Improving Student Technical Communication via Self Reflection

Mr. Kenneth P Mineart, North Carolina State University

Kenneth Mineart received his Bachelor's degree in Chemical & Biochemical Engineering from the University of Iowa. Currently, he is a doctoral student in Chemical & Biomolecular Engineering at North Carolina State University where he works in the field of block copolymer science with Professor Richard Spontak. Kenneth has regularly served as a graduate teaching assistant for a variety of courses including: Unit Operations Laboratory, Material and Energy Balances, Introduction to Polymer Science, and Chemical Engineering Analysis. He has completed the Certificate of Accomplishment in Teaching (CoAT) and Preparing the Professoriate (PTP) programs offered by the North Carolina State University Graduate School. Kenneth's educational research interest focuses on increasing the efficacy of student communication in the engineering classroom through both writing and speaking.

Dr. Matthew Cooper, North Carolina State University

Dr. Matthew Cooper is a Teaching Assistant Professor in the Department of Chemical and Biomolecular Engineering at North Carolina State University where he teaches Material and Energy Balances, Unit Operations, Transport Phenomena and Mathematical / Computational Methods. He is the recipient of the 2014 NCSU Outstanding Teacher Award, 2014 ASEE Southeastern Section Outstanding New Teacher Award, and currently serves as the ASEE Chemical Engineering Division's newsletter editor. Dr. Cooper's research interests include effective teaching, conceptual and inductive learning, integrating writing and speaking into the curriculum and professional ethics.

Improving Technical Communication in the Chemical Engineering Classroom via Student-Based Feedback

Abstract

One area of major importance for engineering graduates entering the workforce is the ability to successfully communicate with coworkers. Formal communication in the engineering workplace relies heavily on presentation skill to provide colleagues with updates and recommendations. Therefore, students are expected to learn how to give effective presentations by the time they graduate. However, communication is a weakness across many engineering curricula due to limited opportunities and minimal constructive criticism. Instructors managing classroom presentations are immersed in many tasks, which partially explains both causes, so increasing the quantity of feedback through other channels provides a potential route for maximizing student benefit from oral presentation experiences.

The presented work examines student-based evaluation and reflection as a route to increasing constructive feedback. Students' firsthand discovery of presentation weaknesses and negative speaking habits increases their awareness of such behavior in subsequent experiences. The potential impact of this study is twofold. First, it provides students with a platform to analyze their own communication skill, take ownership of their findings, and make improvements they themselves discover. Second, it seeks to minimize extraneous work for the instructor.

The study investigates the efficacy of student-based evaluations. Student presentations are recorded, including the post-presentation question and answer session, and made available to presenters. Students are required to critique themselves and their group members based on the recorded videos. The role of the instructor consists only of preparing videos for student viewing, monitoring student participation, and screening feedback to eliminate unconstructive or rude comments. Two presentation repetitions in the selected class provide students with an immediate opportunity to improve on their findings. The effectiveness of student-based evaluations is assessed using: (i) comparisons of student comments on the first and second presentations, (ii) qualitative student feedback via course evaluation forms, and (iii) quantitative changes in student presentation grades. The time required for implementation of these exercises is presented to address the concern of added instructor workload.

The percentage of students submitting feedback suggests that students are more willing to self-reflect on presentations (83%) than to provide feedback to group members (68%). Student comments most commonly focused on the speaker's volume, tone, filler words, and hand gestures regardless of whether they were self-reflecting or group member critiquing. A comparison of grades across the semester cannot yet be conducted since the semester is currently ongoing at the time of this submission. As for the instructor's responsibility, the implementation of the student-based feedback activity adds an average of only 8.5 minutes per group to the instructor's duties. Ultimately, it is anticipated that students participating in these activities will be able to effectively present technical content to a technically-versed audience and gain a toolbox to self-evaluate themselves in future presentations without a significant increase in time commitment by the instructor.

1. Introduction

The ability of students to communicate effectively is important for both their employability[1] and sustained career success[2]. In fact, a study conducted by Cole and Tapper[3] identified oral communication as the third highest trait necessary (behind problem solving and teamwork) by recent Northeastern University Engineering graduates for their jobs. All of this considered, engineering curricula across the country continue to struggle to design effective oral communication exercises for their students. Solely providing the opportunity for students to practice their communication skill is invaluable, but the majority of student growth relies on constructive feedback. This feedback is typically provided by an instructor based on a student's performance in a technical oral presentation assignment.

The role of an instructor during student presentations is exhaustive (monitoring technical content, designing and asking quality questions, etc.), and leaves little time to include extensive feedback on student oral communication. The absence of video recordings further magnifies the instructor's struggle since presentations must be evaluated entirely on first assessment. The weight of these tasks leads many engineering instructors to de-emphasize oral communication efficacy, leaving students at a disadvantage when required to give high-quality formal presentations later in their career.

The authors feel that one possibility capable of making a major impact on developing constructive feedback is recording and subsequent review of oral presentations. Current technology enables presentations to be recorded, edited, and uploaded online with minimal effort required from the instructor. A similar practice has been shown to reduce the time commitment required for pre-laboratory overview lessons.[4] While preparing videos involves little extraneous effort, the instructor still sacrifices his or her time to review presentation videos through multiple iterations. Obviously, increasing the time necessary to critique presentations reduces the potential of video recording as a route to improve student oral communication.

Student-based feedback, on the other hand, provides a path that may alleviate the time related drawbacks of video recording and reviewing presentations. The instructor can request students to reflect on their own performance as well as supply feedback to one another. Under this system, students not only gain perspective through constructive criticism, but also grow from monitoring other students' positive and negative presentation tendencies. Significant student advancement can also be achieved through self-reflection.[5] Specifically, it has been suggested that student self-reflection may aid in carry-over of course material to outside of the classroom[6] and result in students taking responsibility of their own learning[7].

The presented study analyzes student-based feedback methods (discussed more below) that will be utilized in the Spring 2015 semester, and therefore some data is not available for the April 2015 submission deadline. All data will be prepared for the 2015 ASEE Annual Conference.

2. Methods

2.1. Video Collection and Critiques

The recording and editing of videos and subsequent critiquing were conducted in a junior-level, chemical engineering unit operations laboratory course (100 students). In addition, the authors' department as a whole prides itself on producing engineers with high quality communication skills. Students give approximately 10 major oral presentations during their B.S. studies, and the unit operations course that is the focus of this study provides the bulk of formal instruction and practice. The course includes two group oral presentations and one poster presentation each covering the details and analysis related to an assigned experiment. This study investigates the value of directed reflections by students on their own performance as well as the performances of their group members. Students have immediate opportunities to apply what they learn during their self- and group-reflections in later presentations, and this effect will be quantified as part of the study.

Presentations are critiqued for communication aspects in two forms, both of which are student-based. The two types of feedback include student self-reflection and group member critiques each during a subsequent viewing of provided videos. Constructive student responses are incentivized by including participation as a small portion of each presentation grade (~5%). Student feedback is screened and comments that are rude or vapid receive a reduced participation grade. Presentations are recorded for student review using a standard video camera. Windows Movie Maker (Figure 1) is used to edit presentation videos, though other affordable programs are available for similar basic video editing (trimming, etc.).[8]

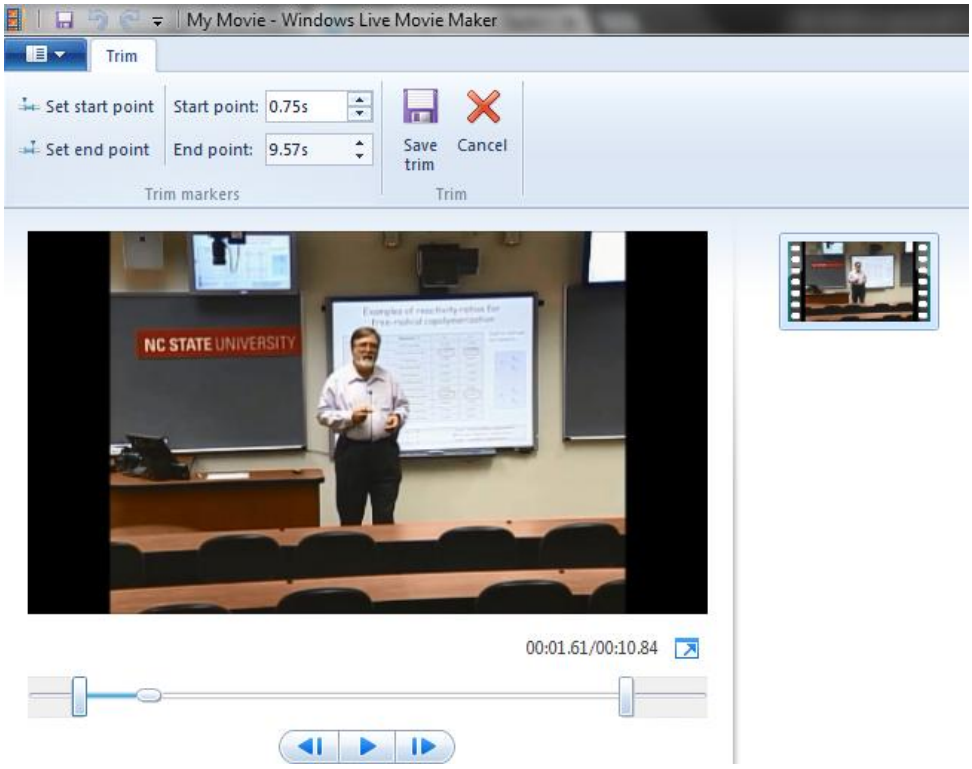

Figure 1. A screenshot of Windows Movie Maker emphasizing the relatively little amount of effort required to trim videos to acceptable lengths for dissemination to students.

Video of student presentations are disseminated using the online video webpage, YouTube. The free use of YouTube requires that videos be 15 minutes or less. Therefore, videos are trimmed to <15 minute clips using Windows Movie Maker as mentioned above. The videos are then uploaded to the instructor's YouTube channel (available through any Gmail account) with the privacy settings set to "Private" so that only student presenters can view the videos. The videos are shared with students by inputting their email addresses into the editing options within the YouTube infrastructure.

Google Forms (a free, online resource also available to any Gmail account) is utilized to efficiently collect, collate, and disseminate student feedback anonymously while also allowing the instructor to monitor student participation (Figure 2). On this basis, the instructors ask for names during online submissions, but they are not included with distribution of student feedback. It is made clear to students that their names are strictly for participation tracking purposes and will not be included with their feedback comments to group members.

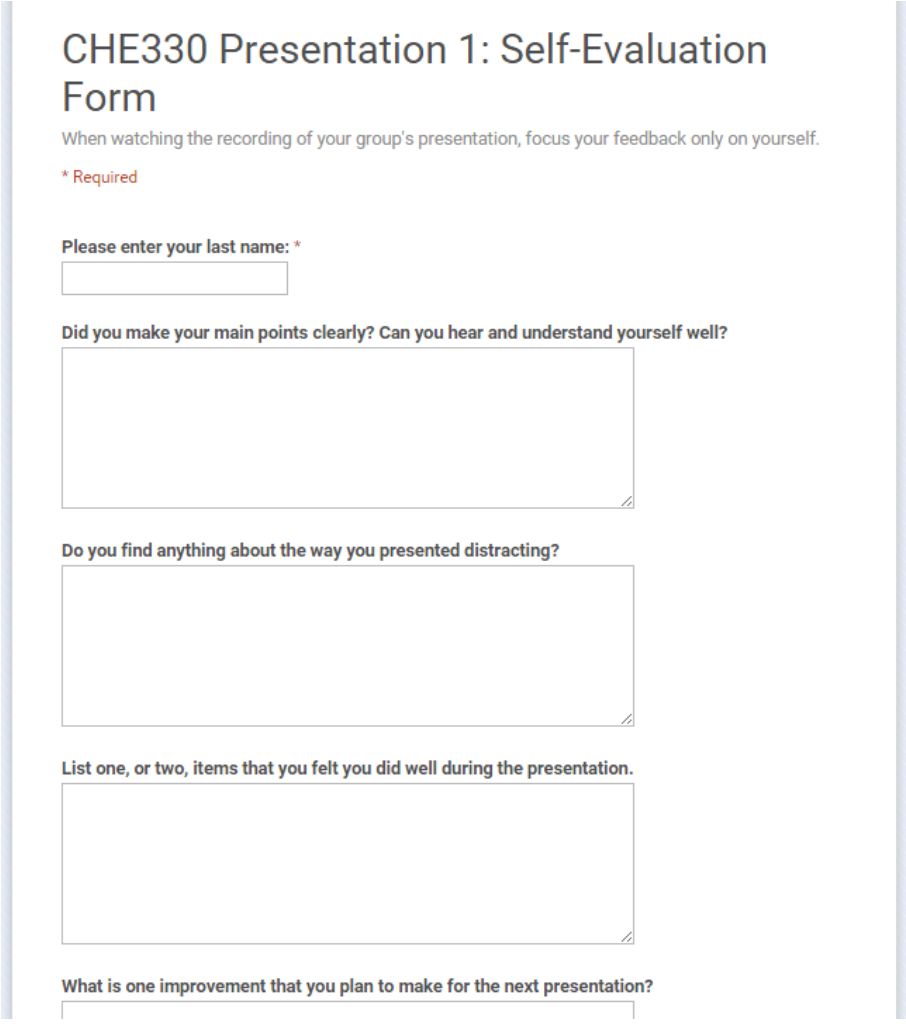

Figure 2. An example of Google Forms used for students to enter their comments from self-reflecting on their presentation.

The instructors provide prompts on the Google Forms survey to direct student comments. It is emphasized that students should consider the presentation grading rubric (Figures A1-A3 in Appendix A) when responding to these prompts. For the first presentation, the instructors ask students to watch their performance and focus on their personal presentation efficacy. They are asked to upload their comments to a Google Form solely to provide confirmation that they participated. Questions to guide self-reflection include:

- Did you make your main points clearly? Can you hear and understand yourself well?
- Do you find anything about the way you presented distracting?
- List one, or two, items that you felt you did well during the presentation?
- What is one improvement that you plan to make for the next presentation?

Following the second presentation, group members are asked to individually watch the video of their group's performance and provide comments pertaining to how effectively they thought the other individuals in their group communicated. They are asked to not focus on themselves so that emphasis is placed on other group members. The Google Forms survey for intra-group critiques requests group number along with critique questions to reduce organizational time required for sorting comments to the correct groups. Guiding questions for the intra-group critique include:

- What are each speaker's main points? Could you understand each speaker (volume/clarity)?
- Do any presenters have distracting body language or speaking habits (filler words: 'uh', 'um'; awkward pauses; monotone voice; etc.)? Or does their body language and speaking style add positively to the presentation? How?
- Do the visual aids match each presenter's discussion? Are there distracting animations? Can you read the text on all of their slides and figures?
- What is the principal recommendation you would make to the group for their next presentation?

Students are provided one week from the time that presentation videos are disseminated to submit their critiques. In the case of the group feedback, their comments are organized and sent to their group members once the deadline has passed.

2.2. Evaluation of the Student-Based Critique System

In order to evaluate the efficacy of the student-based critiquing method described above, three measures will be used. First, a comparison between student comments on their first presentation and group member feedback on the second presentation will be made. The results will indicate whether students worked to address the issues that they noted themselves during self-reflection. Second, qualitative student opinions of the critiquing method will be probed using the following questions on an end of the course evaluation form:

- This semester videos of your presentations were made available to each student group, and you were asked to provide feedback on your individual performance as well as your teammates' performance. Do you feel this experience helped you improve your presentation skills?

- Is it worth it for [the instructor] to continue recording student group presentations and providing videos to groups for their evaluation in the future?
- Which presentation feedback method did you find most helpful – evaluation of your own presentation/Q&A performance or receiving feedback on your presentation/Q&A performance from your teammates?

Third, student presentation grades through the semester (as assigned by the instructor) will provide a quantitative measure of oral communication improvement. It should be highlighted that a minor percentage of the presentation grade is directly impacted by communication efficacy, but technical aspects of the grade are indirectly affected. More importantly, the quantitative measurement of student grade improvement over the period of a semester enables comparisons to be drawn with semesters in which a student-based critiquing method was not used. It is important to reiterate that the third presentation of the semester consists of presenting a poster. This grade will be considered in the analysis, though no critique will take place during the poster presentation, which should not affect the study since it is the last presentation of the course.

Finally, the amount of time required by the instructors to record, trim, and upload videos as well as parse through student comments to gauge participation and disseminate intra-group critiques will be tracked. This information will be used to provide an indication of the added time commitment to incorporate this method into a pre-existing presentation assignment.

3. Results

An examination of the quantity of constructive student feedback provides a metric to gauge student willingness to participate in the student-based feedback activity. On the self-reflection critique, 83% of students provided insightful/constructive feedback, 3% provided vapid suggestions, and 14% failed to submit any comments. The response on the group member evaluation exercises resulted in less participation: 68% insightful/constructive feedback, 8% vapid feedback, and 24% no submitted critique. In both cases, there were no rude/inappropriate comments made by students. There are two possible explanations for the decreased student participation on the group critique. First, students may have been overwhelmed with other coursework since the second critique occurred later in the semester. Second, students were more concerned with their own presentation self-reflection and less concerned with helping their group members improve their oral communication skill.

The students that choose to participate, in general, provided concrete suggestions for either themselves or group members to improve on future presentations. For example, one student wrote on the self-reflection critique, “I plan to continue to improve by trying to take longer pauses and add more variation to my voice.” This student was able to identify that she may be able to hold the audience’s attention better by breaking up her speaking patterns. Other students came to the realization during self-reflection that if they “speak slower and louder” their presentation efficacy could increase. On group critiques, students were able to provide an outside perspective to their group members’ presentation styles. One of the most frequently noted pieces of feedback was along the lines of: “She could be more confident next time and more sure of her answers because in group discussion she is very smart and always knows what she is talking

about." However, some student feedback was not constructive and did not appear to have future benefit, such as this students comment: "My primary recommendation is to keep doing what we are doing." It is inevitable that a fraction of students in any classroom will have little motivation to participate in this type of activity, and sadly, they will miss out on its potential benefits.

Qualitative student opinions on the presented method and tracking of student grades through the entire semester have not been completed at this point. However, this information will be available for the 2015 ASEE Annual Meeting. Since a grade comparison will be drawn to previous semesters that did not utilize the described feedback mechanisms, data of control semesters (those without the method applied) can be presented (Figure 3).

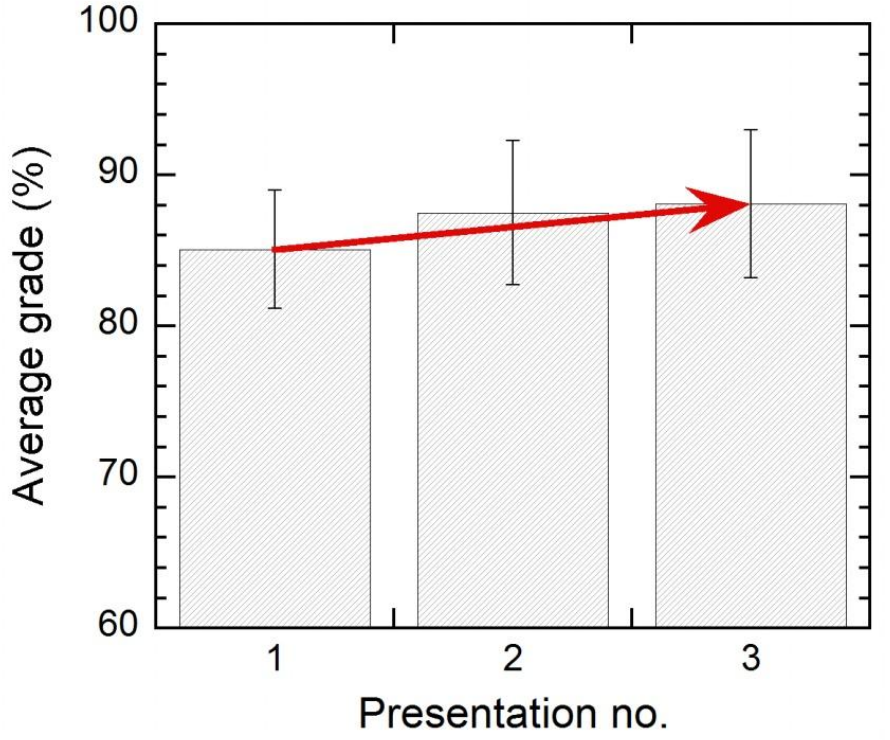

Figure 3. An indication of student presentation grade increase with subsequent presentation number for 60 students in the Fall 2014 junior-level chemical engineering unit operations laboratory course.

This data indicates that student presentation grades increase through the semester even without the implementation of student-based feedback. This is likely due to students learning due to existing instructor feedback mechanisms. Student grades may also show improvement stemming from observing other groups present the experiments they will conduct in the future.

At this point in the Spring 2015 semester, one full cycle of presentation recording, editing, and dissemination, as well as student comment review has been completed. Therefore, the time committed to these exercises for the first rotation can be provided (Figure 4).

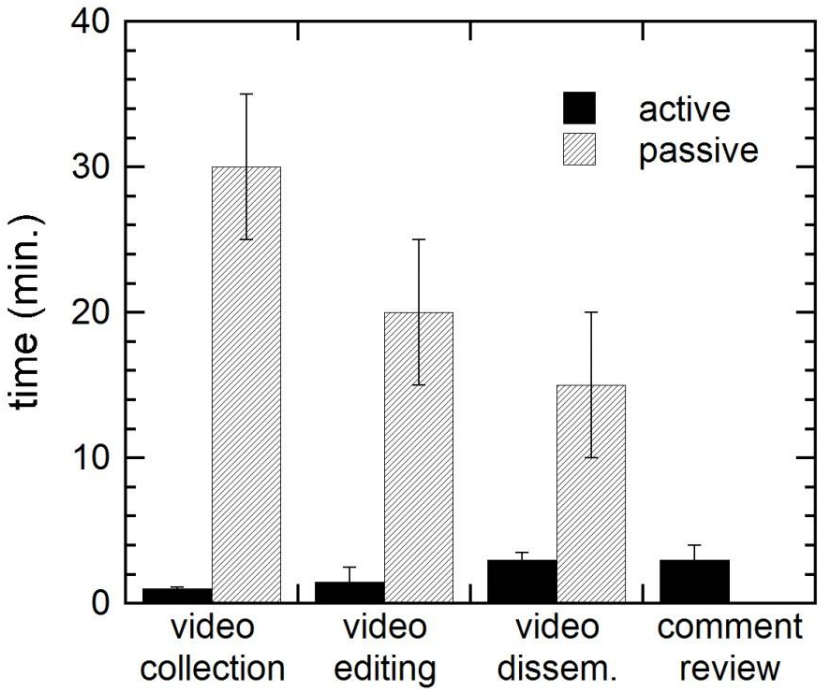

Figure 4. Instructor time commitment for each task of student-based critique system. Time requirements for each task are an average per student group. Active time refers to time the instructor was required to commit full focus, whereas passive time refers to tasks in which the instructor can accomplish other tasks simultaneously.

As can be noted, the majority of time required for the instructor to implement the presented technique is passive. These passive time commitments include transferring videos from the recorder to a computer, saving edited videos, and uploading videos to YouTube. In the authors' experience, these tasks could all be completed while using other functions on the same computer or while performing other tasks entirely. The accumulated active time spent on the first presentation rotation was 8.5 ± 2.5 minutes per student group. The total time it would have taken just to rewatch student presentation videos for communication-focused feedback would be equal to 30 ± 5 minutes per student group, a ~250% increase from the student-based feedback route presented. In other words, the implementation of the presented activity into a pre-existing presentation assignment (i.e. live presentation feedback only) adds approximately 8.5 minutes per student group to the instructor's workload. Conversely, an instructor trying to emulate the presented activity entirely on their own can expect to spend more than 30 minutes per student group on providing feedback.

4. Conclusions

A method comprised of two levels of student-based critique is proposed to increase the oral communication efficacy of chemical engineering undergraduate students. The method relies on the use of recording student presentations to enable students to review their own presentations. With the time constraints of the instructor in mind, individual critiques are conducted via self-reflection and intra-group critiques both using video recording. The efficacy of such oral communication feedback mechanisms will be evaluated based on changes in student-specific

feedback through two iterations, qualitative student opinions of the method, and quantitative student grade improvement during the course of a semester. In addition, the instructor's added time commitment is reported to support the relatively low effort need to implement this method.

The data collection thus far shows that the majority of students in a junior-level course are willing and able to provide both themselves and group members with constructive oral communication feedback. Their comments focus on a variety of practices that each presenter can implement to increase their presentation efficacy. End of the semester student comments and a semester long grade comparison cannot yet be made. However, past semester presentation grades indicate that some increase is expected even without the use of the presented method. It is concluded that this increase is likely related to students developing a better understanding of what is expected from them in their presentations. Finally, it has been shown that implementation of this method only adds 8.5 minutes per group to the instructors workload. The authors feel that the burden of this small time requirement is far exceed by the potential for students to learn and grow as quality presenters for their future careers.

Bibliographic Information

1) A. L. Darling and D. P. Dannels. "Practicing Engineers Talk about the Importance of Talk: A Report on the Role of Oral Communication in the Workplace." *Communication Education* **52** (1), 1–16 (2003).
2) M. Miceli. "Say What?: The Importance of Effective Communication in Engineering." *JOM* **63** (12), 25 (2011).
3) J. Tapper and W. E. Cole. "EET Graduate Survey Results," *Proc. 1998 ASEE Annual Conf.* (1998).
4) M. Cooper. "The Paperless Lab – Streamlining a Modern Unit Operations Laboratory Course to Reduce Faculty Time Commitment." *Proc. 2014 ASEE Annual Conf.* (2014).
5) C. A. Reitmeier and D. A. Vrchota. "Self-Assessment of Oral Communication Presentations in Food Science and Nutrition." *J. Food Sci. Ed.* **8** (4), 88–92 (2009).
6) M. Mentkowski. *Learning That Lasts : Integrating Learning, Development, and Performance in College and beyond*. 1st ed. San Francisco: Jossey-Bass (2000) p 388.
7) J. Bransford and National Research Council. *How People Learn : Brain, Mind, Experience, and School*. Washington, D.C.: National Academy Press, (2000) p 374.
8) Tech Radar. "Best free video editing software: 9 top programs you should download", August 27, 2013. http://www.techradar.com/news/software/applications/best-free-video-editing-software-9-top-programs-you-should-download-1136264.

Appendix A: Grading Rubrics

CHE 330 / 331 Oral Presentation Grade Sheet					Member 1			Member 2			Member 3		
Experiment:													
Date:													
Presentation	**1 (Poor)**	**2 (Satisfactory)**	**3 (Excellent)**	**Weight**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Technical Accuracy / Depth	Many technical errors / Lack of conceptual depth	Some technical errors / misconceptions	No technical errors / good conceptual depth	4									
Delivery	Inaudible and/or poor pace	Acceptable clarity, interest, pace, eye contact	Very clear, dynamic, good pace	4									
Professionalism	Lacking in more than one of dress / language /style	Lacking professionalism in one of dress /style	Presenter professional in dress, language and style	4									
Feedback / Participation	No / vapid / rude feedback	Less-than-constructive feedback	Thoughtful, constructive feedback	3									
Poor Habits	More than 5 "uhs"; multiple distracting habits or hestiations	Less than than 5 "uhs." Very few distracting habits.	No hesitations or "uhs." No distracting habits	4									
Question	No / duplicate / unprofessional question (-3)	Satisfactory question (-0)		--									
			Total (60 maximum):										
Comments:													

Figure A1. Individual student grading rubric (Oral Presenter).

CHE 330 / 331 Oral Q&A Grade Sheet					Member 4			Member 5			Member 6		
Experiment:													
Date:													
Q&A	**1 (Poor)**	**2 (Satisfactory)**	**3 (Excellent)**	**Weight**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Readiness to Answer Questions	Does not voluntarily participate in Q&A session	Provides few answers or dominates Q&A session at expense of others	Readily answers questions while allowing others to participate	7									
Technical Accuracy / Clarity of Response	Multiple mistakes / rambling or off-topic responses	Minor errors or clarity issues	No techncial errors and clear responses	3									
Feedback / Participation	No / vapid / rude feedback	Less-than-constructive feedback	Thoughtful, constructive feedback	4									
Sufficiency	No depth of explanation in answers	Moderate depth in explanation, but missing key points	Explanation shows depth of understanding	3									
Brevity	Very long answers or short answers lacking explanation	Responses moderately too short or long	Appropriate brevity	3									
Question	No / duplicate / unprofessional question (-3)	Satisfactory question (-0)		--									
			Total (60 maximum):										
Comments:													

Figure A2. Individual student grading rubric (Question Answerer).

CHE 330 / 331 Oral Presentation Grade Sheet - Presentation Slides					
Experiment:			**Date:**		**Group:**
Group	**1 (Poor)**	**2 (Satisfactory)**	**3 (Excellent)**	**Weight**	
Technical Accuracy (Slides)	Numerous serious errors / omissions	A few minor errors / omissions	Very few or no errors / omissions	5	
Technical Depth	Much missing discussion	Modest room for more technical depth	Thorough technical depth	3	
Error Analysis	No error analysis presented	Uncertainties missing from some values	Uncertainty explicitly presented	3	
Clarity	Unclear message	Minor clarity issues	Easy-to-understand presentation	5	
Visual aids / graphics	Poor or no graphics	Graphics that moderately support presentation	Attractive graphics that support slides	3	
Presentation Aesthetic	Difficult to read, distracting color scheme	Fonts, margins, etc. are not consistent (and other small distractions)	Pleasing colors, consistent fonts, legible	3	
Timing	Longer than 20 minutes	Presentation too short	Completed within 20 minutes but not exceptionally short	2	
Question Handling	One person dominates Q&A session	One or two Q&A people answered most questions	All Q&A people readily participated	1	
Hard copy	No hard copy provided	Hard copy doesn't match presentation	Hard copy provided	2	
Citations	Mulitple missing citations	One missing citation	All citations present	3	
			Total (90 maximum):		

Figure A3. Group presentation grading rubric.