementation is up to the instructor.

As part of the grant, the distributed CPR4 version of the software was rewritten to accommodate students uploading any file type into the system. Also, adjustments were made to the instructor interface so that handling individual student accounts, viewing results, and managing enrollment became easier.

Of note, prior to the current project, a major change was made in the CPR configuration. CPR-Original (now known as the CPR Demo) runs from UCLA. All student accounts, submissions, results records, and contributed libraries reside on UCLA servers. CPR4 introduced a distributed model. Institutes using CPR versions 4 and 5 run the core software, create student accounts, and store submissions on a local server. However, all assignments reside at UCLA where they are authored, stored in a central shared library, and activated from that server by any licensed user.

Thus, platform changes in CPR were on-going during the course of the grant, making for challenging situation when testing with student populations in actual course environments.

Before CPR5 was transferred to LSU and RHIT, a pilot visual communication assignment was implemented at UCLA to test the upload feature; RHIT and LSU subsequently developed communication assignments focusing on visual and oral communication, as well as rubrics to assess these communication assignments. These assignments were implemented in a variety of courses at RHIT and LSU.

Pilot Assignment at UCLA:

Calibrated Peer Review writing assignments have been components of all the general chemistry laboratory courses at UCLA since 1997. Typically, two or three assignments are made during a 10-week quarter. All deal with the theory or practice of the topics in the courses.

Assignment Rationale: At UCLA, the upload feature focused on teaching scientific graphing skills for first-year engineers and physical scientists in a quantitative chemistry laboratory course. As Tufte articulated in 1983,[1] "Translating and communicating data into a graphical format ranks high as an essential scientific skill." The skill, however, is at best relegated to appendices in high school texts, and future engineers first encounter scientific graphing in college in general chemistry, their first science laboratory course. Typical general chemistry lab manuals devote an introductory section or an appendix to graphing procedures, including explicit directions for layout, format, and data presentation, and newer manuals support technology tools and encourage students to use them to prepare graphs of their experimental data. However, most students have not internalized the principles of scientific graphic, but rather resort to the default options of the "chart" tools of Excel, a program designed for marketing and advertising, not for science.

The goals of the assignment were not only to test the upload feature, but also to teach students how to use the Excel “tool” to prepare scientifically acceptable graphs useful for data analysis.

The CPR graphing assignment seeks to embed an understanding of the essential features through explication of the graphing process, training, and peer evaluation of six examples. The graphing task itself is a component of a lab report for an assignment the students have already done. Thus, it is an authentic representation of students’ own data.

Research Methodology: Engineering and physical science students (n = 172; 70 engineering majors) in the second term of a general chemistry laboratory course wrote a 350-word essay describing how they prepared their graphs for a linear analysis of the data for one of their experiments. They were specifically instructed to describe how they set the scale, chose the title and axes labels, and determined the slope of the line for the analysis of a compound that they had synthesized in the laboratory. The assignment, done outside of class time, was low-stakes accounting for only 3% of the grade in the course.

Student’s participation was high: 100% submitted graphs; 88% completed the assignment, which entailed creation of the graph, writing about the process, training on the rubric with carefully chosen examples, review of peers’ work, and self-review of their own original graph submission. The process continued over a two-week period. Following completion of the assignment, the embedded detailed assessment information on student performance at each step of the assignment was analyzed to investigate the effectiveness of each stage of the assignment in teaching graphing concepts to those students who had not mastered the skills in earlier instruction.

Results: The upload software tool worked robustly. Students successfully uploaded 11 different file types (e.g. pdf, doc, docx, png, xls). All but one upload, which did not have an extension, were successfully downloaded by the peer reviewers.

To determine the impact of evaluation (calibration training and peer review) on content understanding, the study analyzed the *in situ* performance of the students whose submitted graphs were noted as having errors in scaling and grid by all three of their peer reviewers. The sample consisted of 31 students (18% of the class). Two places in the CPR process give evidence of student learning: mastery in the calibration stage and accurate self-assessment of the original graph. The data from the study are provided in Table 2.

Discussion: The sample chosen to study represents the most egregious of the graphs submitted in the assignment and, thus, the students most in need of remediation. Even though student habits, and perhaps misconceptions, are resistant to change, 77% of the students in this group eventually were able to correctly evaluate the strengths and faults of the graphs provided in the calibration training; 80% of those students transferred this new learning to recognize the faults in their own work, which they had submitted prior to any evaluation training. Of the remaining, 20% (6), who did not master the calibration training, half of them recognized their original mistakes when they encountered them at the end of the assignment, during the self-assessment stage. Thus, the CPR process “rescued” 22 students in the class, or 77% of those who had entered the class without the requisite understanding of graphing principles and who would otherwise have failed the assignment.

Table 2: Content Learning of Graphing Principles During the Reviewing Stages of a Calibrated Peer Review Assignment

Sample	#
Number of graphs for which all peer reviewers noted technical errors in scaling and grid (18% of class)	31
***In situ* performance of 30 students with poor graphs** (one student did not complete the assignment)	
Students with poor graphs who later demonstrated understanding of the concepts at the end of training (calibration stage) # of these students recognizing errors in their own graphs (self-assessment stage)	24 19
Students with poor graphs, who did NOT master concepts at the calibration stage # of these students who nonetheless recognized their errors (self-assessment stage)	6 3
Cumulative number of students learning graphing principles through the CPR reviewing processes	**22**

The assignment was repeated in the same course in Fall 2011 with an additional 160 students.

CPR Assignments at RHIT:

RHIT has completed nine years of experience using Calibrated Peer Review (CPR) from 2002 through 2011. During this period, over 1,200 students used the software through a liaison between the Humanities/Social Science Department (HSS) and the Electrical and Computer Science Department (ECE). Much of this work was supported by three NSF awards (DUE-CCLI #9980867; DUE–CCLI-ASA #0404923; and DUE-CCLI Phase II #0816849). Results from these years have been reported elsewhere.[2 – 30] The current collaboration has resulted in new learning materials and teaching strategies, coupled with evaluation studies that contribute to reform-driven engineering education. [2-19, 24]

<u>Visual Communication Assignments at RHIT:</u> During academic years 2010-2011 and 2011-2012, both the ECE department and the HSS department used newly released CPR4 and CPR5. The software was implemented in two courses: RH 131 Rhetoric and Composition and ECE 160 Engineering Practice.

- **RH 131 Rhetoric and Composition – 4 credit hours**
  This course emphasizes rhetorical analysis of texts and images, research methods, and the conventions of academic and professional writing, including argumentation. It includes practice in public presentations and integration of verbal and visual components.

- **ECE 160 Engineering Practice – 2 credit hours**
  The principles of system engineering design and teamwork are used by student teams as

they design, test, and build an autonomous robot to meet a set of performance specifications. An end-of-term competition for testing the robots' performance to meet the design specifications and for honor and glory features exciting matchups between teams. Students and instructors are encouraged to have fun throughout the course.

Table 3 summarizes the assignments and the CPR software versions used over the past two years (AY2010/11 and AY 2011/12). RHIT is on the quarter system with courses meeting 40 times during a ten-week period. The curricula for RH 131 and ECE 160 have used CPR for a number of years, and each has developed a suite of central writing assignments integral to the course instruction. Because each course already had – on average – five CPR sessions within a ten-week period, we had to make some trade-offs in order to include the visual communication modules that accommodate this project's focus.

The assignments were contributed to the CPR Central Library, where they are available for use at other participating institutions. We concentrate here on the highlighted assignments which emphasize aspects of visual communication.

Table 3: Enhanced CPR Usage at RHIT, AY 2009 – 2011

<table>
<tr><th>Course</th><th>CPR Version</th><th colspan="2">Students</th><th>Assignments</th></tr>
<tr><td>RH131 (Fall 2009)</td><td rowspan="3">CPR-Original</td><td>44</td><td rowspan="3">110</td><td>1. Critiquing an Oral Presentation
2. Critiquing a Team Presentation</td></tr>
<tr><td>RH131 (Spring 2010)</td><td>22</td><td rowspan="2">3. Practice Writing a Summary
4. A Mini Position Paper
5. Writing a Solid Paragraph
6. Opening Paragraph for a Reflection</td></tr>
<tr><td>RH131 (Fall 2010)</td><td>44</td></tr>
<tr><td>ECE 160 (Fall 2009)</td><td rowspan="2">CPR 4</td><td>63</td><td rowspan="2">117</td><td rowspan="2">1. Introduction – How Did You Select Your Major
2. Talking Minutes – Team Design Meeting</td></tr>
<tr><td>ECE 160 (Winter 2010)</td><td>54</td></tr>
<tr><td rowspan="2">RH131 (Fall 2011)</td><td rowspan="2">CPR 5</td><td colspan="2" rowspan="2">43</td><td>1. Critiquing an Oral Presentation
2. Using Assertion-Evidence PowerPoint Slides</td></tr>
<tr><td>3. Opening Paragraph for a Reflection
4. Practice Writing a Summary
5. A Mini Position Paper
6. Writing a Solid Paragraph</td></tr>
<tr><td rowspan="2">ECE 160 (Fall 2011)</td><td rowspan="2">CPR 5</td><td colspan="2" rowspan="2">66</td><td>1. Project Verification Matrix</td></tr>
<tr><td>2. Taking Notes at a Design Meeting
3. Project Report</td></tr>
</table>

- *Designing Assertion-Evidence PowerPoint Slides*: This module invites students to think in terms of information design when constructing visuals for an engineering presentation.

In the classroom instruction, students are led through an exercise to identify both audience and purpose. They then examine a gallery of slide-augmented presentations appropriate for their own rhetorical situation. Examples are drawn from noted practitioners in technical communication (for example, Michael Alley's collection of materials available at http://www.writing.engr.psu.edu/handbook/visuals.html.)[20, 31]

- *Oral Presentations*: This module addresses central issues for presentational skills and engineering education. (RH 131 for the fall of 2009 did both a short talk and a longer, two-person team presentation.) The suite of classroom activities included units for specific types of talks, all drawn from engineering practice. Students did the talk in front of an audience and were video-taped. Peer review covered requisites for good public speaking, including (1) content, (2) organization, (3) delivery, and (4) audience engagement. This CPR module emphasized quality written feedback and depended heavily upon the instruction and supplemental exercises that took place in the classroom.

- *Engineering Design Documentation – Project Verification Matrix:* Within the module, students in the ECE freshman design course learn to use standard documentation for communication between team members and between the design team and its client. The Project Verification Matrix is a visual representation of a process to ensure that the design team and its product have satisfied the requirements of the customer. Assignments using other graphical representations that provide a synoptic overview of a complex process (such as a Gantt chart) are being designed.

In all, 336 students from RH 131 and ECE 160 used CPR assignments during this two year period. 219 participated in at least one visual communication assignment implemented through CPR.

CPR Assignments at LSU:

During academic years 2010-2011 and 2011-2012, LSU used CPR5 in three courses:

- **CM 1030 Engineering Graphics –2 credit hours**
  This is an introduction to engineering graphics using AutoCAD. CPR was used to assess correct dimensioning standards required for engineering drawings.

- **CM 3400 Construction Materials – 3 credit hours**
  This class addresses fundamentals involved in design, evaluation, testing, and construction of asphalt, concrete, aggregates, steel, timber, and composites; mechanic properties of soils, compaction, and slope stability; construction of shallow and deep foundations, and retaining walls. Student teams presented their final projects in a poster presentation open to guests from the entire College of Engineering.

- **ENGR 1050 Introduction to Engineering – 2 credit hours**
  This freshman-level course introduces students to basic concepts found in all areas of engineering. Student teams compose posters illustrating a semester project.

Table 4 summarizes the assignments and the CPR software versions used over the past two years (AY2010/11 and AY 2011/12).

Table 4: Enhanced CPR Usage at LSU, AY 2010 – 2011

Course	CPR Version	Students	Assignments
ENGR 1050 (Fall 2010)	CPR 4	46	Poster Guidelines for Technical Presentations
ENGR 1050 (Fall 2011)*	CPR 5	14*	Poster Guidelines for Technical Presentations
CM 1030 (Spring 2011)	CPR 5	26	Dimensioning
CM 1030 (Fall 2011)	CPR 5	39	Dimensioning
CM 3400 (Spring 2011)	CPR 5	40	ASTM Standard Poster Assignment
CM 3400 (Fall 2011)	CPR 5	41	ASTM Standard Poster Assignment

*Because of the large number of students in this section, rather than use CPR5 to teach the freshmen, CPR5 was used as a calibration tool for training undergraduate teaching assistants.

The above assignments were contributed to the CPR Central Library, where they are available for use at other participating institutions.

- *Poster Guidelines for Technical Presentations*: The goals of this assignment are to develop strategies to use when generating a technical poster for an oral presentation. Through this assignment you will learn: 1. To use proper grammar & efficient use of words to depict and describe the subject 2. To summarize testing standards and create concise, informative technical posters 3. To choose appropriate colors, fonts and pictures to maximize communication of ideas 4. To reflect upon and select supporting documentation such as tables, graphs and schematics to relay technical content of testing standards 5. To distinguish between different parts of a testing standard & to select the parts that best enable an audience to comprehend the rationale and requirements of the standard.
- *Dimensioning:* This assignment is designed to teach students to correctly dimension circles, arcs, contours, holes, prisms, and cylinders. In addition, students learn correct placement and form of these dimensions including: dimension text, dimensions lines, extension lines, arrows, leader lines and notes on the two-dimensional drawing.

- *ASTM Standard Poster Assignment:* This assignment is the same as the Poster Guidelines assignment listed above; however, the poster content requirements were specific to the ASTM standards covered in the class.

In all, 206 students from ENGR 1050, CM 1030 and CM 3400 used CPR on visual communication assignments during this two year period.

Assessment:

RHIT Preliminary Assessment Results: The sections below provide examples of how using CPR can generate both empirical performance data on student learning outcomes as well as opportunities for more fine-grained student satisfaction questionnaires. The ECE Department at our institution has used CPR data in a successful ABET Self-Report, as reported in. [2, 3]

Quantitative – Student Achievement: All versions of CPR offer insight into the process of student learning. The system's built-in data collection provides a range of *in-situ* observations from which outcomes can be measured through standard and specialized data reduction methods.

These learning outcomes can be represented as growth for individual students or aggregates over time, or they can be given as synoptic overviews resulting from statistical methods such as regression analysis or aptitude-treatment interaction, to name just two forms of statistical inferences that can be applied to the data routinely collected in a CPR session

To demonstrate the types of quantitative assessment that can be performed on these data sets, we use the results from the RH131 Fall 2011 "Critique of an Oral Presentation" assignment (see Table 5). This assignment was completed using CPR5. The variables being correlated are defined in the legend below Table 5.

Table 5: Correlation Between Four Measures of Performance

		CalDev	PresRate	SADev	RevDev
CalDev	Pearson Correlation	1	-.418(**)	-.061	-.084
	Sig. (1-tailed)		.004	.358	.307
	N	38	38	38	38
PresRate	Pearson Correlation	-.418(**)	1	-.078	-.065
	Sig. (1-tailed)	.004		.321	.350
	N	38	38	38	38
SADev	Pearson Correlation	-.061	-.078	1	.403(**)
	Sig. (1-tailed)	.358	.321		.006
	N	38	38	38	38
RevDev	Pearson Correlation	-.084	-.065	.403(**)	1
	Sig. (1-tailed)	.307	.350	.006	
	N	38	38	38	38

** Correlation is significant at the 0.01 level (1-tailed).

CalDev	The difference between student's evaluation of benchmark samples and the instructor-provided answer key. Useful as a fine-grained measure for individual learning in the calibration phase. (A low standard deviation indicates that the student can determine to what degree a benchmark sample meets a set of performance standards.)
PresRate	Completed before the calibration, this measure can indicate how well a student has absorbed the unit's instruction prior to the CPR session. As such, this variable can be used as a proxy for a pre-treatment variable.
RevDev	The difference between a student's evaluation of peer samples and the evaluation number given by other peers. Less deviation from the standard may indicate that the student has correctly applied the abilities taught in the calibration.
SADev	The difference between a student's self-evaluation and that of her peers. As in RevDev, the objective is to be within an acceptable range of the standard.

In the RH 131 Oral Presentation assignment, 38 of 43 students completed all phases of the CPR session and were included in the sample. Using SPSS, correlations between four measures of performance were calculated.

Two statistically significant correlations appear in Table 5 (above). Both are moderately strong for human behavior studies. For this assignment and for this sample of students, the stronger the student's oral presentation (as rated by peers), the more likely the student will do well on the calibration ratings. In other words, the assignment appears to integrate well with the classroom instruction. Note that this correlation is negative because the text rating (from 1 – 10) should increase the better the student's presentation, while the deviation number (variance from expert evaluation provided for the benchmarks) in the calibration becomes smaller the better the student performs in this phase of the CPR.

The second significant correlation (between RevDev and SADev) also appears to indicate that the students have understood the performance requirements (the rubric) and can apply these standards reasonably well. The correlation indicates that -- for a statistically significant portion of the sample -- smaller deviations in peer reviews carried over to smaller deviations in the rating given in the self-review.

Examining the interactions among the variables in CPR provide learning outcome data both in individual assignments and across assignments. As part of this project, RHIT will make available a set of Excel templates for descriptive analysis (distribution, measure of central tendency, standard deviation) and for inferential statistics (interaction among variables and predictive power within a sample population).

The *in situ* data collected by CPR may also be examined for learning outcomes without using statistical methods.

Qualitative – Student Opinion: The students (44) in the fall 2011 RH131 course were asked to fill out a self-report survey consisting of 27 questions. These students had used CPR5 and had completed six CPR assignments. Based on the Views about Science Survey (VASS) format (but not the aim or the content of the original instrument), the survey format permits more nuanced answers than the standard Likert-style indicators. (See http://modeling.la.asu.edu/halloun/pdf/VASSsynp.pdf for a more complete description of VASS -- including format, scoring, and interpretation of results.)

A VASS-type poll presents respondents with an incomplete statement and two possible completions. The eight-part scale allows respondents to give weights to each of the two potentials. Figure 2, below, illustrates the modulations in response available for each survey item. The scale collects more nuanced attitudes and beliefs than the "strongly agree," "strongly disagree," or somewhere in between dimension of a Likert scale. Thus, the profiles generated from this type of survey can be a source of rich, qualitative interpretation. On the other hand, because of the multi-dimensional nature of the responses, interpretation of results runs a danger of being more subjective than the standard Likert model.

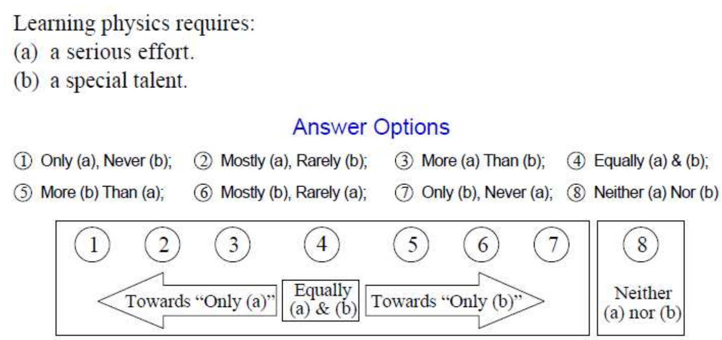
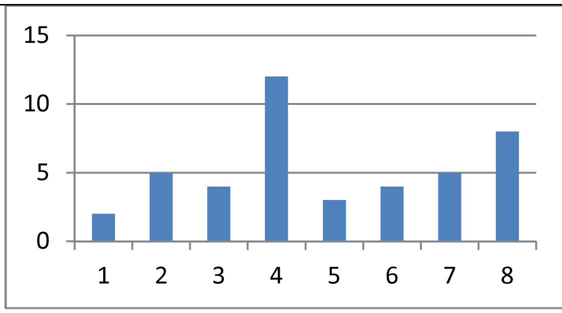


Figure 2: A VASS-like Response Scale, Adapted from[32]

On the survey given to the RH131 Fall 2011 class, seven of the 27 questions dealt directly with the efficacy of CPR. The remaining 20 items focus on attitudes toward communication, peer review, revision, and locus of authority in evaluation of student work. 43 students completed the survey within an ANGEL Course Management System environment. This presentation uses only the seven questions specifically on CPR. Results are presented in Table 6.

Table 6: Survey Items Profiling Attitude toward CPR, Fall Quarter 2011, Using CPR5

Question 3

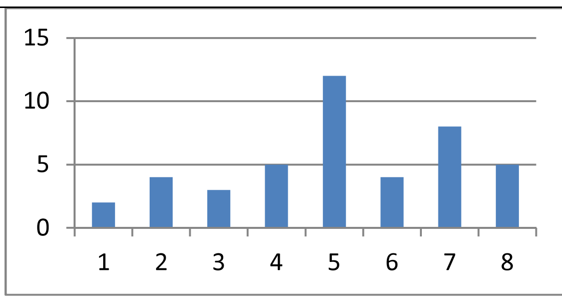


3. When using CPR (Calibrated Peer Review),
   a. I focused on the comments I received from my peer reviewers
   b. I focused on the numerical rating I was given by my peer reviewers

Comment

n=43; Average Response: 4.9
The profile is encouraging. 12 students (or 27.9% of the sample) felt that the qualitative and the quantitative feedback were equally useful. Of some concern, 8 students (or 18.6% of the sample) indicated that they focused on "neither" of these important aspects of the CPR system.

Question 5

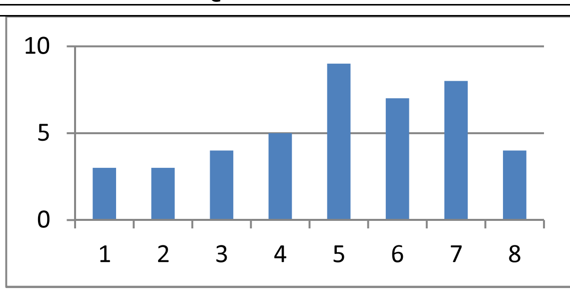


5. When using CPR, the calibration segment of the session
   a. Helped me to make meaningful comments on the communication items I reviewed
   b. Took more time than I wanted to devote to the assignment

Comment

n=43; Average Response = 5.1
The profile shows that – when given the dicotomy of (a) and (b) – only 20.9% of the sample felt that the learning outweight the amount of time the CPR required, while 55.8% felt that the CPR calibrations were time-consuming. Five students were balanced between the two choices. Five students opted for the "neither" response.

Question 20

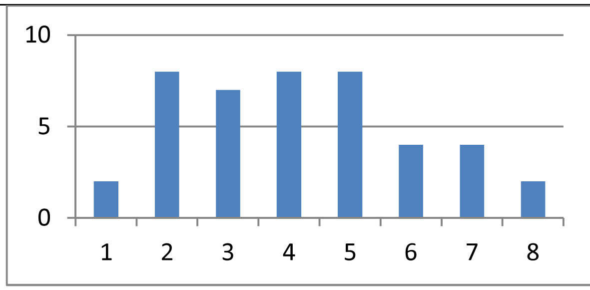


20. In CPR, the **self-assessment** activity
   a. Helped me to view my own draft with new insights or awareness how to improve
   b. Took more time than I wanted to give to the assignment

Comment

n=43; Average Response = 5.0
The profile indicates that student reactions were mixed on the benefits of the self-assessment activity versus the time required. 55.8% leaned toward saying that the segment took more time than they want to give; 23.2% felt that they gained insights on how to improve (and that this out-weighted the time portion of the item). Five students were balanced between time required and learning advantage. Only 4 students (less than 9.3%) selected the "neither" option on this question.

Question 21

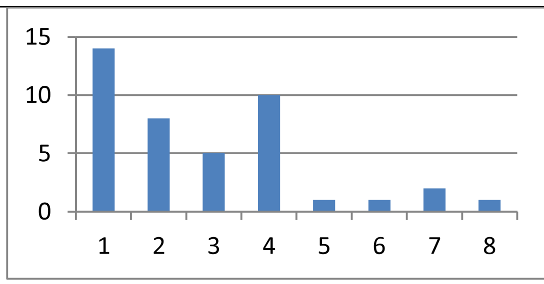


21. In deciding to use CPR for communication assignments in technical classes, I believe
   a. The software would help to review drafts for such things as lab reports
   b. Would just add another layer of work without improving performance

Comment

n=43; Average Response = 4.2
In the profile, students – on balance -- are positive about using CPR in technical courses. The eight students who selected the mid-level “both” option seem to be saying that the software would help, but might not improve performance adequate to justify the additional work. 39.5% of the sample believed that the software would be beneficial in a technical class. 37.2% felt there might be a benefit but that the time required would be a deterrent. Less than10% of the students indicated that the software would only add more work without producing a performance gain. Two students selected the “neither” option.

Question 22

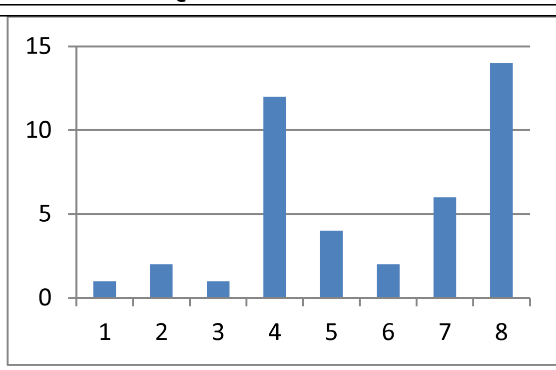


22. A drawback to CPR was
   a. Remembering the schedule for the different deadlines
   b. Being held accountable for a focused review of the work of others

Comment

n=42; Average Response = 2.8
In the profile, the preponderance of students felt that the different deadlines associated with a CPR session were more of a burden than being held accountable for doing meaningful reviews of classmates’ work. However, 10 students felt that both were a drawback. Only 1 student felt that “neither” was a drawback. 14 students (or 33.3% of the sample) felt that of the choices given; only the deadlines were a drawback.

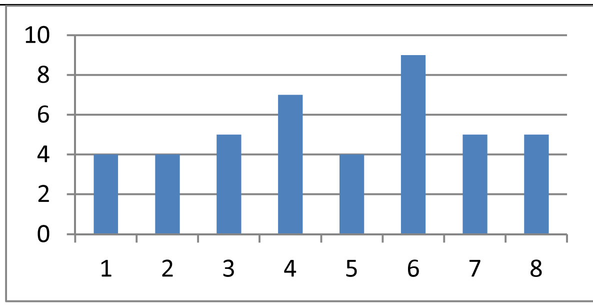
Question 24



24. Overall, I believe CPR
   a. Helped me mature as a communicator
   b. Helped me become a better evaluator of other

Comment

n=42; Average Response = 5.8
The profile – on balance – is favorable to CPR usage. Although 14 students (or 33.3%) answered “neither” for the suggested benefits, the profile clearly indicates that the majority of the students felt there was some gain. Twelve students (28.5%) felt that the software helped them with both learning dimensions. 9.5% (4 students) leaned toward growth as a communicator, while treble that number (12 students or 28.5% of the sample) indicated that they became a better evaluator of

people's communication	others.
Question 25	**Comment**
 25. Overall, I believe CPR a. Helped me learn how to provide focused feedback on other people's communication b. Was a segment of the course that I marginalized	n=43; Average Response = 4.7 The profile indicates an underlying student ambivalence toward CPR. 16.2% felt that the software helped them become better reviewers, but admitted that they did not concentrate on CPR as a learning experience. 30.2% respondents leaned toward saying that they did not marginalize the CPR sessions, while 41.8% leaned toward saying that they did. Five students selected the "neither" option.

Interpreting a VASS-like survey works best if there is a second sample population representing a definable difference from the first sample – such as in levels of exposure/expertise, in demographic characteristics, or in contrasting treatments / conditions. This same survey was administered to an RH131 course in the Fall Quarter of 2005. The 48 students in the 2005 sample population used CPR-Original and did not incur a CPR-enabled visual communication assignment. Thus, these two data sets represent different treatments/conditions. Comparing these results is currently underway. Additionally, interactions between individual responses on the self-report survey and performance on CPR assignments are being examined.

In addition to the formative and on-going assessment carried out at UCLA, RHIT, and LSU, the project had an external evaluator whose responsibilities included administering a pre- and post-survey to measure students' perceptions of their abilities. We provide results from the latest survey administered to a course at LSU in the spring of 2011 and to a course at RHIT during the fall of 2011. A single CPR session at LSU emphasized posters while two sessions at RHIT focused on oral presentations supported by PowerPoint.

The multiple-item online questionnaire asked students to self-report on four dimensions of CPR and visual communication. Presented here are results from the cluster of items that rated student confidence levels (perceived self-efficacy) for a range of skills required in preparing, giving, or peer reviewing multi-modal presentations

The same core instrument and items were used for students in the pre- and post-test. Additional items were used on the LSU survey instrument due to the nature of the CPR assignment. Using an online environment for each, students responded on a Likert scale, ranging from 1 (lowest) to 5 (highest). Participation was encouraged but voluntary.

Results from a two-tailed, non-parametric Mann-Whitney test are summarized in Table 7 (significant at $p = 0.05$).

Table 7: Perceived Self-Efficacy on Topics Addressed with CPR Assignments

	RHIT	LSU
Giving a presentation to a group of peers	+++	++
Giving a presentation to a group of strangers	++	++
Gathering content material for a topic	+++	++
Organizing content material in a logical sequence	+++	++
Deciding on the main messages in the talk	+++	++
Speaking clearly and audibly	+++	+++
Maintaining a pace without stumbling or using 'ums'	++	+++
Using appropriate gestures and voice inflection to keep audience attention	+++	+++
Making eye content with the audience	+++	++
Presenting without reading from notes	+++	++
Summarizing the main points	+++	+++
Keeping to a time limit	++	++
Responding to audience questions	+++	+++
Creating a slide show to accompany a presentation	+++	+++
Deciding on how much to put on each slide	+++	+
Making slides attractive but not overdone	+++	++
Generating graphs and charts from data	+++	++
Labeling graphs and charts	+++	+++
Identify weaknesses in the presentations of others	+++	++
Make suggestions to others to improve presentations skills	+++	+++
Creating and displaying a title for a poster		+++
Selecting information for the content of the poster.		+++
Dividing the content of the poster into sections.		+++
Laying out the content of a poster		+++
Highlighting major topics or points on a poster		+++
Summarizing technical information.		++
Making a poster easy to read and follow.		+++
Using different fonts and styles.		+++
Selecting images for the poster.		+++
Labeling and referencing pictures and figures.		+++
Creating graphs and figures, e.g. using Excel.		++
Providing a bibliography or references.		+++
Greeting the audience during the poster presentation session.		+++
Being able to maintain the interest of the audience.		+++
Answering questions raised by the audience.		+++

+++ Improvement, statistically significant
++ Improvement, not statistically significant
+ No improvement

Recommendations:

CPR features a searchable database of authors and assignments housed at the central CPR administrative site. All of the calibration and peer review occurs at a separate site. Therefore, faculty must keep track of two sets of user names. Version 6, which is under development, will remove this complexity and allow one set of user names. Because one has to sign into the local site and then retrieve assignments from the central assignment database, faculty using CPR for the first time can often become confused about which site contains what information, as well as which user names and passwords are appropriate. Once faculty have used the system a few times, these issues become easier to overcome.

Students experienced similar frustrations because they had to sign in initially using a student ID. After signing in with their student ID, they were given a password and user name by CPR. Though instructors regularly told them to make note of their student ID, user name, and password, students routinely confused the three, trying to sign in with the wrong user name or password. Rather than staying with the project and trying to figure things out, students would often simply e-mail the instructor in frustration, claiming that the system didn't work. This led to quite a few exchanges between instructors and students where instructors who were confused about their own user names and passwords tried to help students who were confused by user names and passwords. Because these were often conducted at varying times via e-mail, progress in solving these issues was slow. Version 6 should remove this barrier for students.

Some difficulties with using CPR 5 stemmed from the fact that previous versions dealt only with text. Initially, there was a setting which required a minimum number of words for assignments that were meant to be uploaded as single visual files. While this problem was quickly corrected by CPR's administrators, a glitch remained. On the page that prompted students to upload the files containing their visual artifacts, a button prompted them to "submit text." While rhetoricians understand that even a visual artifact is a text, students tend to think of text as strictly meaning written work. Therefore, when they saw the button saying submit text, they assumed it did not apply to them. Because they had been prompted to upload a file and CPR told them that task had been successfully accomplished, they were confused when the interface did not allow them to proceed to the calibration portion. This was easily corrected once instructors had had it happen in their classes; however, first-time instructors were often baffled because there was nothing on the screen that implied that there was a problem. The file showed itself as uploaded and nothing guided the students to hit the "submit text" button.

Other challenges with CPR were small in comparison to these. Frustrations over the number of clicks it took to find an appropriate page or confusion over how to navigate through the different pages added to the overall frustration of the instructors. Once familiar with CPR, it is not terribly difficult to use; however, the learning curve is steep, and students and faculty may take a while to warm up to using CPR 5.

Perseverance on the part of technical support and the faculty proved that classes of varying sizes can use CPR successfully and that increased familiarity with the system does ease frustrations. Despite the relatively small but vexing challenges posed by implementing CPR 5 into classes, these assignments were successfully integrated.

Conclusions:

Evaluation through peer review is traditionally used in many classes for the evaluation of text and is the standard practice for advancing knowledge in an academic discipline. This study demonstrates that CPR5 effectively extends the documented CPR process of training and peer review of concepts through writing[2-19] to concepts communicated through visual and oral mechanisms.

Acknowledgements:

This material is based upon work supported by the National Science Foundation (NSF) under grants #0817015, #0816859, #0816660. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

1. Tufte, E. R. *The Visual Display of Quantitative Information* Graphics Press Cheshire CT, 1983.

2. Balfour, S. Teaching Writing and Assessment Skills: The Intrinsic and Conditional Pedagogy of Calibrated Peer Review™. Assessment Handbook (submitted), contact balfour@tamu.edu for pre-print.

3. Berry, F.C., P.A. Carlson, and D.L. Millard. 2006. Calibrated Peer Review for ABET Assessment. *Proceedings of the National STEM Assessment Conference*, 190-193.

4. Carlson, P.A., and F.C. Berry. 2003. Calibrated Peer Review™ and Assessing Learning Outcomes. In *Proceedings of the 33rd Annual Frontiers in Education Conference*, ed. D. Budny, 2, F3E1-F3E6, Piscataway, NJ: IEEE Digital Library.

5. Carlson, P.A., and F.C. Berry. 2008. Using Computer-Mediated Peer Review in an Engineering Design Course. *IEEE Transactions of the Professional Communication Society* 51, no. 3: 264-279.

6. Enders, F. B., S. Jenkins, and V, Hoverman. 2010. Calibrated Peer Review for Interpreting Linear Regression Parameters: Results from a Graduate Course. *Journal of Statistics Education*, 18, no. 2: (2010) 1- 27.

7. Furman, B., and W. Robinson. 2003. Improving Engineering Report Writing with Calibrated Peer Review™. In *Proceedings of the 33rd Annual Frontiers in Education Conference*, ed. D. Budny, 2, F3E14-16, Piscataway, NJ: IEEE Digital Library.

8. Gerdeman, R.D., A.A. Russell, and K.J. Worden. 2007. Web-Based Student Writing and Reviewing Performance in a Large Biology Course. *Journal of College Science Teaching* 36: 46-53.

9. Hartberg, Y., A.B. Guernsel, N.J. Simpson, and V. Balaster. 2008. Development of Student Writing in Biochemistry Using Calibrated Peer Review. *Journal for the Scholarship of Teaching and Learning* 8, no. 1: 29-44, http://www.iupui.edu/~josotl/VOL_8/No_1/V8N1_TOC.htm.

10. Keeney-Kennicutt, W., A.B. Guernsel, and N. Simpson. 2008. Overcoming Student Resistance to a Teaching Innovation. *Journal for the Scholarship of Teaching and Learning* January: 1-26.

11. Likkel, L. 2012. Calibrated Peer Review™ Essays Increase Student Confidence in Assessing Their Own Writing. *Journal of College Science Teaching* (in press). 41, no. 342-47

12. McCarty, T., M.V. Parkes, T.T. Anderson, J. Mines, B.J. Skipper, and J. Grebosky. 2005. Improved Patient Notes from Medical Students during Web-Based Teaching Using Faculty-Calibrated Peer Review and Self-Assessment. *Academic Medicine* 80, no. 10 suppl.: S67-70.

13. Pelaez, N. 2002. Problem-Based Writing with Peer Review Improves Academic Performance in Physiology. *Advances in Physiology Education* 26: 174-184, http://advan.physiology.org/cgi/content/full/26/3/174.

14. Plutsky, S., and B.A. Wilson. 2004. Comparison of Three Methods for Teaching and Evaluating Writing: A Quasi-experimental Study. *Delta Pi Epsilon Journal* 46: 50-61.

15. Prichard, J.R. 2005. Writing to Learn: An Evaluation of the Calibrated Peer Review™ Program in Two Neuroscience Courses. *The Journal of Undergraduate Neuroscience Education* 4, no. 1 (Fall): A34-A39.

16. Rudd, J.A., V.Z. Wang, Cervato, C., and Ridkey, Calibrated Peer Review™ assignments for the Earth sciences. Submitted to *Journal of Geoscience Education*, MS# 08-217.

17. Russell, A.A. 2005. Calibrated Peer Review™ A writing and critical-thinking instructional tool. In Invention and Impact: Building Excellence in Undergraduate Science, Technology, Engineering and Mathematics (STEM) Education. Washington DC: American Association for the Advancement of Science, http://www.aaas.org/publications/books_reports/CCLI/.

18. Simpson, N., A.A. Russell, A.B. Gunersel, and J. Layne. 2006. Calibrated Peer Review™ in Math and Science: Research and Practice. *Proceedings of the National STEM Assessment Conference*, 266-273.

19. Walvoord, M.E., M.H. Hoefnagels, D.D. Gaffin, M.M. Chumchal, and D.A. Long. 2008. An Analysis of Calibrated Peer Review (CPR) in a Science Lecture Classroom. *Journal of College Science Teaching* 37: 66-73.

20. Alley, M., Schreiber, M., Ramsdell, K., Muffo, J., "How the Design of Headlines in Presentation Slides Affects Audience Retention," *Technical Communication*, 53(2), pp. 225-234, 2006.

21. Berry, F. C. & Carlson, P. A., "Assessing Engineering Design Experiences using Calibrated Peer Review," *International Journal of Engineering Education*, vol. 26, no. 6, pp. 1503-1507, December 2010. (4?)

22. Berry, F. C. & Carlson, P. A., "ABET Assessment Using Calibrated Peer Review," *Proceedings*, ASEE Annual Conference, 2007.

23. Carlson, P. A., "Nine Years of Calibrated Peer Review in Rhetoric and Engineering Design," *Proceedings*, ASEE Annual Conference, 2011.

24. Carlson, P. A., Hull, W., Raubenheimer, D., & Russell, A., "Engineering Education: Oral and Visual Communication Using Enhanced Calibrated Peer Review," *Proceedings*, ASEE Annual Conference, 2009.

25. Carlson, P. A. & Berry, F.C., "Using Writing Assess Learning in Engineering Design: Quantitative Approaches," *Proceedings*, ASEE Annual Conference, 2008.

26. Carlson, P. A. & Berry, F. C., "Using Computer-Mediated Peer Review in an Engineering Design Course," *IEEE Transactions on Professional Communication*, vol. 51, no. 3, pp. 264-279., September 2008.

27. Carlson, P. A. & Berry, F. C., "A Web-based Tool for Implementing Peer Review," *Proceedings*, ASEE Annual Conference, 2007.

28. Carlson, P. A. & Berry, F. C., "Calibrated Peer Review: A Tool for Assessing the Process as Well as the Product in Learning Outcomes," *Proceedings*, ASEE Annual Conference, 2005.

29. Carlson, P. A., Berry, F. C., & Voltmer, D., "Incorporating Student Peer-Review into an Introduction to Engineering Design Course," *Proceedings*, ASEE/IEEE Frontiers in Education Conference, 2005.

30. Carlson, P. A., Berry, F. C., & Voltmer, D., "Using Calibrated Peer Review to Mediate Writing and the Assess Instructional Outcomes," *Proceedings*, ASEE Annual Conference, 2003.

31. Garner, J.K., Alley, M., Gaudelli, Al. F., & Zappe, S. E., "Common Use of PowerPoint versus the Assertion-Evidence Structure: A Cognitive Psychology Perspective," *Technical Communication*, 56 (4), pp. 331-345, 2009.

32. Halloun, I. & Hestenes, D., "Interpreting VASS Dimensions and Profiles for Physics Students," *Science Education*, 7(6), pp. 553-577, 1998.